MATCH LINE - SEE SHEET L-2

811 Know what's below Call before you dig
MISS DIG System, Inc. www.missdig.net

TREE PROTECTION NOTE

No person may conduct any construction or development activity within the drip line of any regulated tree not approved for removal, including but not limited to land clearing, grubbing, trenching, grading, or filling, nor shall any person place solvents, building material, construction equipment, soil deposits, or other harmful materials within the drip line unless authorized by the parks and natural resources department.

During construction or development activity, persons shall not attach any device or wire to any regulated tree not approved for removal.

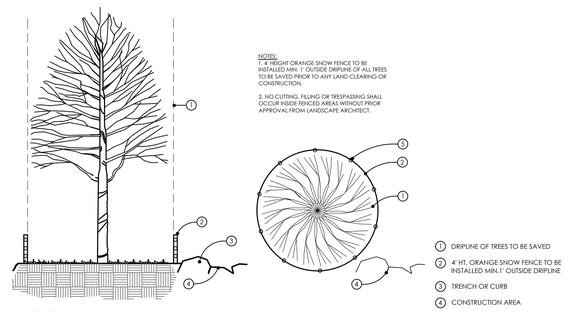
Replacement and relocated trees must be staked, fertilized, and mulched and shall be guaranteed by the tree removal permit holder to exhibit a normal growth cycle for at least one year following planting

Any plant material that is designated to be maintained that dies or is damaged during or as a result of construction shall be replaced in kind with like species and sizes.

Tree Mitigation Calculations

Regulated Trees Surveyed	432
Tree Exemptions	78 (building envelop (37), poor / dead (41))
Remaining Regulated Trees	354 (432-78)
Trees Required to be Saved	141 (354 x 40%)
Regulated Trees Saved	145
Percentage of Trees Saved	40.9% (145/354)
Regulated Trees Removed	246
Regulated Trees Required	246 (391-145)
Specimen Trees Removed	33 (1,197")
Specimen Trees Saved	52
Specimen Trees Credits	52 (1 - 2" tree credit per saved tree)
Specimen Trees Required	248 ((1,197" * 50% = 599" / 2 = 299 2" trees - 52 credits)
Regulated Replacements Required	246
Regulated Replacements Provided	**129**
Specimen Replacements Required	495"
Specimen Replacements Provided	**318"** (106 @ 3" - (89) 3" Deciduous, (17) 12' Evergreen)
Trees Paid into City Tree Fund	206

*SEE SHEET L-3 FOR TREE LIST



TREE PROTECTION
NOT TO SCALE

NOT FOR CONSTRUCTION

0 15 30 60
SCALE: 1" = 30'-0"
NORTH
CITY FILE #22-037 SECTION #32

VVLA vert verde landscape architecture
734.249.3568 Plymouth, MI
james@vertverde.com

Issued For:

11.15.2022	Site Plan Review
04.25.2023	Revision per City Comments
08.22.2023	Revision per City Comments
01.10.2024	Revisions
01.18.2024	Revisions
03.12.2024	Revisions
05.22.2024	Revisions
07.11.2025	Revision

Project:

AUBURN ANGARA OAKS

West Auburn Road
Rochester Hills, Michigan

Project Sponsor:

Three Oaks Communities, LLC
P.O. Box 8307
Ann Arbor, MI 48107

Sheet Name:

Tree Removal and Preservation Plan North

Seal:

STATE OF MICHIGAN
JAMES GRAY
LANDSCAPE ARCHITECT
No. 1528
REGISTERED LANDSCAPE ARCHITECT

Drawn:	JG
Checked:	JG
Date:	10.2022
Scale:	1" = 30'-0"

Project Number: 22.025

Sheet Number: L-1

MATCH LINE - SEE SHEET L-1

TREE TO BE SAVED, TYP.

TREE PROTECTION FENCING, TYP.

25' NATURAL FEATURE SETBACK

EXISTING WETLAND
SEE CIVIL FOR IMPACTS

ANGARA DRIVE
(Private)

UNIT 53

UNIT 54

UNIT 55

UNIT 56

UNIT 57

UNIT 58

3172 DEVONDALE RD
#15-32-201-016

3200 DEVONDALE RD
#15-32-201-031

25' NATURAL FEATURE SETBACK

DETENTION BASIN
See Sheet L-5

TREE TO BE REMOVED, TYP.

TREE PROTECTION FENCING, TYP.

TREE TO BE SAVED, TYP.

EXISTING WETLAND
SEE CIVIL FOR IMPACTS

25' NATURAL FEATURE SETBACK AT FENCE LINE

25' NATURAL FEATURE SETBACK

PVT. ESMT. FOR STORM WATER SEDIMENTATION & DETENTION

#15-32-201-007

TREE PROTECTION FENCING

TREE TO BE REMOVED, TYP.

14" CEDAR

14" CEDAR

16"

NOT FOR CONSTRUCTION

0 15 30 60

SCALE: 1" = 30'-0"

NORTH

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CITY FILE #22-037 SECTION #32

VVLA vert verde landscape architecture
734.249.3568 Plymouth, MI
james@vertverde.com

Issued For:

11.15.2022	Site Plan Review
04.25.2023	Revision per City Comments
08.22.2023	Revision per City Comments
01.10.2024	Revisions
01.18.2024	Revisions
03.12.2024	Revisions
05.22.2024	Revisions
07.11.2025	Revision

Project:

AUBURN ANGARA OAKS

West Auburn Road
Rochester Hills, Michigan

Project Sponsor:

Three Oaks Communities, LLC
P.O. Box 8307
Ann Arbor, MI 48107

Sheet Name:

Tree Removal and Preservation Plan South

Seal:

STATE OF MICHIGAN
JAMES GRAY
LANDSCAPE ARCHITECT
No. 1528
REGISTERED LANDSCAPE ARCHITECT

Drawn:	JG
Checked:	JG
Date:	10.2022
Scale:	1" = 30'-0"

Project Number:
22.025

Sheet Number:
L-2

Tag No.	DBH (in.)	Common Name	Botanical Name	Condition	Specimen	Remove	Exempt
617	8	Norway Maple	*Acer platanoides*	Good		X	
618	11	Norway Maple	*Acer platanoides*	Good		X	
619	10	Norway Maple	*Acer platanoides*	Good		X	
620	15	Norway Maple	*Acer platanoides*	Good		X	
621	7	Norway Maple	*Acer platanoides*	Good		X	
622	10	Boxelder	*Acer negundo*	Poor		X	X
623	26	Boxelder	*Acer negundo*	Poor	X	X	X
624	18	Norway Maple	*Acer platanoides*	Good		X	
625	74	Silver Maple	*Acer saccharinum*	Poor	X	X	X
626	56	Silver Maple	*Acer saccharinum*	Fair	X		
627	21	Norway Maple	*Acer platanoides*	Good		X	
628	88	Elm	*Ulmus americana*	Fair	X	X	X
629	82	Silver Maple	*Acer saccharinum*	Fair	X	X	
630	66	Silver Maple	*Acer saccharinum*	Good	X	X	
631	48	Elm	*Ulmus americana*	Poor	X	X	X
632	68	Silver Maple	*Acer saccharinum*	Good	X	X	
633	DEAD					X	X
634	54	Silver Maple	*Acer saccharinum*	Good	X	X	
635	42	Silver Maple	*Acer saccharinum*	Good	X	X	
636	12	Elm	*Ulmus americana*	Poor		X	
637	12	Norway Maple	*Acer platanoides*	Good			
638	84	Silver Maple	*Acer saccharinum*	Fair	X		
639	60	Silver Maple	*Acer saccharinum*	Good	X	X	
640	108	Silver Maple	*Acer saccharinum*	Good	X	X	
641	10	Blue Spruce	*Picea pungens*	Good		X	
642	8	Blue Spruce	*Picea pungens*	Fair		X	
643	15	Scotch Pine	*Pinus sylvestris*	Good		X	
644	7	Scotch Pine	*Pinus sylvestris*	Good		X	
645	12	Red Oak	*Quercus rubra*	Good		X	
646	38	Elm	*Ulmus americana*	Poor	X	X	
647	9,9,10,10	Apple	*Malus ssp.*	Good		X	
648	30	Silver Maple	*Acer saccharinum*	Poor	X	X	X
649	6	Silver Maple	*Acer saccharinum*	Good		X	
650	16	Silver Maple	*Acer saccharinum*	Good		X	
651	7,6	Silver Maple	*Acer saccharinum*	Good		X	
652	6,12,12	Silver Maple	*Acer saccharinum*	Good		X	
653	7	Silver Maple	*Acer saccharinum*	Poor		X	X
654	9	Elm	*Ulmus americana*	Good		X	
655	9	Elm	*Ulmus americana*	Poor		X	X
656	22,15,15,20	Silver Maple	*Acer saccharinum*	Poor	X	X	X
657	23,18	Silver Maple	*Acer saccharinum*	Good	X	X	
658	12,26,29	Silver Maple	*Acer saccharinum*	Good	X	X	
659	18	Norway Maple	*Acer platanoides*	Good		X	
660	8	Black Cherry	*Prunus serotina*	Good		X	
661	12	Black Cherry	*Prunus serotina*	Poor		X	X
662	8	Black Cherry	*Prunus serotina*	Good		X	
663	8	Boxelder	*Acer negundo*	Poor		X	X
664	10	Norway Maple	*Acer platanoides*	Good		X	
665	48	Cottonwood	*Populus deltoides*	Good	X	X	
666	42	Cottonwood	*Populus deltoides*	Good	X	X	
667	80	Cottonwood	*Populus deltoides*	Good	X	X	
668	18	Black Cherry	*Prunus serotina*	Poor	X	X	X
669	58	Black Cherry	*Prunus serotina*	Good	X	X	
670	6	Black Cherry	*Prunus serotina*	Good		X	
671	10	Norway Maple	*Acer platanoides*	Good		X	
672	28	Black Cherry	*Prunus serotina*	Good	X		
673	34	Black Cherry	*Prunus serotina*	Good	X		
674	7	Elm	*Ulmus americana*	Good			
675	24	Black Cherry	*Prunus serotina*	Good	X		
676	20	Black Cherry	*Prunus serotina*	Good	X		
677	16,31	Silver Maple	*Acer saccharinum*	Good	X		
678	24	Black Cherry	*Prunus serotina*	Good	X		
679	24	Sassafras	*Sassafras albidum*	Good	X		
680	28	Elm	*Ulmus americana*	Good	X		
681	42	Silver Maple	*Acer saccharinum*	Good	X		
682	7	Elm	*Ulmus americana*	Good			
683	70	Cottonwood	*Populus deltoides*	Good	X		
684	40	Cottonwood	*Populus deltoides*	Good	X		
685	12	Silver Maple	*Acer saccharinum*	Good			
686	14	Silver Maple	*Acer saccharinum*	Good			
687	15	Silver Maple	*Acer saccharinum*	Good			
688	30	Silver Maple	*Acer saccharinum*	Good	X		
689	11	Silver Maple	*Acer saccharinum*	Good			
690	11	Silver Maple	*Acer saccharinum*	Good			
691	40	Silver Maple	*Acer saccharinum*	Good	X		
692	44	Silver Maple	*Acer saccharinum*	Good	X		
693	16	Silver Maple	*Acer saccharinum*	Good			
694	9	Silver Maple	*Acer saccharinum*	Good			
695	6	Elm	*Ulmus americana*	Poor			
696	11	Elm	*Ulmus americana*	Good			
697	24,14,23	Silver Maple	*Acer saccharinum*	Good	X		
698	22	Silver Maple	*Acer saccharinum*	Good			
699	19	Silver Maple	*Acer saccharinum*	Good			
700	48	Silver Maple	*Acer saccharinum*	Good	X		
701	8	Red Maple	*Acer rubrum*	Good			
702	18	Silver Maple	*Acer saccharinum*	Good			
703	11	Red Maple	*Acer rubrum*	Good		X	
704	17	Red Maple	*Acer rubrum*	Good		X	
705	9	Black Cherry	*Prunus serotina*	Good		X	
706	11	Silver Maple	*Acer saccharinum*	Good		X	
707	8	Elm	*Ulmus americana*	Poor		X	X
708	9	Red Maple	*Acer rubrum*	Good		X	
709	38	Black Cherry	*Prunus serotina*	Good	X	X	
710	12	Silver Maple	*Acer saccharinum*	Good		X	
711	10	Red Maple	*Acer rubrum*	Good		X	
712	21	Red Maple	*Acer rubrum*	Good		X	
713	12	Red Maple	*Acer rubrum*	Good			
714	14,42,15	Silver Maple	*Acer saccharinum*	Good	X		
715	6	Boxelder	*Acer negundo*	Good		X	
716	11	Black Cherry	*Prunus serotina*	Good		X	
717	15	Red Maple	*Acer rubrum*	Good		X	
718	DEAD					X	X
719	DEAD					X	X
720	15	Red Maple	*Acer rubrum*	Good			
721	8	Red Maple	*Acer rubrum*	Good			
722	19	Silver Maple	*Acer saccharinum*	Good			
723	22,19	Silver Maple	*Acer saccharinum*	Good			
724	20	Silver Maple	*Acer saccharinum*	Good			
725	25	Silver Maple	*Acer saccharinum*	Good	X		
726	18	Red Maple	*Acer rubrum*	Good			
727	50,86,12,10	Silver Maple	*Acer saccharinum*	Good	X		
728	10	Elm	*Ulmus americana*	Good		X	
729	10	Elm	*Ulmus americana*	Good		X	
730	18	Black Cherry	*Prunus serotina*	Good	X	X	
731	DEAD					X	X
732	9	Black Cherry	*Prunus serotina*	Good		X	
733	7	Black Cherry	*Prunus serotina*	Good		X	
734	9	Black Cherry	*Prunus serotina*	Poor		X	
735	13	Buckthorn	*Rhamnus cathartica*	Good		X	
736	9	Black Cherry	*Prunus serotina*	Good		X	
737	18	Silver Maple	*Acer saccharinum*	Good		X	
738	33	Black Cherry	*Prunus serotina*	Good	X	X	
739	9	Boxelder	*Acer negundo*	Poor		X	
740	14	Boxelder	*Acer negundo*	Poor		X	
741	8	Boxelder	*Acer negundo*	Poor		X	
742	9	Boxelder	*Acer negundo*	Poor		X	X
743	9	Red Maple	*Acer rubrum*	Good		X	
744	9	Black Cherry	*Prunus serotina*	Good		X	
745	DEAD					X	X
746	14	Norway Maple	*Acer platanoides*	Good		X	
747	18	Black Cherry	*Prunus serotina*	Poor	X	X	X
748	12	Black Cherry	*Prunus serotina*	Good		X	
749	13	Black Cherry	*Prunus serotina*	Good		X	
750	10	Black Cherry	*Prunus serotina*	Good		X	
751	16	Black Cherry	*Prunus serotina*	Good		X	
752	8	Boxelder	*Acer negundo*	Poor		X	X
753	9	Black Cherry	*Prunus serotina*	Good		X	
754	7	Red Maple	*Acer rubrum*	Good		X	
755	7	Black Cherry	*Prunus serotina*	Good		X	
756	9,7	Silver Maple	*Acer saccharinum*	Good		X	
757	22	Black Cherry	*Prunus serotina*	Poor	X	X	X
758	8	Black Cherry	*Prunus serotina*	Poor		X	X
759	14	Black Cherry	*Prunus serotina*	Poor		X	X
760	19	Silver Maple	*Acer saccharinum*	Good		X	
761	7	Elm	*Ulmus americana*	Good		X	
762	26	Silver Maple	*Acer saccharinum*	Good	X	X	
763	8	Elm	*Ulmus americana*	Good		X	
764	33	Silver Maple	*Acer saccharinum*	Good	X	X	
765	6	Elm	*Ulmus americana*	Good		X	
766	32	Red Maple	*Acer rubrum*	Good	X	X	
767	11	Silver Maple	*Acer saccharinum*	Good		X	
768	18	Black Cherry	*Prunus serotina*	Good	X	X	
769	9	Silver Maple	*Acer saccharinum*	Good		X	
770	13	Silver Maple	*Acer saccharinum*	Good		X	
771	14	Black Cherry	*Prunus serotina*	Good		X	
772	7	Red Maple	*Acer rubrum*	Good		X	
773	14	Black Cherry	*Prunus serotina*	Good		X	
774	8	Black Cherry	*Prunus serotina*	Good		X	
775	10	Black Cherry	*Prunus serotina*	Good		X	
776	7	Elm	*Ulmus americana*	Good		X	
777	9	Black Cherry	*Prunus serotina*	Good		X	
778	7	Black Cherry	*Prunus serotina*	Poor		X	X
779	8	Apple	*Malus ssp.*	Poor		X	X
780	9	Black Cherry	*Prunus serotina*	Poor		X	X
781	15	Black Cherry	*Prunus serotina*	Good		X	
782	15	Silver Maple	*Acer saccharinum*	Good		X	
783	13	Black Cherry	*Prunus serotina*	Good		X	
784	10	Black Cherry	*Prunus serotina*	Good		X	
785	7	Elm	*Ulmus americana*	Good		X	
786	16	Cottonwood	*Populus deltoides*	Poor		X	X
787	8	Black Cherry	*Prunus serotina*	Good		X	
788	21	Red Maple	*Acer rubrum*	Good		X	
789	14	Red Maple	*Acer rubrum*	Good		X	
790	8	Black Cherry	*Prunus serotina*	Good		X	
791	13	Black Cherry	*Prunus serotina*	Good		X	
792	DEAD					X	X
793	8	Black Cherry	*Prunus serotina*	Good		X	
794	DEAD					X	
795	15	Black Cherry	*Prunus serotina*	Good		X	
796	15	Black Cherry	*Prunus serotina*	Good		X	
797	34	Elm	*Ulmus americana*	Good	X	X	
798	17	Black Cherry	*Prunus serotina*	Good		X	
799	7	Black Cherry	*Prunus serotina*	Good			
800	14	Black Cherry	*Prunus serotina*	Good		X	
906	DEAD					X	X
907	DEAD					X	X
908	11	Boxelder	*Acer negundo*	Poor		X	X
909	19	Black Cherry	*Prunus serotina*	Good	X	X	
910	14	Black Cherry	*Prunus serotina*	Good		X	
911	15	Black Cherry	*Prunus serotina*	Good		X	
912	10	Black Cherry	*Prunus serotina*	Good		X	
913	19	Bitternut Hickory	*Carya cordiformis*	Good	X	X	
914	14,15,19	Bitternut Hickory	*Carya cordiformis*	Good	X	X	
915	8	Black Cherry	*Prunus serotina*	Good		X	
916	7	Black Cherry	*Prunus serotina*	Good		X	
917	11	Black Cherry	*Prunus serotina*	Good		X	
918	13	Black Cherry	*Prunus serotina*	Good		X	
919	11	Black Cherry	*Prunus serotina*	Good		X	
920	9	Black Cherry	*Prunus serotina*	Good		X	
921	8	Black Cherry	*Prunus serotina*	Good		X	
922	16	Bitternut Hickory	*Carya cordiformis*	Good		X	
923	19	Elm	*Ulmus americana*	Good			
924	11	Elm	*Ulmus americana*	Good			
925	18	Black Cherry	*Prunus serotina*	Good	X		
926	105	White Oak	*Quercus alba*	Good	X		
927	12	Black Cherry	*Prunus serotina*	Good			
928	10	Bitternut Hickory	*Carya cordiformis*	Good			
929	20	Black Cherry	*Prunus serotina*	Good	X		
930	12	White Oak	*Quercus alba*	Good		X	
931	11	Black Cherry	*Prunus serotina*	Good		X	
932	22	Bitternut Hickory	*Carya cordiformis*	Good	X	X	
933	26	Elm	*Ulmus americana*	Good	X	X	
934	30	Bitternut Hickory	*Carya cordiformis*	Good	X	X	
935	28,26,23	Black Cherry	*Prunus serotina*	Fair	X	X	
936	26	Bitternut Hickory	*Carya cordiformis*	Good	X	X	
937	18	Mulberry	*Morus alba*	Good	X	X	
938	28	Bitternut Hickory	*Carya cordiformis*	Good	X	X	
939	7	Elm	*Ulmus americana*	Good		X	
940	56	Black Cherry	*Prunus serotina*	Poor	X	X	X
941	12	Boxelder	*Acer negundo*	Good		X	
942	32	Boxelder	*Acer negundo*	Poor	X	X	X
943	11	Elm	*Ulmus americana*	Good		X	
944	18	Black Cherry	*Prunus serotina*	Good	X		
945	DEAD					X	X
946	27	Black Cherry	*Prunus serotina*	Good	X		
947	33	Cottonwood	*Populus deltoides*	Good	X		
948	12	Black Cherry	*Prunus serotina*	Good		X	
949	7	Black Cherry	*Prunus serotina*	Good		X	
950	DEAD					X	X
951	10	Elm	*Ulmus americana*	Good		X	
952	12	Black Cherry	*Prunus serotina*	Good		X	
953	10,11	Black Cherry	*Prunus serotina*	Good		X	
954	14	Elm	*Ulmus americana*	Good		X	
955	7	Elm	*Ulmus americana*	Good		X	
956	15	Black Cherry	*Prunus serotina*	Good		X	
957	10	Black Cherry	*Prunus serotina*	Good		X	
958	10	Black Cherry	*Prunus serotina*	Good		X	
959	19	Black Cherry	*Prunus serotina*	Good	X	X	
960	14	Black Cherry	*Prunus serotina*	Fair		X	
961	DEAD					X	X
962	18	Basswood	*Tilia americana*	Good	X	X	
963	12	Elm	*Ulmus americana*	Good		X	
964	7	Elm	*Ulmus americana*	Poor		X	X
965	8	Black Walnut	*Juglans nigra*	Good		X	
966	7	Elm	*Ulmus americana*	Good		X	
967	12	Black Cherry	*Prunus serotina*	Good		X	
968	14	Elm	*Ulmus americana*	Good		X	
969	8	Black Cherry	*Prunus serotina*	Good		X	
970	21	Black Cherry	*Prunus serotina*	Good	X	X	
971	9	Black Cherry	*Prunus serotina*	Good		X	
972	15	Elm	*Ulmus americana*	Good		X	
973	8	Black Cherry	*Prunus serotina*	Good		X	
974	10	Black Cherry	*Prunus serotina*	Good		X	
975	7	Black Cherry	*Prunus serotina*	Good			
976	DEAD					X	
977	14	Black Cherry	*Prunus serotina*	Good		X	
978	8	Elm	*Ulmus americana*	Good		X	
979	9	Black Cherry	*Prunus serotina*	Good		X	
980	16	Elm	*Ulmus americana*	Good		X	
981	9	Elm	*Ulmus americana*	Good		X	
982	9	Elm	*Ulmus americana*	Good		X	
983	DEAD					X	
984	28	Black Cherry	*Prunus serotina*	Good	X	X	
985	12	Buckthorn	*Rhamnus cathartica*	Fair			
986	12	Black Cherry	*Prunus serotina*	Good			
987	12	Black Cherry	*Prunus serotina*	Good			
988	10	Black Cherry	*Prunus serotina*	Good			
989	24	Cottonwood	*Populus deltoides*	Good	X		
990	11	Elm	*Ulmus americana*	Good			
991	9	Black Cherry	*Prunus serotina*	Good			
992	8	Black Cherry	*Prunus serotina*	Good			
993	18	White Oak	*Quercus alba*	Good	X		
994	10	Elm	*Ulmus americana*	Good			
995	15	Elm	*Ulmus americana*	Good			
996	11	Elm	*Ulmus americana*	Good			
997	12	Black Cherry	*Prunus serotina*	Good			
998	24	Black Cherry	*Prunus serotina*	Poor	X		
999	10	Black Cherry	*Prunus serotina*	Good			
1000	13	Elm	*Ulmus americana*	Good			
1001	29	Norway Maple	*Acer platanoides*	Good	X		
1002	10	Black Cherry	*Prunus serotina*	Good			
1003	9	Black Cherry	*Prunus serotina*	Good			
1004	8	Elm	*Ulmus americana*	Good			
1005	7	Elm	*Ulmus americana*	Good			
1006	8	Elm	*Ulmus americana*	Good			
1007	13	Elm	*Ulmus americana*	Good			
1008	14	Elm	*Ulmus americana*	Good			
1009	21	White Pine	*Pinus strobus*	Good	X		
1010	21	Elm	*Ulmus americana*	Good			
1011	11	Elm	*Ulmus americana*	Good			
1012	15	Norway Maple	*Acer platanoides*	Good			
1013	10	Black Cherry	*Prunus serotina*	Good			
1014	23	Black Cherry	*Prunus serotina*	Good	X		
1015	17	Black Cherry	*Prunus serotina*	Good			
1016	DEAD						
1017	11	Black Cherry	*Prunus serotina*	Good			
1018	10	Elm	*Ulmus americana*	Good			
1019	DEAD						
1020	8	Black Cherry	*Prunus serotina*	Good			
1021	8	Black Cherry	*Prunus serotina*	Good			
1022	7	Black Cherry	*Prunus serotina*	Good			
1023	11	Black Cherry	*Prunus serotina*	Good			
1024	13	Black Cherry	*Prunus serotina*	Fair			
1025	13	Black Cherry	*Prunus serotina*	Good			
1026	10	Black Cherry	*Prunus serotina*	Good			
1027	13	Black Cherry	*Prunus serotina*	Good			
1028	12	Black Cherry	*Prunus serotina*	Good			
1029	12	Black Cherry	*Prunus serotina*	Good			
1030	9	Elm	*Ulmus americana*	Good			
1031	9	Elm	*Ulmus americana*	Poor			
1032	14	Black Cherry	*Prunus serotina*	Good			
1033	15	Elm	*Ulmus americana*	Good			
1034	11	Black Cherry	*Prunus serotina*	Good			
1035	12	Black Cherry	*Prunus serotina*	Good			
1036	20	Red Cedar	*Juniperus virginiana*	Good	X		
1037	11	Black Cherry	*Prunus serotina*	Good			
1038	8	Black Cherry	*Prunus serotina*	Good			
1039	16	Red Maple	*Acer rubrum*	Good			
1040	18,14	Silver Maple	*Acer saccharinum*	Good			
1041	13	Silver Maple	*Acer saccharinum*	Good			
1042	24	Silver Maple	*Acer saccharinum*	Good	X		
1043	25	Silver Maple	*Acer saccharinum*	Good	X		
1087	9,14	Red Maple	*Acer rubrum*	Good			
1088	9,10	Red Maple	*Acer rubrum*	Good			
1089	8	Red Maple	*Acer rubrum*	Good		X	
1090	37	Salix Alba	*Golden Willow*	Poor	X	X	X
1091	12	Red Maple	*Acer rubrum*	Good		X	
1092	52	Red Maple	*Acer rubrum*	Fair	X		
1093	51	Cottonwood	*Populous deltoides*	Good	X		
1094	21	Elm	*Ulmus americana*	Fair			
1095	26	Cottonwood	*Populous deltoides*	Good	X		
1096	13	Cottonwood	*Populous deltoides*	Good			
1097	41	Cottonwood	*Populous deltoides*	Good	X		
1098	10	Red Maple	*Acer rubrum*	Good			
1099	17,32	Silver Maple	*Acer saccharinum*	Good	X		
1100	8	Red Maple	*Acer rubrum*	Good			
1101	8,9	White Ash	*Fraxinus*	Good			
1102	14	Black Walnut	*Juglans nigra*	Good			
1103	12	Elm	*Ulmus americana*	Good			
1104	22,26	Cottonwood	*Populous deltoides*	Good	X		
1105	27	Cottonwood	*Populous deltoides*	Good	X		
1106	46	Cottonwood	*Populous deltoides*	Good	X		
1107	12	Red Maple	*Acer rubrum*	Good			
1108	18	Cottonwood	*Populous deltoides*	Good			
1109	54	Cottonwood	*Populous deltoides*	Good	X		
1110	22	Cottonwood	*Populous deltoides*	Good			
1111	19	Cottonwood	*Populous deltoides*	Good			
1112	24	Cottonwood	*Populous deltoides*	Good	X		
1113	22	Cottonwood	*Populous deltoides*	Good			
1114	58	Cottonwood	*Populous deltoides*	Good	X		
1115	8	Elm	*Ulmus americana*	Good			
1116	9	Black Cherry	*Prunus serotina*	Good			
1117	10	Black Cherry	*Prunus serotina*	Good			
1118	DEAD						
1119	8	Red Cedar	*Juniperus virginiana*	Good			
1120	9	Elm	*Ulmus americana*	Good			
1121	10	Elm	*Ulmus americana*	Good			
1122	DEAD						
1123	11	Elm	*Ulmus americana*	Good			
1124	10	Elm	*Ulmus americana*	Good		X	
1125	9	Red Maple	*Acer rubrum*	Good		X	
1126	8,7	Red Maple	*Acer rubrum*	Good		X	
1127	19	Red Maple	*Acer rubrum*	Good		X	
1128	15	Red Maple	*Acer rubrum*	Good		X	
1129	8	Cottonwood	*Populous deltoides*	Good		X	
1130	10	Cottonwood	*Populous deltoides*	Good		X	
1131	9	Black Cherry	*Prunus serotina*	Good		X	
1132	8	Elm	*Ulmus americana*	Good		X	
1133	DEAD					X	X
1134	15	Elm	*Ulmus americana*	Good		X	
1135	30	Black Walnut	*Juglans nigra*	Good	X		
1136	8	Black Cherry	*Prunus serotina*	Good		X	
1137	16	Elm	*Ulmus americana*	Good			
1138	10	Elm	*Ulmus americana*	Poor			
1139	26	Silver Maple	*Acer saccharinum*	Good	X		
1140	20	Silver Maple	*Acer saccharinum*	Good			
1141	24	Silver Maple	*Acer saccharinum*	Good	X		
1142	20	Silver Maple	*Acer saccharinum*	Good			
1143	14	Silver Maple	*Acer saccharinum*	Fair			
1144	14	Silver Maple	*Acer saccharinum*	Good			
1145	7	Black Cherry	*Prunus serotina*	Fair			
1146	13	Silver Maple	*Acer saccharinum*	Good			
1147	28	Silver Maple	*Acer saccharinum*	Good			
1148	10	Silver Maple	*Acer saccharinum*	Good			
1149	10	Silver Maple	*Acer saccharinum*	Fair			
1150	16	Silver Maple	*Acer saccharinum*	Good			
1151	28	Silver Maple	*Acer saccharinum*	Good	X	X	
1152	7	Black Cherry	*Prunus serotina*	Fair		X	
1153	14	Silver Maple	*Acer saccharinum*	Fair		X	
1154	9	Red Cedar	*Juniperus virginiana*	Good			
1155	12	Boxelder	*Acer negundo*	Poor			
1156	6	Black Cherry	*Prunus serotina*	Fair			
1157	10	Black Cherry	*Prunus serotina*	Good			
1158	26	Silver Maple	*Acer saccharinum*	Good	X		
1159	14	Silver Maple	*Acer saccharinum*	Good			
1160	11	Silver Maple	*Acer saccharinum*	Fair			
1161	14	Silver Maple	*Acer saccharinum*	Fair			
1162	11	Black Cherry	*Prunus serotina*	Fair			
1163	24	Red Maple	*Acer rubrum*	Good	X		
1164	8	Black Cherry	*Prunus serotina*	Good			
1165	6	Black Cherry	*Prunus serotina*	Fair			
1166	6	Red Oak	*Quercus rubra*	Good			
1167	7	Black Cherry	*Prunus serotina*	Fair			
1168	18	Shagbark Hickory	*Carya ovata*	Good			
1169	30	Silver Maple	*Acer saccharinum*	Good	X		
1170	15	Silver Maple	*Acer saccharinum*	Good			
1171	30	Silver Maple	*Acer saccharinum*	Good	X		
1172	14	Silver Maple	*Acer saccharinum*	Good			
1173	30	Silver Maple	*Acer saccharinum*	Good	X		
1174	7	Silver Maple	*Acer saccharinum*	Poor			
1175	22	Silver Maple	*Acer saccharinum*	Fair			
1176	35	Silver Maple	*Acer saccharinum*	Good	X		
1177	14	Silver Maple	*Acer saccharinum*	Good			
1178	14	Elm	*Ulmus americana*	Fair			
1179	14	Apple	*Malus ssp.*	Poor			
1180	22	Elm	*Ulmus americana*	Fair			
1181	32	Silver Maple	*Acer saccharinum*	Good	X		
1182	18	Silver Maple	*Acer saccharinum*	Good			
1183	12	Apple	*Malus ssp.*	Poor			
1184	8	Elm	*Ulmus americana*	Fair			
1185	11	Elm	*Ulmus americana*	Good			
1186	11	Silver Maple	*Acer saccharinum*	Good			
1187	11	Silver Maple	*Acer saccharinum*	Fair			
1188	11	Silver Maple	*Acer saccharinum*	Good			
1189	8	Elm	*Ulmus americana*	Fair			
1190	10	Ornamental Pear	*Pyrus calleryana*	Good			
1191	15	Shagbark Hickory	*Carya ovata*	Good			
1192	18	Red Maple	*Acer rubrum*	Good			
1193	6	Red Maple	*Acer rubrum*	Good			
1194	11	Silver Maple	*Acer saccharinum*	Good			
1195	18	Silver Maple	*Acer saccharinum*	Fair			
35050	14	Blue Spruce	*Picea pungens*	Good			X

811
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CITY FILE #22-037 SECTION #32

VVLA vert verde landscape architecture
734.249.3568 Plymouth, MI
james@vertverde.com

Issued For:

11.15.2022	Site Plan Review
04.25.2023	Revision per City Comments
08.22.2023	Revision per City Comments
01.10.2024	Revisions
01.18.2024	Revisions
03.12.2024	Revisions
05.22.2024	Revisions
07.11.2025	Revision

Project:

AUBURN ANGARA OAKS

West Auburn Road
Rochester Hills, Michigan

Project Sponsor:

Three Oaks Communities, LLC
P.O. Box 8307
Ann Arbor, MI 48107

Sheet Name:

Tree List

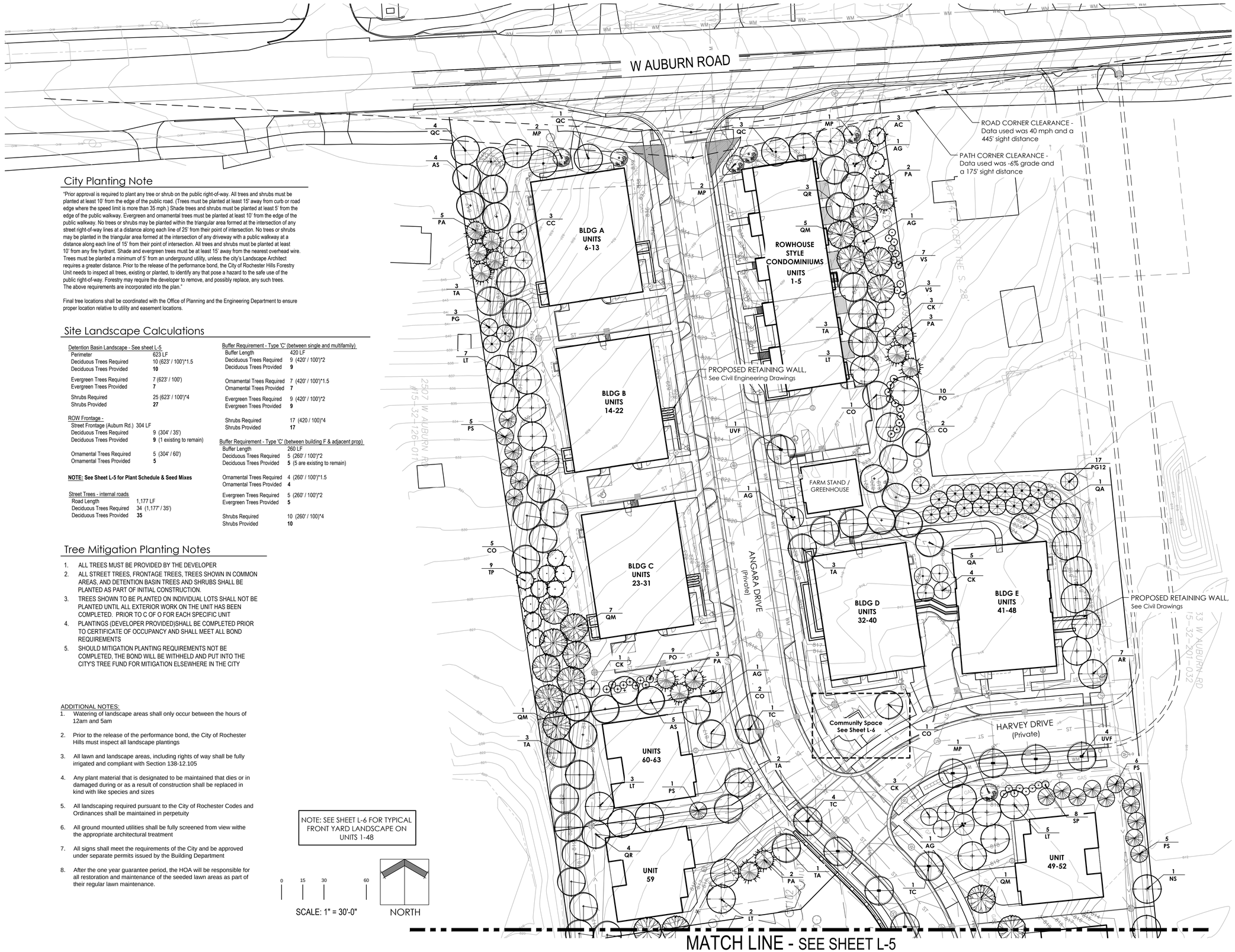
Seal:

STATE OF MICHIGAN
JAMES GRAY
LANDSCAPE ARCHITECT
No. 1528
REGISTERED LANDSCAPE ARCHITECT

Drawn: JG
Checked: JG
Date: 10.2022
Scale: No Scale

Project Number:
22.025

Sheet Number:
L-3



City Planting Note

"Prior approval is required to plant any tree or shrub on the public right-of-way. All trees and shrubs must be planted at least 10' from the edge of the public road. (Trees must be planted at least 15' away from curb or road edge where the speed limit is more than 35 mph.) Shade trees and shrubs must be planted at least 5' from the edge of the public walkway. Evergreen and ornamental trees must be planted at least 10' from the edge of the public walkway. No trees or shrubs may be planted within the triangular area formed at the intersection of any street right-of-way lines at a distance along each line of 25' from their point of intersection. No trees or shrubs may be planted in the triangular area formed at the intersection of any driveway with a public walkway at a distance along each line of 15' from their point of intersection. All trees and shrubs must be planted at least 10' from any fire hydrant. Shade and evergreen trees must be at least 15' away from the nearest overhead wire. Trees must be planted a minimum of 5' from an underground utility, unless the city's Landscape Architect requires a greater distance. Prior to the release of the performance bond, the City of Rochester Hills Forestry Unit needs to inspect all trees, existing or planted, to identify any that pose a hazard to the safe use of the public right-of-way. Forestry may require the developer to remove, and possibly replace, any such trees. The above requirements are incorporated into the plan."

Final tree locations shall be coordinated with the Office of Planning and the Engineering Department to ensure proper location relative to utility and easement locations.

Site Landscape Calculations

Detention Basin Landscape - See sheet L-5

Perimeter	623 LF
Deciduous Trees Required	10 (623' / 100')*1.5
Deciduous Trees Provided	**10**
Evergreen Trees Required	7 (623' / 100')
Evergreen Trees Provided	**7**
Shrubs Required	25 (623' / 100')*4
Shrubs Provided	**27**

ROW Frontage -

Street Frontage (Auburn Rd.)	304 LF
Deciduous Trees Required	9 (304' / 35')
Deciduous Trees Provided	**9** (1 existing to remain)
Ornamental Trees Required	5 (304' / 60')
Ornamental Trees Provided	**5**

NOTE: See Sheet L-5 for Plant Schedule & Seed Mixes

Street Trees - internal roads

Road Length	1,177 LF
Deciduous Trees Required	34 (1,177' / 35')
Deciduous Trees Provided	**35**

Buffer Requirement - Type 'C' (between single and multifamily)

Buffer Length	420 LF
Deciduous Trees Required	9 (420' / 100')*2
Deciduous Trees Provided	**9**
Ornamental Trees Required	7 (420' / 100')*1.5
Ornamental Trees Provided	**7**
Evergreen Trees Required	9 (420' / 100')*2
Evergreen Trees Provided	**9**
Shrubs Required	17 (420 / 100)*4
Shrubs Provided	**17**

Buffer Requirement - Type 'C' (between building F & adjacent prop)

Buffer Length	260 LF
Deciduous Trees Required	5 (260' / 100')*2
Deciduous Trees Provided	**5** (5 are existing to remain)
Ornamental Trees Required	4 (260' / 100')*1.5
Ornamental Trees Provided	**4**
Evergreen Trees Required	5 (260' / 100')*2
Evergreen Trees Provided	**5**
Shrubs Required	10 (260' / 100)*4
Shrubs Provided	**10**

Tree Mitigation Planting Notes

1. ALL TREES MUST BE PROVIDED BY THE DEVELOPER
2. ALL STREET TREES, FRONTAGE TREES, TREES SHOWN IN COMMON AREAS, AND DETENTION BASIN TREES AND SHRUBS SHALL BE PLANTED AS PART OF INITIAL CONSTRUCTION.
3. TREES SHOWN TO BE PLANTED ON INDIVIDUAL LOTS SHALL NOT BE PLANTED UNTIL ALL EXTERIOR WORK ON THE UNIT HAS BEEN COMPLETED. PRIOR TO C OF O FOR EACH SPECIFIC UNIT
4. PLANTINGS (DEVELOPER PROVIDED)SHALL BE COMPLETED PRIOR TO CERTIFICATE OF OCCUPANCY AND SHALL MEET ALL BOND REQUIREMENTS
5. SHOULD MITIGATION PLANTING REQUIREMENTS NOT BE COMPLETED, THE BOND WILL BE WITHHELD AND PUT INTO THE CITY'S TREE FUND FOR MITIGATION ELSEWHERE IN THE CITY

ADDITIONAL NOTES:

1. Watering of landscape areas shall only occur between the hours of 12am and 5am
2. Prior to the release of the performance bond, the City of Rochester Hills must inspect all landscape plantings
3. All lawn and landscape areas, including rights of way shall be fully irrigated and compliant with Section 138-12.105
4. Any plant material that is designated to be maintained that dies or in damaged during or as a result of construction shall be replaced in kind with like species and sizes
5. All landscaping required pursuant to the City of Rochester Codes and Ordinances shall be maintained in perpetuity
6. All ground mounted utilities shall be fully screened from view withe the appropriate architectural treatment
7. All signs shall meet the requirements of the City and be approved under separate permits issued by the Building Department
8. After the one year guarantee period, the HOA will be responsible for all restoration and maintenance of the seeded lawn areas as part of their regular lawn maintenance.

NOTE: SEE SHEET L-6 FOR TYPICAL FRONT YARD LANDSCAPE ON UNITS 1-48

0 15 30 60

SCALE: 1" = 30'-0"

NORTH

MATCH LINE - SEE SHEET L-5

CITY FILE #22-037 SECTION #32

VVLA vert verde landscape architecture
734.249.3568 Plymouth, MI
james@vertverde.com

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07.11.2025	Revisions

Project:

AUBURN ANGARA OAKS

West Auburn Road
Rochester Hills, Michigan

Project Sponsor:

Three Oaks Communities, LLC
P.O. Box 8307
Ann Arbor, MI 48107

Sheet Name:

Landscape Plan North

NOT FOR CONSTRUCTION

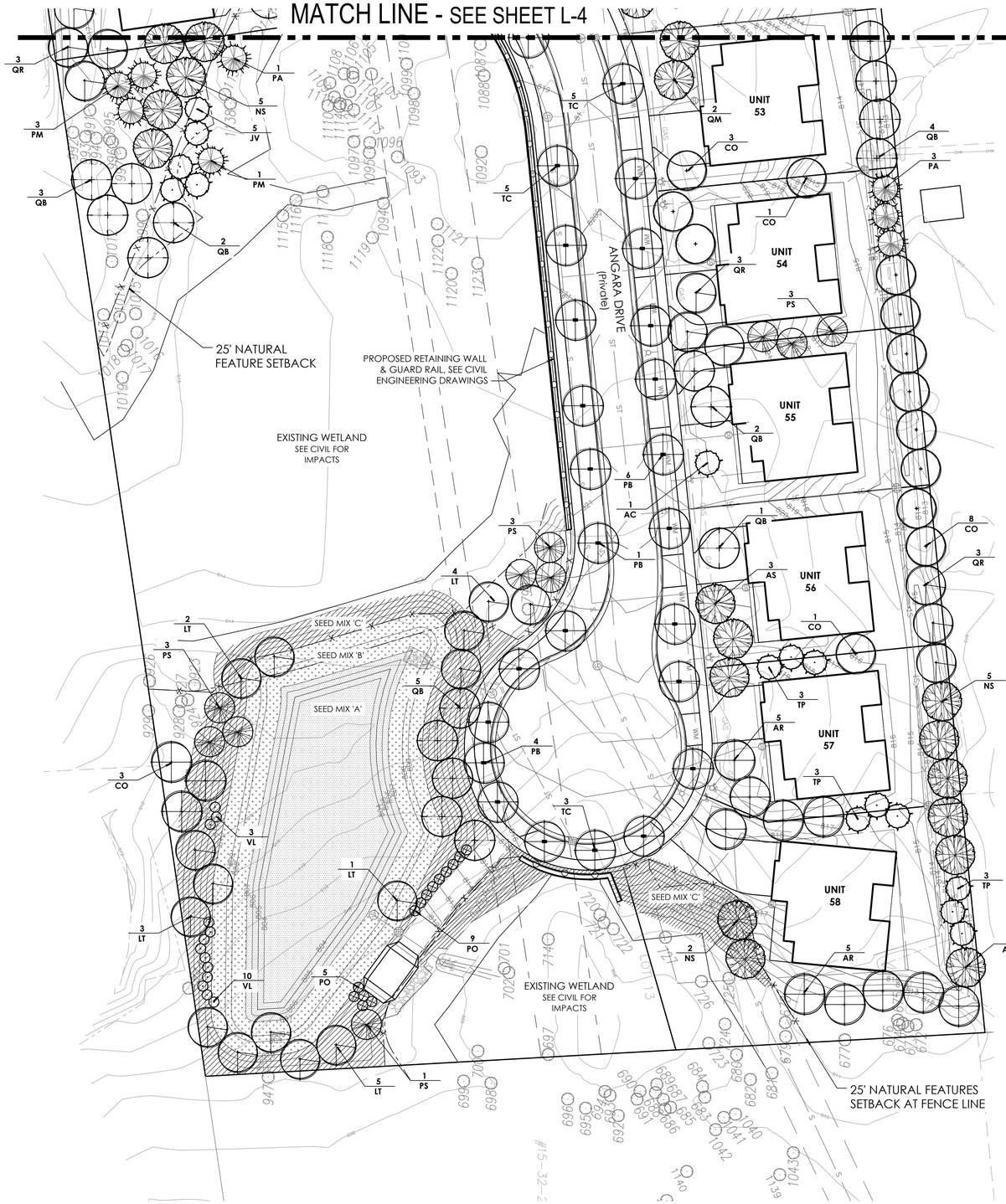
Seal:

STATE OF MICHIGAN JAMES GRAY LANDSCAPE ARCHITECT No. 1528 REGISTERED LANDSCAPE ARCHITECT

Drawn:	JG
Checked:	JG
Date:	10.2022
Scale:	1" = 30'-0"

Project Number: 22.025

Sheet Number: L-4



PLANT MATERIAL SHALL NOT BE PLACED CLOSER THAN 4' FROM ANY FENCE OR PROPERTY LINE

Seed Mix 'A'

Stormwater Seed Mix

Botanical Name	Common Name		PLS Ounces/Acre
Permanent Grasses/Sedges/Rushes			
Carex crinita	Crested Oval Sedge		1.00
Carex frankii	Brittly Carled Sedge		1.00
Carex lurida	Sallow Broom Sedge		2.00
Carex scoparia / stipata	Pointed Broom Sedge		2.00
Carex vulpinoidea	Brown Fox Sedge		6.00
Eleocharis ovata	Ovate Spike Rush		0.50
Elymus virginicus	Virginia Wild Rye		12.00
Glyceria striata	Fowl Manna Grass		1.00
Juncus effusus	Common Rush		1.00
Juncus tenuis	Slender Rush		0.25
Leersia oryzoides	Rice Cut Grass		1.00
Panicum virgatum	Switch Grass		2.00
Scirpus atrovirens	Dark Green Rush		1.00
Scirpus cyperinus	Wool Grass		0.50
Sparganium eurycarpum	Broad Fruit Bur-Reed		6.00
		Total	45.75
Temporary Cover:			
Avena sativa	Common Oat		360.00
Lolium multiflorum	Annual Rye		116.00
		Total	476.00
Forbs			
Alisma spp.	Water Plantain (Various Mix)		4.25
Asclepias incarnata	Swamp Milkweed		1.00
Bidens spp.	Beggar's Ticks (Various Mix)		2.00
Impatiens pallida/biflora	Orange Jewelweed		3.00
Mimulus ringens	Monkey Flower		1.00
Penthorum sedoides	Ditch Stonecrop		0.50
Polygonum pensylvanicum	Smartweed		4.00
Rudbeckia subtomentosa	Sweet Black-Eyed Susan		1.00
Sagittaria latifolia	Broad Leaf Arrowhead		1.00
Verbena hastata	Wild Vervine		1.00
Thalictrum dasycarpum	Purple Meadow Rue		2.50
		Total	21.25

Seed Mix 'B'

Low-Profile Prairie Seed Mix

Botanical Name	Common Name		PLS Ounces/Acre
Permanent Grasses			
Bouteloua curtipendula	Side Oats Grama		10.00
Carex spp.	Prairie Sedge Mix		1.00
Elymus canadensis	Canada Wild Rye		16.00
Koeleria pyramidata	Junie Grass		2.00
Panicum virgatum	Switch Grass		1.00
Schizachyrium scoparium	Little Bluestem		25.00
Sporobolus heterolepis	Prairie Dropseed		2.00
		Total	61.00
Temporary Cover:			
Avena sativa	Common Oat		360.00
Lolium multiflorum	Annual Rye		120.00
		Total	480.00
Forbs			
Amorpha canescens	Lead Plant		1.00
Anemone cylindrica	Thimbleweed		0.50
Aquilegia canadensis	Wild Columbine		0.50
Asclepias tuberosa	Butterfly Milkweed		2.00
Aster ericoides	Heath Aster		0.25
Aster laevis	Smooth Blue Aster		0.75
Aster novae-angliae	New England Aster		0.25
Baptisia alba	White Wild Indigo		1.00
Chamaecrista fasciculata	Partridge Pea		0.50
Coreopsis lanceolata	Sand Coreopsis		1.50
Coreopsis palmata	Prairie Coreopsis		1.00
Dalea candidum	White Prairie Clover		1.50
Dalea purpurea	Purple Prairie Clover		1.50
Echinacea purpurea	Broad-Leaved Purple Coneflower		3.50
Eryngium yuccifolium	Rattlesnake Master		2.50
Kuhnia eupatoides	False Bone-Set		0.50
Lespedeza capitata	Round-Headed Bush Clover		2.00
Liatris aspera	Rough Blazing Star		0.50
Lupinus perennis	Wild Lupine		2.00
Monarda fistulosa	Wild Bergamot		0.50
Parthenium integrifolium	Wild Quinine		1.00
Pedicularis dipsiaca	Fragrine Beard Tongue		0.50
Physostegia virginiana	False Dragonhead		0.25
Pycnanthemum virginianum	Common Mountain Mint		1.00
Ratibida pinnata	Yellow Coneflower		3.00
Rudbeckia hirta	Black-Eyed Susan		2.00
Rudbeckia subtomentosa	Sweet Black-Eyed Susan		1.00
Silphium integrifolium	Rosin Weed		0.50
Silphium terebinthinaceum	Prairie Dock		2.00
Solidago nemoralis	Old-Field Goldenrod		0.25
Solidago rigida	Stiff Goldenrod		1.00
Tradescantia ohiensis	Common Spiderwort		5.75
Vernonia spp.	Ironweed (Various Mix)		1.00
Veronicastrum virginianum	Culver's Root		0.25
		Total	45.75

Seed Mix 'C'

Swale Seed Mix

Botanical Name	Common Name		PLS Ounces/Acre
Permanent Grasses/Sedges			
Andropogon gerardii	Big Bluestem		12.00
Carex comosa	Bristly Sedge		2.00
Carex crotalorata	Crested Oval-Sedge		2.00
Carex lurida	Sallow Broom Sedge		2.00
Carex sparganioides v. cephalodea	Rough Clustered Sedge		3.00
Carex vulpinoidea	Brown Fox Sedge		1.00
Elymus virginicus	Virginia Wild Rye		8.00
Glyceria striata	Fowl Manna Grass		1.00
Panicum virgatum	Switch Grass		2.00
Scirpus atrovirens	Dark Green Rush		2.00
Scirpus cyperinus	Wool Grass		0.50
Spartina pectinata	Prairie Cord Grass		2.00
		Total	40.50
Temporary Cover:			
Avena sativa	Common Oat		360.00
Lolium multiflorum	Annual Rye		28.00
		Total	388.00
Forbs			
Alisma spp.	Water Plantain (Various Mix)		1.00
Asclepias incarnata	Swamp Milkweed		2.00
Aster novae-angliae	New England Aster		0.50
Coreopsis tripteris	Tall Coreopsis		2.00
Eupatorium maculatum	Spotted Joe-Pye Weed		0.25
Iris virginica	Blue Flag Iris		1.50
Liatris spicata	Marsh Blazing Star		2.00
Lobelia cardinalis	Cardinal Flower		0.25
Lobelia siphilitica	Great Blue Lobelia		0.50
Sagittaria latifolia	Broad-Leaf Arrowhead		0.75
Silphium terebinthinaceum	Prairie Dock		1.00
Verbena hastata	Blue Vervain		1.00
Zizia aurea	Golden Alexanders		1.00
		Total	16.00

Plant Schedule

FRONTAGE PLANTINGS

TREES

QTY	SYM	BOTANICAL NAME	COMMON NAME	SIZE	SPACING	ROOT	COMMENTS	UNIT	TOTAL
5	MP	*Malus 'Prairie Fire'*	Prairie Fire Crabapple	2" cal.	as shown	B&B	Single straight trunk	$ 325.00	$ 1,625.00
8	QC	*Quercus coccinea*	Scarlet Oak	3" cal.	as shown	B&B	Single straight trunk	$ 450.00	$ 3,600.00

DETENTION BASIN PLANTINGS

TREES

10	LT	*Liriodendron tulipfera*	Tulip Tree	3" cal.	as shown	B&B	Single straight trunk	$ 450.00	$ 4,500.00
7	PS	*Pinus strobus*	Eastern White Pine	10' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 2,800.00

SHRUBS

14	PO	*Physocarpus o. 'Coppertina'*	Coppertina Ninebark	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 700.00
13	VL	*Viburnum lentago*	Nannyberry Viburnum	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 650.00

TREE MITIGATION PLANTINGS

TREES

7	AC	*Abies concolor*	Concolor Fir	8' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 2,800.00
1	AG	*Amalanchier x g. 'Autumn Brilliance'*	Autumn Brilliance Serviceberry	8' ht.	as shown	B&B	Minimum 5 stems	$ 400.00	$ 400.00
17	AR	*Acer r. 'October Glory'*	October Glory Red Maple	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 6,800.00
8	AS	*Acer s. 'Green Mountain'*	Green Mountain Sugar Maple	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 3,200.00
3	CC	*Cercis canadensis*	Eastern Redbud	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 1,200.00
4	CK	*Cornus kousa 'Milkyway'*	Milkyway Kousa Dogwood	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 1,600.00
27	CO	*Celtis occidentalis*	Northern Hackberry	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 10,800.00
5	JV	*Juniperus virginiana*	Eastern Red Cedar	8' ht.	as shown	B&B	Single straight trunk	$ 400.00	$ 2,000.00
22	LT	*Liriodendron tulipfera*	Tulip Tree	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 8,800.00
13	NS	*Nyssa sylvatica*	Blackgum	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 5,200.00
11	PA	*Picea abies*	Norway Spruce	8' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 4,400.00
3	PG	*Picea glauca 'Densata'*	Black Hills Spruce	8' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 1,200.00
17	PG12	*Picea glauca 'Densata'*	Black Hills Spruce	12' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 6,800.00
4	PM	*Pseudotsuga menziesii*	Douglas Fir	8' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 1,600.00
10	PS	*Pinus strobus*	Eastern White Pine	8' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 1,600.00
6	QA	*Quercus alba*	White Oak	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 4,000.00
17	QB	*Quercus bicolor*	Swamp White Oak	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 6,800.00
16	QR	*Quercus rubra*	Red Oak	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 6,400.00
15	QM	*Quercus macrocarpa*	Burr Oak	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 6,000.00
15	TA	*Tilia americana 'Redmond'*	Redmond American Basswood	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 6,000.00
18	TP	*Thuja plicata*	Western Giant Arborvitae	8' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 7,200.00

FRONT YARD & COMMUNITY SPACE PLANTINGS

SHRUBS

10	PO	*Physocarpus o. 'Coppertina'*	Coppertina Ninebark	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 500.00
21	SP	*Syringa p. 'Miss Kim'*	Miss Kim Dwarf Korean Lilac	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 1,050.00
21	HP	*Hydrangea p. 'Little Quick Fire'*	Little Quick Fire Hydrangea	36" ht.	as shown	cont.	Well rooted	$ 50.00	$ 1,050.00
33	FG	*Fothergilla gardenii "Mt. Airy'*	Dwarf Fothergilla	24" ht.	as shown	cont.	Well rooted	$ 50.00	$ 1,650.00
113	TD	*Taxus x m. 'Densiformis'*	Dense Yew	24" ht.	24" o.c.	B&B	Trim to Hedge	$ 50.00	$ 5,650.00
14	TW	*Taxus x m. 'Wardii'*	Wards Yew	24" ht.	as shown	B&B	Trim to Hedge	$ 50.00	$ 700.00
33	SJ	*Spirea japonica 'Neon Flash'*	Neon Flash Spirea	24" ht.	as shown	cont.	Well rooted	$ 50.00	$ 1,650.00
16	JP	*Juniperus c. 'Pfitzeriana Compacta'*	Compact Pfitzer Juniper	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 800.00
110	WF	*Weigela f. 'Spilled Wine'*	Spilled Wine Weigela	18" ht.	as shown	cont.	Well rooted	$ 50.00	$ 5,500.00

PERENNIALS

43	RF	*Rudbeckia f. 'Goldstrum'*	Black-eyed Susan	#1	as shown	cont.	Well rooted	$ 15.00	$ 645.00
9	PV	*Panicum v. 'Heavy Metal'*	Heavy Metal Switchgrass	#2	as shown	cont.	Well rooted	$ 15.00	$ 135.00
42	CA	*Calamagrostis a. Karl Foerster'*	Karl Foerster Feather Reed Grass	#2	as shown	cont.	Well rooted	$ 15.00	$ 630.00
105	SA	*Sedum 'Autumn Fire'*	Autumn Fire Sedum	#1	as shown	cont.	Well rooted	$ 15.00	$ 1,575.00
54	HH	*Hemercalis 'Happy Returns'*	Happy Returns Daylily	#1	as shown	cont.	Well rooted	$ 15.00	$ 810.00

BUFFER TYPE 'C' PLANTINGS

TREES

4	AG	*Amalanchier x g. 'Autumn Brilliance'*	Autumn Brilliance Serviceberry	7' ht.	as shown	B&B	Minimum 5 stems	$ 400.00	$ 1,600.00
7	CK	*Cornus kousa 'Milkyway'*	Milkyway Kousa Dogwood	2" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 2,800.00
1	MP	*Malus 'Prairie Fire'*	Prairie Fire Crabapple	2" cal.	as shown	B&B	Single straight trunk	$ 325.00	$ 325.00
1	QM	*Quercus macrocarpa*	Burr Oak	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 400.00
5	AS	*Acer s. 'Green Mountain'*	Green Mountain Sugar Maple	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 2,000.00
3	LT	*Liriodendron tulipfera*	Tulip Tree	3" cal.	as shown	B&B	Single straight trunk	$ 400.00	$ 1,200.00
8	PA	*Picea abies*	Norway Spruce	10' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 3,200.00
6	PS	*Pinus strobus*	Eastern White Pine	10' ht.	as shown	B&B	Unsheared, branched to ground	$ 400.00	$ 3,200.00

SHRUBS

9	PO	*Physocarpus o. 'Coppertina'*	Coppertina Ninebark	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 450.00
8	SP	*Syringa p. 'Miss Kim'*	Miss Kim Dwarf Korean Lilac	30" ht.	as shown	cont.	Well rooted	$ 50.00	$ 400.00
10	VS	*Viburnum p.t. 'Summer Snowflake'*	Summer Snowflake Viburnum	36" ht.	as shown	B&B		$ 50.00	$ 500.00

STREET TREE PLANTINGS

TREES

10	PB	*Platanus x. acerifolia 'Bloodgood'*	Bloodgood London Plane Tree	3" cal.	as shown	B&B	Single straight trunk	$ 425.00	$ 4,250.00
5	UVF	*Ulmus americana 'Valley Forge'*	Valley Forge American Elm	3" cal.	as shown	B&B	Single straight trunk	$ 425.00	$ 2,125.00
20	TC	*Tilia cordata 'Greenspire'*	Greenspire Linden	3" cal.	as shown	B&B	Single straight trunk	$ 425.00	$ 8,500.00

Irrigation estimate	$ 15,000.00
Landscape Cost Estimate	**$ 171,745.00**

LB Landscape Bond — Landscape Bond = $171,745 plus inspection fees.

Maintenance Notes

The owner of the property shall be responsible for all maintenance of site landscaping, as follows:

A. Landscaping shall be kept in a neat, orderly and healthy growing condition, free from debris and refuse.

B. Pruning shall be minimal at the time of installation, only to remove dead or diseased branches. Subsequent pruning shall assure proper maturation of plants to achieve their approved purpose.

C. All dead, damaged, or diseased plant material shall be removed immediately and replaced within six (6) months after it dies or in the next planting season, whichever occurs first. For purposes of this section, the planting season for deciduous plants shall be between March 1 and June 1 and from October 1 until the prepared soil becomes frozen. The planting season for evergreen plants shall be between March 1 and June 1. Plant material installed to replace dead or diseased material shall be as close as practical to the size of the material it is intended to replace. The City may notify property owners of the need to replace dead, damaged, or diseased material.

D. The approved landscape plan shall be considered a permanent record and integral part of the Site Plan Approval. Unless otherwise approved in accordance with the aforementioned procedures, any revisions to or removal of plant materials, or non-compliance with the maintenance requirements of this *Section 138-12.109* will place the parcel in non-conformity with the approved landscape plan and be a violation of this ordinance.

E. If protected trees are damaged, a fine shall be issued on an inch-by-inch basis at a monetary rate as defined by the Forestry Department.

Whenever a landscape planting screen or other plantings are required under this ordinance, such plantings shall be installed according to accepted good planting procedures and in a sound, workmanlike manner. All plant material shall meet current standards of the American Association of Nurserymen and approved by the American National Standards Institute, Inc. (ANSI 260.1, 1996).

A. All plant material shall be true to name in conformance to the current edition of Standardized Plant Names established by the American Joint Committee on Horticultural Nomenclature, or other source accepted by the City.

B. All plant material shall be nursery grown in a northern climate; hardy to the climate of Michigan; appropriate for the soil, climatic and environmental conditions; and resistant to disease and insect attack.

C. A minimum four (4) inches of topsoil shall be provided for all lawn areas, ground covers, and planting beds.

D. Artificial plant material is prohibited and shall not be used to meet the requirements of this Article.

To assist in maintaining plant materials in a healthy condition, all landscaped areas (including lawns) shall be provided with an automatic, underground, or drip irrigation system, subject to the following:

A. The Planning Department may approve an alternative form of irrigation for a particular site, or may waive this requirement upon determining that underground irrigation is not necessary for the type of proposed plant materials.

B. All automatic irrigation systems shall be designed to minimize water usage, and shall be shut off during water emergencies, periods of protracted rainfall, or water rationing periods.

NOT FOR CONSTRUCTION

0 15 30 60

SCALE: 1" = 30'-0"

NORTH

CITY FILE #22-037 SECTION #32

811 Know what's below Call before you dig
MISS DIG System, Inc. www.missdig.net

VVLA vert verde landscape architecture
734.249.3568 Plymouth, MI
james@vertverde.com

Issued For:

11.15.2022	Site Plan Review
04.25.2023	Revision per City comments
08.22.2023	Revision per City comments
01.10.2024	Revisions
01.18.2024	Revisions
03.12.2024	Revisions
05.22.2024	Revisions
07.11.2025	Revisions

Project:

AUBURN ANGARA OAKS

West Auburn Road
Rochester Hills, Michigan

Project Sponsor:

Three Oaks Communities, LLC
P.O. Box 8307
Ann Arbor, MI 48107

Sheet Name:

Landscape Plan South

Seal:

STATE OF MICHIGAN · JAMES GRAY · LANDSCAPE ARCHITECT · No. 1528 · REGISTERED LANDSCAPE ARCHITECT

Drawn:	JG
Checked:	JG
Date:	10.2022
Scale:	1" = 30'-0"

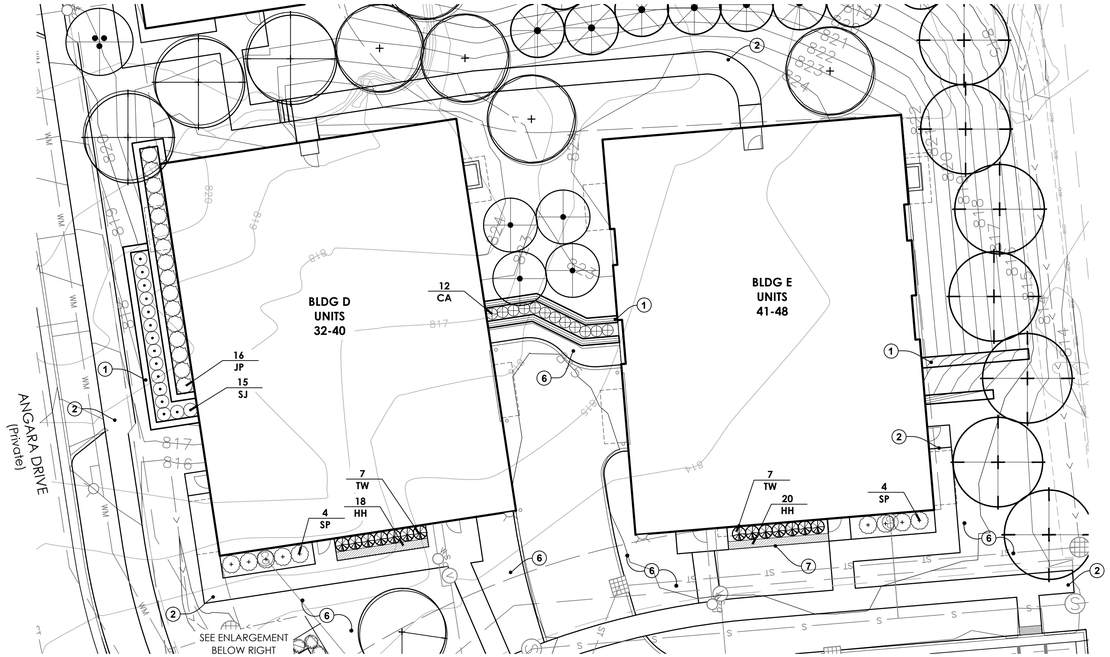
Project Number: 22.025

Sheet Number: L-5

TYPICAL FRONT YARD LANDSCAPES: BLDGs A-C

SCALE: 1" = 10'-0"

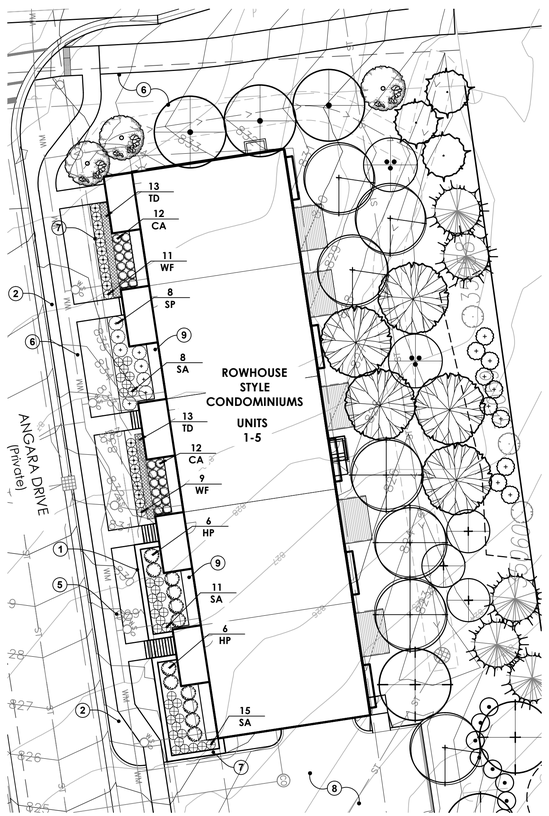
0 5 10 20



LANDSCAPE ENLARGEMENT: BLDGs D&E

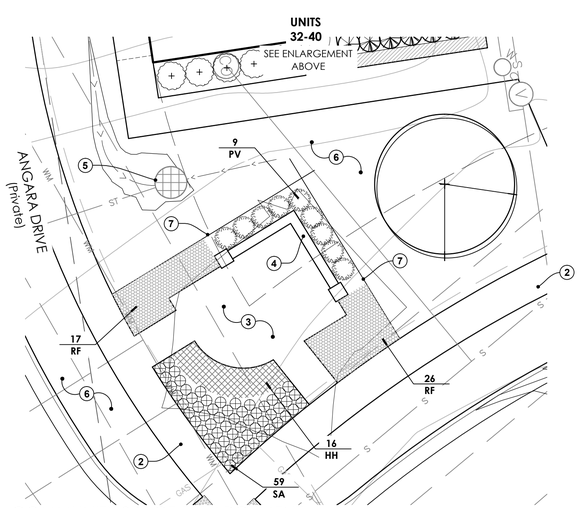
SCALE: 1/16" = 1'-0"

0 8 16 32



FRONT YARD LANDSCAPE: BLDG F

0 5 10 20



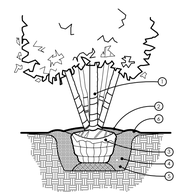
COMMUNITY SPACE ENLARGEMENT

SCALE: 1" = 10'-0"

0 5 10 20

NOTES:
1. CONTRACTOR TO VERIFY PERCOLATION OF PLANTING PIT PRIOR TO INSTALLATION
2. SET TOP OF ROOTBALL 2" ABOVE FINISH GRADE

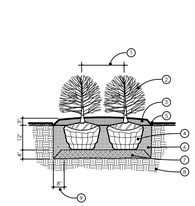
1. REMOVE ALL TAGS, STRINGS, PLASTICS, AND ANY OTHER MATERIALS WHICH ARE UNSIGHTLY OR COULD CAUSE GIRDLING.
2. COVER PLANTING W/ 3" DOUBLE SHREDDED HARDWOOD BARK MULCH, MINIMUM 4' DIA. LEAVE 3" CIRCLE OF BARE SOIL AROUND BASE OF THE STEMS.
3. REMOVE ALL NON-BIODEGRADABLE MATERIALS FROM THE ROOTBALL. FOLD DOWN ALL BURLAP AND REMOVE WIRE BASKET FROM THE TOP 1/3 OF THE ROOTBALL.
4. PLANT MIX
5. TREE PIT TO BE THREE TIMES WIDTH OF ROOTBALL
6. 4" TOPSOIL SAUCER



MULTISTEM TREE PLANTING
NOT TO SCALE

NOTES:
1. CONTRACTOR TO VERIFY PERCOLATION OF PLANTING PIT PRIOR TO INSTALLATION
2. SET TOP OF ROOTBALL 2" ABOVE FINISH GRADE

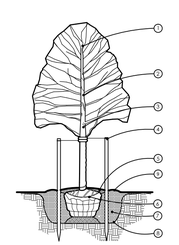
1. SEE PLAN FOR SPACING
2. SHRUBS, SEE PLANT SCHEDULE
3. 3" DEPTH DOUBLE SHREDDED HARDWOOD MULCH, TYPICAL
4. REMOVE ALL NON-BIODEGRADABLE TWINE FROM ENTIRE ROOTBALL. REMOVE BURLAP FROM TOP 1/3 OF ROOTBALL.
5. SHOVEL CUT OR METAL EDGE, SEE PLAN
6. EXCAVATE EXISTING SOIL TO 12" DEPTH, REPLACE WITH PLANT MIX
7. SCARIFY TO 4" DEPTH AND RECOMPACT
8. UNDISTURBED SUBGRADE
9. MINIMUM 8" BETWEEN ROOTBALL AND EDGE OF PLANTING PIT



SHRUB PLANTING
NOT TO SCALE

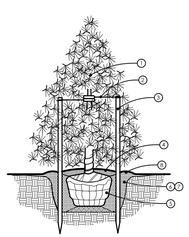
1. REMOVE SECONDARY LEADERS. DO NOT PRUNE TERMINAL LEADER OR BRANCH TOPS. PRUNE ALL DEAD AND BROKEN BRANCHES.
2. REMOVE ALL TAGS, STRINGS, PLASTICS, AND ANY OTHER MATERIALS WHICH ARE UNSIGHTLY OR COULD CAUSE GIRDLING.
3. STAKE TREES JUST BELOW FIRST BRANCH W/ TWO WIDE BELT-LIKE, FABRIC STRAPS ONLY, ARBOR TIE OR APPROVED EQUAL. (CONNECT FROM TREE TO STAKE OPPOSITE FROM EACH OTHER, AND ALLOW FOR SOME "FLEXING") DO NOT USE WIRE OR ROPE THROUGH A HOSE. REMOVE AFTER ONE YEAR.
4. (2) 2"X2" HARDWOOD STAKES OR EQUIVALENT DRIVEN 6'-8" OUTSIDE OF ROOTBALL. REMOVE AFTER ONE YEAR.
5. COVER PLANTING W/ 3" DOUBLE SHREDDED HARDWOOD BARK MULCH, MINIMUM 4' DIA. LEAVE 3" CIRCLE OF BARE SOIL AROUND THE BASE OF THE TRUNK.
6. REMOVE ALL NON-BIODEGRADABLE MATERIALS FROM THE ROOTBALL. FOLD DOWN ALL BURLAP AND REMOVE WIRE BASKET FROM THE TOP 1/3 OF THE ROOTBALL.
7. PLANT MIX
8. TREE PIT TO BE 3 TIMES WIDTH OF ROOTBALL
9. 4" TOPSOIL SAUCER

NOTE:
TREE SHALL BEAR SAME RELATION TO FINISH GRADE AS IT BORE ORIGINALLY OR SLIGHTLY HIGHER THAN FINISH GRADE UP TO 4" ABOVE GRADE, IF DIRECTED BY LANDSCAPE ARCHITECT FOR HEAVY CLAY SOIL AREAS.



DECIDUOUS TREE PLANTING
NOT TO SCALE

1. REMOVE ALL TAGS, STRINGS, PLASTICS, AND ANY OTHER MATERIALS WHICH ARE UNSIGHTLY OR COULD CAUSE GIRDLING.
2. STAKE TREES WITH 2-3" WIDE BELT-LIKE, FABRIC STRAPS ONLY. ARBOR TIE OR APPROVED EQUAL. (CONNECT FROM TREE TO STAKE OPPOSITE FROM EACH OTHER, AND ALLOW FOR SOME "FLEXING") DO NOT USE WIRE OR ROPE THROUGH A HOSE. REMOVE AFTER ONE YEAR.
3. (3) 2"X2" HARDWOOD STAKES OR EQUIVALENT DRIVEN 6-8' OUTSIDE OF ROOTBALL. REMOVE AFTER ONE YEAR.
4. COVER PLANTING W/ 3" SHREDDED HARDWOOD BARK MULCH. MINIMUM 6' DIAMETER. CONNECT EVERGREEN PLANTINGS WHERE POSSIBLE
5. REMOVE ALL NON-BIODEGRADABLE MATERIALS FROM THE ROOTBALL. FOLD DOWN ALL BURLAP AND REMOVE WIRE BASKET FROM THE TOP 1/3 OF THE ROOTBALL.
6. PLANT MIX
7. TREE PIT TO BE 3 TIMES WIDTH OF ROOTBALL
8. 4" TOPSOIL SAUCER



EVERGREEN TREE PLANTING
NOT TO SCALE

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NOTE KEY:

1. RETAINING WALL, SEE CIVIL DRAWINGS
2. CONCRETE SIDEWALK, TYPICAL
3. PROPOSED CONCRETE PATIO / PUBLIC OUTDOOR SEATING AND GATHERING SPACE
4. PROPOSED 18" HT. PRECAST CONCRETE BLOCK SEAT WALL AND PIERS. UNILOCK BRUSSELS BLOCK OR EQUAL
5. PROPOSED UTILITY, PROTECT AS REQUIRED DURING CONSTRUCTION
6. SODDED LAWN OVER MINIMUM 4" DEPTH TOPSOIL TO LIMITS OF DISTURBANCE
7. METAL EDGING BETWEEN LAWN AND LANDSCAPE BED
8. PROPOSED ASPHALT PARKING LOT
9. CONCRETE SLAB - POTTED PLANTINGS AND FURNITURE BY OWNER

NORTH

NOTE: SEE SHEET L-5 FOR PLANT SCHEDULE

CITY FILE #22-037 SECTION #32

VVLA vert verde landscape architecture
734.249.3568 Plymouth, MI
james@vertverde.com

Issued For:

04.25.2023	Revision per City comments
08.22.2023	Revision per City comments
01.10.2024	Revisions
01.18.2024	Revisions
03.12.2024	Revisions
05.22.2024	Revisions
07.11.2025	Revisions

Project:

AUBURN ANGARA OAKS

West Auburn Road
Rochester Hills, Michigan

Project Sponsor:

Three Oaks Communities, LLC
P.O. Box 8307
Ann Arbor, MI 48107

Sheet Name:

Enlargements & Landscape Details

NOT FOR CONSTRUCTION

Seal:

STATE OF MICHIGAN
JAMES GRAY
LANDSCAPE ARCHITECT
No. 1528
REGISTERED LANDSCAPE ARCHITECT

Drawn:	JG
Checked:	JG
Date:	10.2022
Scale:	AS NOTED

Project Number:
22.025

Sheet Number:
L-6

PROPOSED REDI-ROCK® RETAINING WALLS
"AUBURN ANGARA OAKS"
CITY OF ROCHESTER HILLS, OAKLAND COUNTY, MI

RETAINING WALL PLANS
AND
ENGINEERING CALCULATIONS

PREPARED FOR:

Mr. BRUCE MICHAEL
AUBURN ANGARA OAKS, LLC
14496 N. SHELDON RD., SUITE 230
PLYMOUTH, MI 49180
Phone: (248)703-4653
Email: bruce@three-oaks.com

PROJECT NO.: 25-102

APRIL 28, 2025

GES-LLC
Civil Engineering ♦ Surveying ♦ Consulting

5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-787-0008
E-MAIL: daniel_rwdesign@yahoo.com

GES-LLC
Civil Engineering ♦ Surveying ♦ Consulting

5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-272-9763
E-MAIL: ges734@gmail.com

April 28, 2025

Mr. Bruce Michael
Project Manager
Auburn Angara Oaks, LLC
14496 N. Sheldon Road, Suite 230
Plymouth, MI 49180
Phone: (248)703-4653
E-mail: bruce@three-oaks.com

Re: **Proposed Redi-Rock® Retaining Walls**
Shop drawings and Engineering Calculations
"Auburn Angara Oaks"
City of Rochester Hills, Oakland County, MI
GES-LLC Project No.: 25-102

Dear Mr. Michael:

Per your request, GES-LLC has prepared the shop drawings and engineering calculations for the proposed Redi-Rock® gravity type walls for the above referenced project. The information related to locations, elevations and wall height are based on the "Grading Plan-South", Sheet C-7.2, prepared by MEGA, Inc., dated 04-01-2054, document supplied by you via email.

RediWall Wall® Software was used for supporting engineering calculations with the project specifications, including overturning, sliding resistance, bearing capacity, slope stability / internal compound stability. Our stability analysis calculations indicate that the designed retaining wall sections will have adequate safety factors with respect to these failure mechanisms if the wall is constructed in accordance with GES-LLC Plans and Specifications, dated 04-28-2025.

Attached are the engineering supporting calculations and shop drawings for your use and reproduction.

Thank you for the opportunity to provide our services to you on this project. If there are any questions or concerns regarding to this letter, plans, or engineering calculations, please contact us at **734-787-0008** or **daniel_rwdesign@yahoo.com**.

Sincerely,

GES-LLC

Daniel Horotan
RW Designer

Majed El Ghussaini, P.E.
President

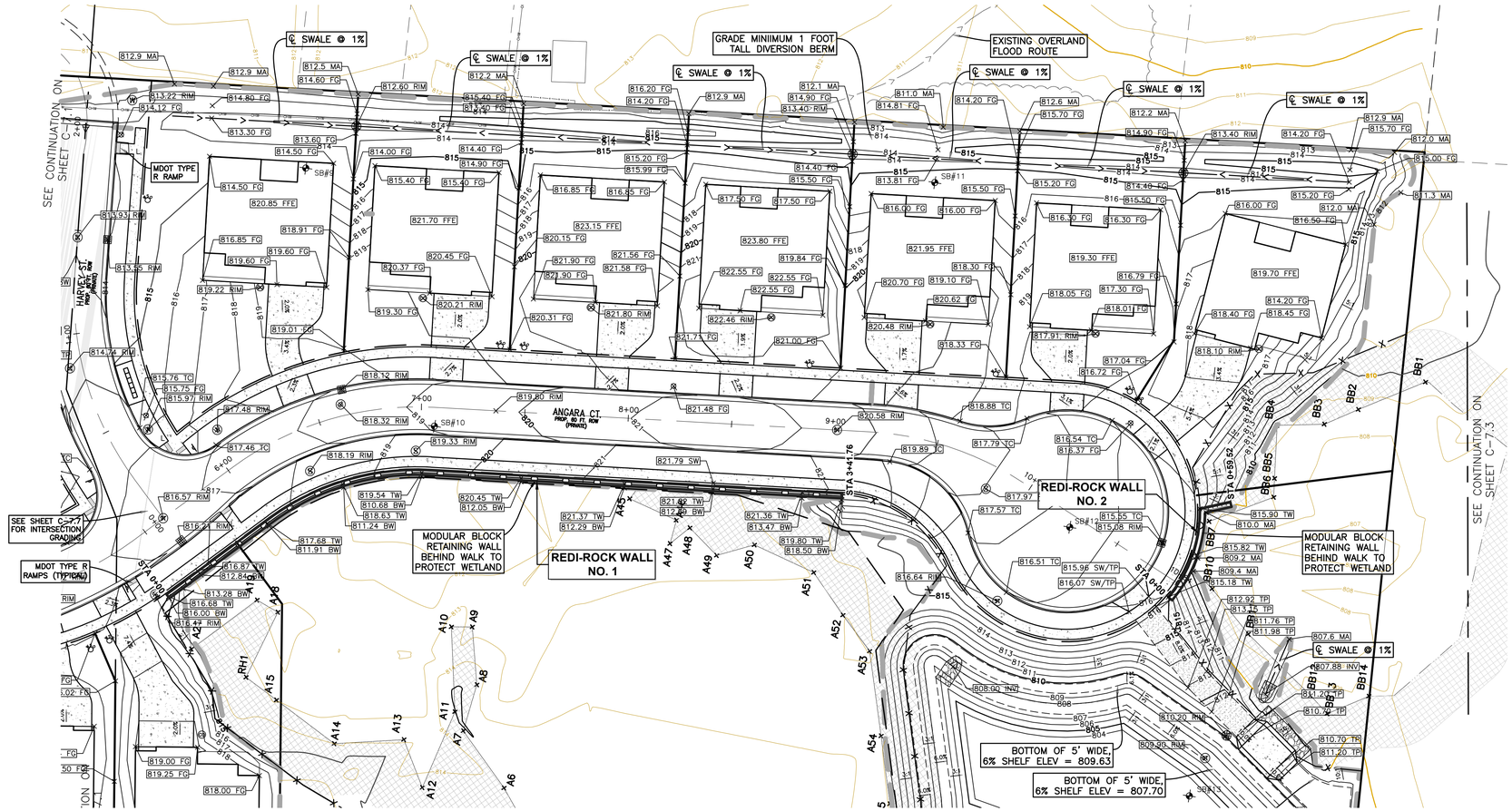
Enclosures: Engineering calculations and shop drawings

RETAINING WALL DESIGN AND DETAILS

PREPARED FOR:

PROPOSED REDI-ROCK RETAINING WALLS
AUBURN ANGARA OAKS

CITY OF ROCHESTER HILLS, OAKLAND COUNTY, MI



SCHEMATIC PLAN VIEW

SCALE: N.T.S.

NOTE:
- THE PLAN VIEW IS FOR ILLUSTRATION PURPOSES ONLY.
- WALLS MUST BE LAID OUT BY A REGISTERED LAND SURVEYOR BASED ON THE PROJECT GRADING PLANS.

INDEX

DATE	REVISIONS	BY
04-28-25	SUBMITTAL	M.G.

DATE	REVISIONS	BY

CLIENT:

AUBURN ANGARA OAKS, LLC
14496 N. SHELDON RD., SUITE 230
PLYMOUTH, MI 49180
Phone: (248)703-4653
Email: bruce@three-oaks.com

DESIGN BY:	D.H.
CHECKED BY:	M.G.
APPROVED BY:	M.G.

STATE OF MICHIGAN
MAJED A. EL GHUSSAINI
ENGINEER
No. 046886
LICENSED PROFESSIONAL ENGINEER

SEAL:

GES-LLC
Civil Engineering ♦ Surveying ♦ Consulting
5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-787-0008

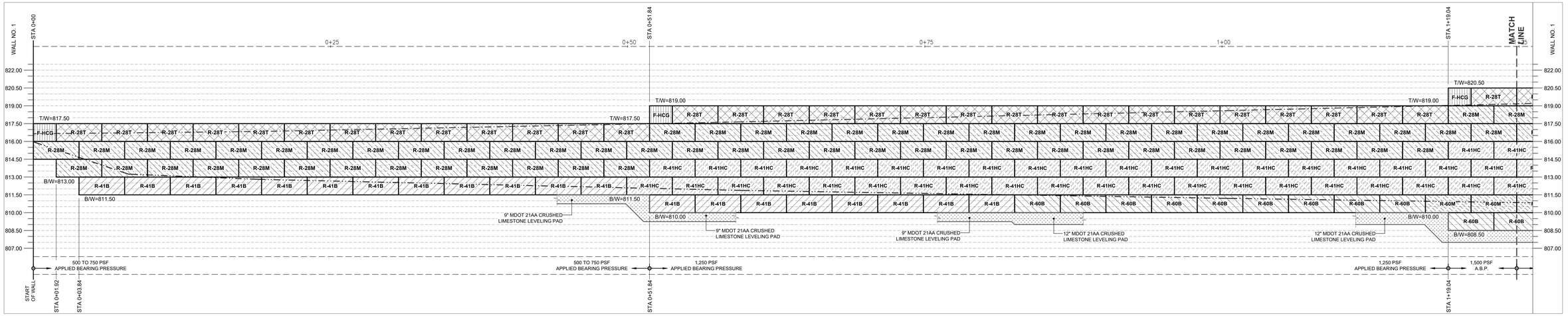
PROPOSED REDI-ROCK® RETAINING WALLS
AUBURN ANGARA OAKS
CITY OF ROCHESTER HILLS, OAKALND COUNTY, MI

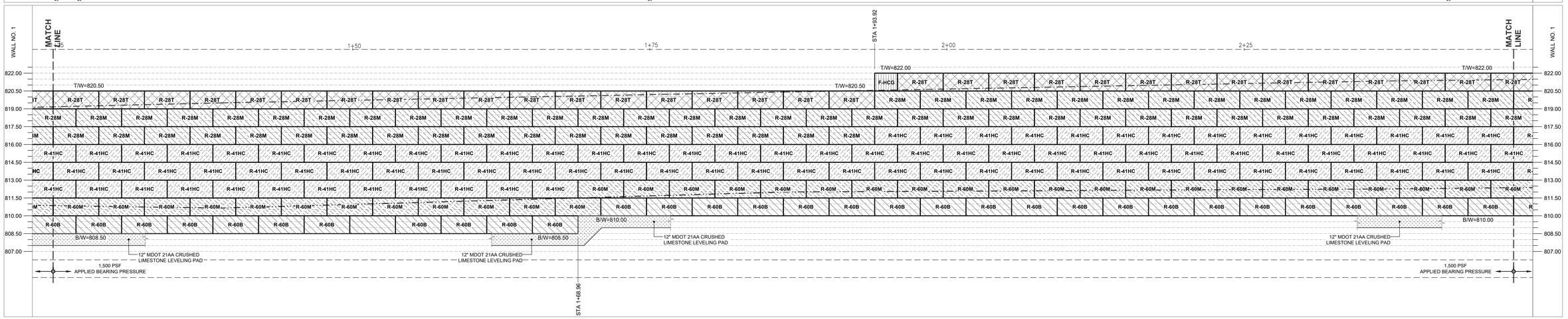
TITLE SHEET

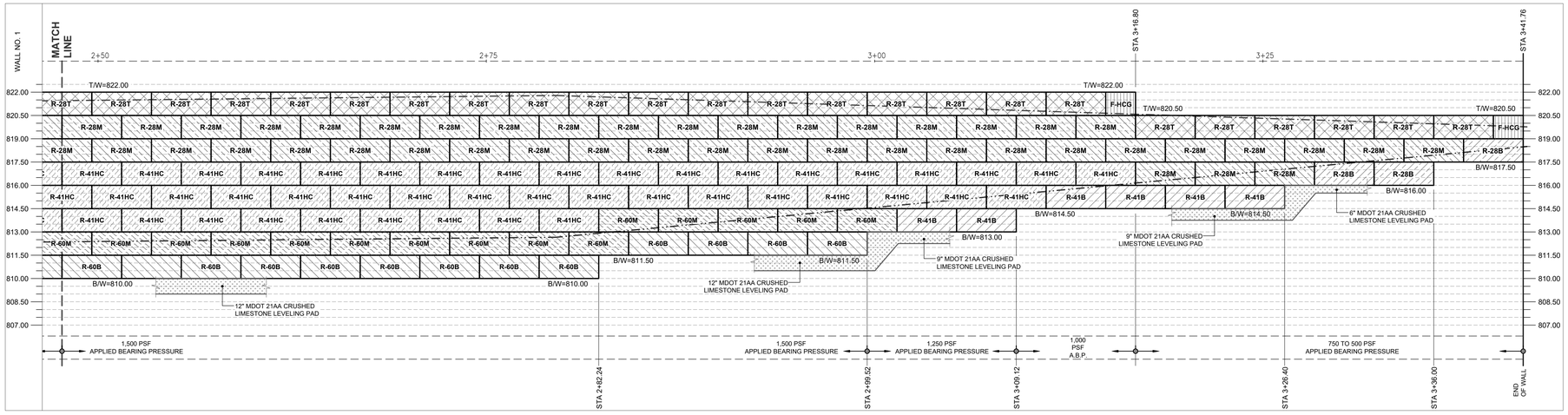
SCALE: AS NOTED

PROJECT No.: 25-102

SHEET No.: RW-0







NOTES:

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2. DESIGN IS BASED ON THE "GRADING PLAN - SOUTH" (SHEET C-7.2), PREPARED BY MEGA, INC., DATED 04-02-25. THE CONTRACTOR IS RESPONSIBLE TO FIELD VERIFY ALL ELEVATIONS AND DIMENSIONS SHOWN ON THE CURRENT RETAINING WALL SHOP DRAWINGS PRIOR TO CONSTRUCT THE WALL. ANY DISCREPANCIES OR DIFFERENCES SHOULD BE CORRECTED PRIOR TO WALL INSTALLATION.
3. MAINTAIN MIN. BURIED BLOCKS AS SHOWN IN ELEVATION VIEW (MIN. 6-INCH).
4. WALL TO BE SUPPORTED ON 6-INCH TO 12-INCH MIN. MDOT 21AA CRUSHED LIMESTONE LEVELING PAD, COMPACTED TO MIN. 95% OF MAX. DRY DENSITY (MODIFIED PROCTOR).
5. FALL PROTECTION FENCING WHERE APPLICABLE SHALL BE INSTALLED IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL CODES. TO BE DESIGN BY OTHERS AND INSTALLED BY OWNER'S FENCING CONTRACTOR. SEE SHEET RW-2 FOR TYPICAL REDI-ROCK DETAILS.
6. 4" MIN. DIA. PERFORATED DRAIN TILE WRAPPED IN FILTER FABRIC TO BE DAYLIGHTED AT MAX. 50 FEET C/C AND AT END OF WALLS WITH RODENT GUARD OR CONNECTED TO THE SITE STORM SYSTEM, APPROVED BY CIVIL ENGINEER.
7. THE ELEVATIONS SHOWN ON THE PLANS ARE FOR REFERENCES ONLY. WALL STATION NUMBERS REFERS TO FRONT OF WALL. THE WALL SHALL BE LAID-OUT BY A CERTIFIED LAND SURVEYOR.

DATE	REVISIONS	BY
04-28-25	SUBMITTAL	M.G.

DATE	REVISIONS	BY

1 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG
1-800-482-7171
(TOLL FREE)

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL UTILITIES BEFORE COMMENCING WORK, AND AGREES THAT HE WILL BE SOLELY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NOTICE:
PURSUANT TO NEW YORK STATE LABOR LAW 241(6), THE CONTRACTOR SHALL BE RESPONSIBLE FOR COMPLIANCE WITH ALL APPLICABLE PROVISIONS OF THE INDUSTRIAL CODE REGULATIONS. NEITHER THE OWNER NOR THE ENGINEER SHALL BE EXPECTED TO ASSUME ANY RESPONSIBILITY FOR SAFETY OF THE WORK, OF PERSONS ENGAGED IN THE WORK, OF ANY NEARBY STRUCTURES, OR OF ANY OTHER PERSONS.

CLIENT:

AUBURN ANGARA OAKS, LLC
14496 N. SHELDON RD., SUITE 230
PLYMOUTH, MI 49180
Phone: (248)703-4653
Email: bruce@three-oaks.com

DESIGN BY:	D.H.
CHECKED BY:	M.G.
APPROVED BY:	M.G.

STATE OF MICHIGAN
MAJED J. EL GHUSSAINI
ENGINEER
No. 046886
LICENSED PROFESSIONAL ENGINEER

SEAL:

GES-LLC
Civil Engineering ♦ Surveying ♦ Consulting
5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-787-0008

PROPOSED REDI-ROCK® RETAINING WALLS

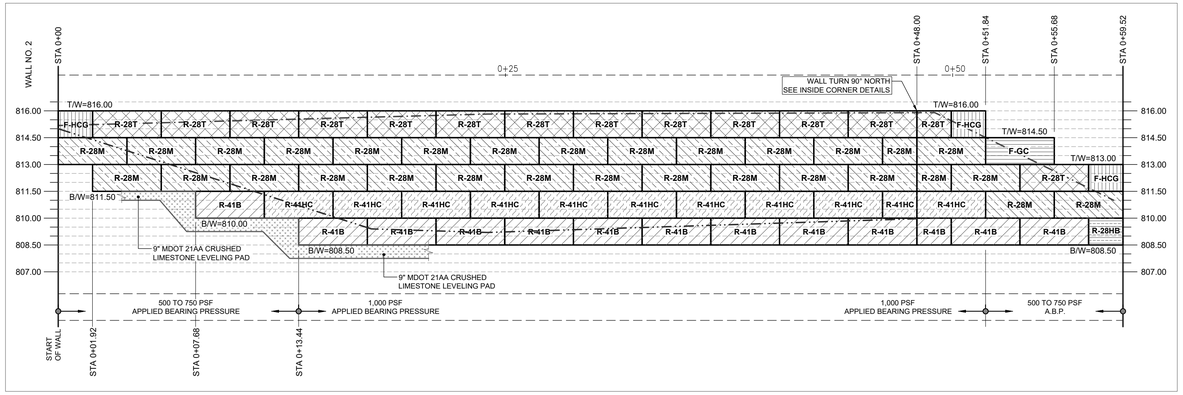
AUBURN ANGARA OAKS
CITY OF ROCHESTER HILLS, OAKALND COUNTY, MI

WALL ELEVATION

SCALE:
4 0 2 4
GRAPHIC SCALE 1"= 4'

PROJECT No.: 25-102

SHEET No.: RW-1.1



NOTES:

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REDI-ROCK

LEGEND:		QUANTITIES
F-HCG	HALF CORNER GARDEN TOP	= 9 BLOCKS
F-GC	CORNER GARDEN TOP	= 1 BLOCK
R-28T	28-INCH TOP	= 100 BLOCKS
R-28M	28-INCH MIDDLE	= 203 BLOCKS
R-28B	28-INCH BOTTOM	= 3 BLOCKS
R-28HB	28-INCH HALF BOTTOM	= 1 BLOCK
R-41HC	41-INCH HOLLOW CORE	= 184 BLOCKS
R-41B	41-INCH BOTTOM	= 39 BLOCKS
R-60M	60-INCH MIDDLE	= 49 BLOCKS
R-60B	60-INCH BOTTOM	= 53 BLOCKS
	6" TO 9" THICK MDOT 21AA CRUSHED LIMESTONE LEVELING LAYER (TYP.)	
	FINISH GRADE AT TOP OF WALL	
	FINISH GRADE IN FRONT OF WALL	
T/W=100.00	TOP OF WALL ELEVATION	
B/W=100.00	BOTTOM OF WALL ELEVATION	

DATE	REVISIONS	BY
04-28-25	SUBMITTAL	M.G.

DATE	REVISIONS	BY

3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG 1-800-482-7171 (TOLL FREE)

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NOTICE:
CONSTRUCTION SITE SAFETY IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR; NEITHER THE PROFESSIONAL ENGINEER NOR THE OWNER SHALL BE RESPONSIBLE FOR SAFETY OF THE WORK, OF PERSONS ENGAGED IN THE WORK, OF ANY ADJACENT STRUCTURES, OR OF ANY OTHER PERSONS.

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Phone: (248)703-4653
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DESIGN BY:	D.H.
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GES-LLC

STATE OF MICHIGAN
MAJED A. EL GHUSSAINI
ENGINEER
No.: 040838
LICENSED PROFESSIONAL ENGINEER

SEAL:

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Civil Engineering ♦ Surveying ♦ Consulting
5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-787-0008

PROPOSED REDI-ROCK® RETAINING WALLS

AUBURN ANGARA OAKS
CITY OF ROCHESTER HILLS, OAKALND COUNTY, MI

WALL ELEVATION

SCALE: 4 0 2 4
GRAPHIC SCALE 1" = 4'

PROJECT No.: 25-102

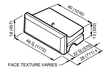
SHEET No.: RW-1.2

RETAINING BLOCKS

28" Series

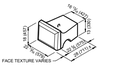
R-28T 28" (710mm) TOP

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1230 lb (557 kg)	1160 lb (530 kg)
Block Volume:	8.07 ft³ (0.243 m³)	8.07 ft³ (0.229 m³)
Center of Gravity:	14.9" (378mm)	14.2" (360mm)



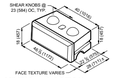
R-28HT 28" (710mm) HALF TOP

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	570 lb (260 kg)	540 lb (240 kg)
Block Volume:	4.01 ft³ (0.113 m³)	3.76 ft³ (0.106 m³)
Center of Gravity:	15.3" (389 mm)	14.7" (373 mm)



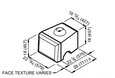
R-28M 28" (710mm) MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1610 lb (730 kg)	1540 lb (700 kg)
Block Volume:	11.28 ft³ (0.319 m³)	10.78 ft³ (0.305 m³)
Center of Gravity:	13.9" (354 mm)	13.4" (340 mm)



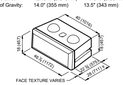
R-28HM 28" (710mm) HALF MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	750 lb (340 kg)	710 lb (320 kg)
Block Volume:	5.23 ft³ (0.148 m³)	4.88 ft³ (0.141 m³)
Center of Gravity:	14.3" (364 mm)	13.8" (350 mm)



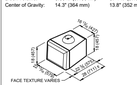
R-28B 28" (710mm) BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1740 lb (790 kg)	1670 lb (760 kg)
Block Volume:	12.19 ft³ (0.345 m³)	11.70 ft³ (0.331 m³)
Center of Gravity:	14.0" (355 mm)	13.5" (343 mm)



R-28HB 28" (710mm) HALF BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	810 lb (370 kg)	770 lb (350 kg)
Block Volume:	5.66 ft³ (0.160 m³)	5.41 ft³ (0.153 m³)
Center of Gravity:	14.3" (364 mm)	13.8" (352 mm)

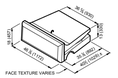


RETAINING BLOCKS

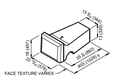
41" Series

R-41T 41" (1030mm) TOP *

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1750 lb (790 kg)	1660 lb (750 kg)
Block Volume:	12.22 ft³ (0.346 m³)	11.73 ft³ (0.332 m³)

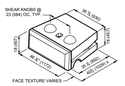


R-41HT 41" (1030mm) HALF TOP *



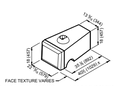
R-41M 41" (1030mm) MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	2310 lb (1050 kg)	2240 lb (1020 kg)



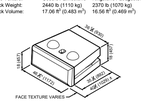
R-41HM 41" (1030mm) HALF MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone



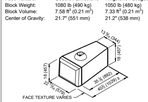
R-41B 41" (1030mm) BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	2440 lb (1110 kg)	2370 lb (1070 kg)
Block Volume:	17.06 ft³ (0.483 m³)	16.56 ft³ (0.469 m³)



R-41HB 41" (1030mm) HALF BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1080 lb (490 kg)	1050 lb (480 kg)
Block Volume:	7.58 ft³ (0.21 m³)	7.33 ft³ (0.21 m³)
Center of Gravity:	21.7" (551 mm)	21.2" (538 mm)

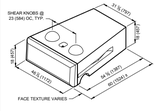


RETAINING BLOCKS

60" Series

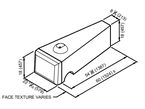
R-60M 60" (1520mm) MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	3290 lb (1490 kg)	3220 lb (1460 kg)
Block Volume:	23.00 ft³ (0.651 m³)	22.49 ft³ (0.637 m³)
Center of Gravity:	31.0" (786 mm)	30.4" (772 mm)



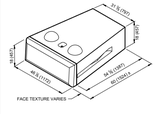
R-60HM 60" (1520mm) HALF MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1340 lb (610 kg)	1300 lb (590 kg)
Block Volume:	9.34 ft³ (0.264 m³)	9.09 ft³ (0.258 m³)
Center of Gravity:	33.7" (856 mm)	33.1" (840 mm)



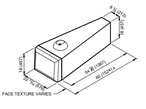
R-60B 60" (1520mm) BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	3350 lb (1520 kg)	3280 lb (1520 kg)
Block Volume:	23.90 ft³ (0.677 m³)	23.40 ft³ (0.663 m³)
Center of Gravity:	31.6" (802 mm)	31.0" (788 mm)



R-60HB 60" (1520mm) HALF BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1400 lb (630 kg)	1360 lb (620 kg)
Block Volume:	9.77 ft³ (0.277 m³)	9.52 ft³ (0.270 m³)
Center of Gravity:	34.3" (871 mm)	33.7" (856 mm)

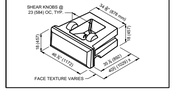


RETAINING BLOCKS

Hollow Core

R-41HC 41" (1030mm) HOLLOW-CORE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1,690 lb (780 kg)	1,620 lb (735 kg)
Block Volume:	11.83 ft³ (0.33 m³)	11.33 ft³ (0.32 m³)
Center of Gravity:	22.0" (558 mm)	21.3" (540 mm)
Infill Volume	6.53 ft³ (0.18 m³)	

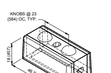


FREESTANDING BLOCKS

Free Standing

F-SM STRAIGHT MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1410 lb (640 kg)	1260 lb (570 kg)
Block Volume:	9.84 ft³ (0.279 m³)	8.84 ft³ (0.250 m ³)

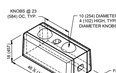


F-SG STRAIGHT GARDEN TOP

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1050 lb (480 kg)	910 lb (410 kg)
Block Volume:	7.35 ft³ (0.208 m³)	6.35 ft³ (0.180 m³)

F-SB STRAIGHT BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1320 lb (600 kg)	1300 lb (590 kg)
Block Volume:	10.65 ft³ (0.302 m³)	9.66 ft³ (0.273 m ³)



F-ST STRAIGHT TOP

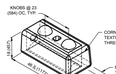
Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1380 lb (630 kg)	1230 lb (560 kg)
Block Volume:	9.61 ft³ (0.272 m³)	8.62 ft³ (0.244 m³)

FREESTANDING BLOCKS

Corner Blocks

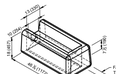
F-CM CORNER MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1370 lb (620 kg)	1360 lb (620 kg)
Block Volume:	9.6 ft³ (0.27m³)	9.5 ft³ (0.27m³)



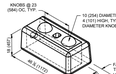
F-CG CORNER GARDEN TOP

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1070 lb (480 kg)	1060 lb (480 kg)
Block Volume:	7.5 ft³ (0.21m³)	7.4 ft³ (0.21m³)



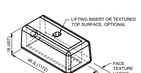
F-CB CORNER BOTTOM

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1490 lb (680 kg)	1480 lb (670 kg)
Block Volume:	10.4 ft³ (0.30m³)	10.3 ft³ (0.29m³)



F-CT CORNER TOP

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	1340 lb (610 kg)	1330 lb (600 kg)
Block Volume:	9.4 ft³ (0.26m³)	9.3 ft³ (0.26m³)

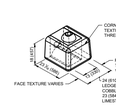


FREESTANDING BLOCKS

Half Corner Blocks

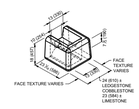
F-HCM HALF CORNER MIDDLE

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	660 lb (300 kg)	650 lb (300 kg)
Block Volume:	4.6 ft³ (0.13m³)	4.6 ft³ (0.13m³)



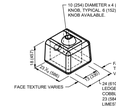
F-HCG HALF CORNER GARDEN TOP

Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	530 lb (240 kg)	530 lb (240 kg)
Block Volume:	3.7 ft³ (0.11m³)	3.7 ft³ (0.10m³)



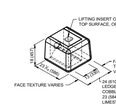
F-HCB HALF CORNER BOTTOM

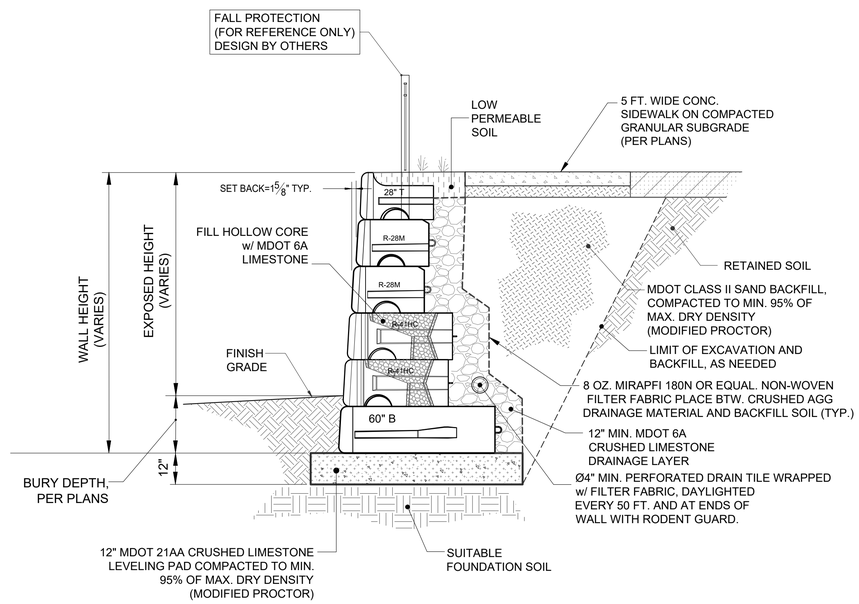
Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	710 lb (320 kg)	700 lb (320 kg)
Block Volume:	5.0 ft³ (0.14m³)	4.9 ft³ (0.14m³)



F-HCT HALF CORNER TOP

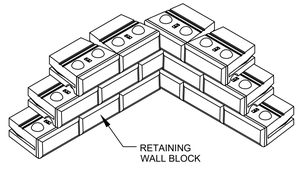
Face Texture:	Cobble / Limestone	Kingstone / Ledgestone
Block Weight:	640 lb (290 kg)	630 lb (290 kg)
Block Volume:	4.5 ft³ (0.13m³)	4.4 ft³ (0.13m³)



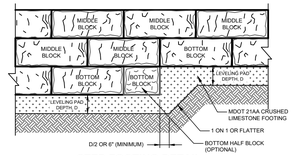


TYPICAL GRAVITY WALL SECTION
SECTION "A - A"

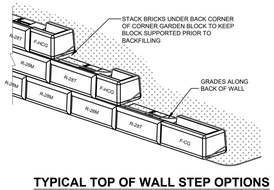
N.T.S.



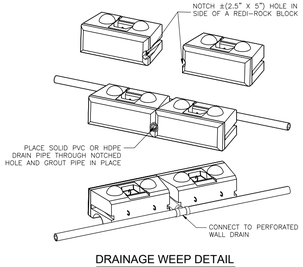
90° INSIDE CORNER VIEW
SCALE: NONE



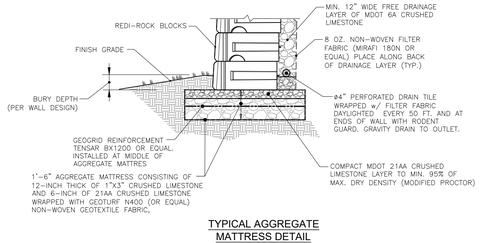
STEP FOOTING DETAIL
NO SCALE



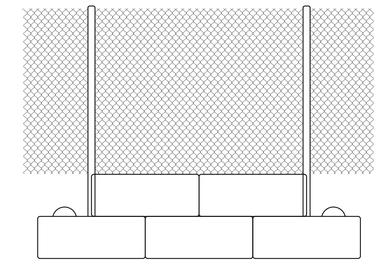
TYPICAL TOP OF WALL STEP OPTIONS
NO SCALE



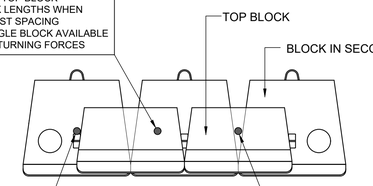
DRAINAGE WEEP DETAIL
NO SCALE



TYPICAL AGGREGATE
MATTRESS DETAIL
(IF REQ'D)

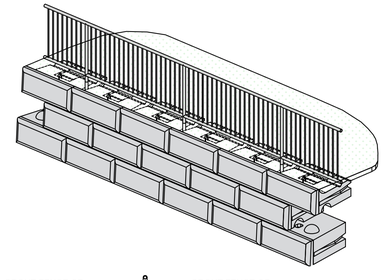


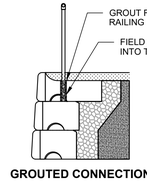
CONNECTION OPTION #1
ANCHOR INTO THE TOP BLOCK
- CONSIDER BLOCK LENGTHS WHEN DETERMINING POST SPACING
- WEIGHT OF A SINGLE BLOCK AVAILABLE TO RESIST OVERTURNING FORCES



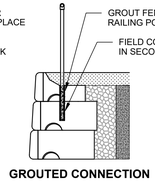
CONNECTION OPTION #2
GROUT POSTS IN V-SHAPED OPENING BETWEEN TOP BLOCKS
- SPACING IN MULTIPLES OF 46 1/8"
- WEIGHT OF A 2 ADJACENT BLOCKS AVAILABLE TO RESIST OVERTURNING FORCES

CONNECTION OPTION #3
CORE THROUGH TOP BLOCK AND GROUT POSTS IN V-SHAPED OPENING BETWEEN LOWER BLOCKS
- SPACING IN MULTIPLES OF 46 1/8" (1172 MM)
- WEIGHT OF A 2 ADJACENT BLOCKS ON SECOND LEVEL DOWN AND 3 TOP ROW BLOCKS AVAILABLE TO RESIST OVERTURNING FORCES





GROUTED CONNECTION
(1 Block)



GROUTED CONNECTION
(2 Blocks)

THESE GENERIC PEDESTRIAN GUARD AND FENCE DETAILS SHOW A FEW POTENTIAL OPTIONS FOR THEIR INSTALLATION ON THE TOP OF A REDI-ROCK RETAINING WALL. IT IS THE DESIGN ENGINEER'S RESPONSIBILITY TO FULLY DESIGN AND DETAIL THE CONNECTION OF THE GUARD POSTS TO THE RETAINING WALL BLOCKS AND ASSURE ACCEPTABLE RESISTANCE TO THE APPLIED FORCES. REDI-ROCK BLOCKS ARE PLAIN CONCRETE, WITHOUT STEEL REINFORCEMENT.

FLANGE BOLTED CONNECTION

MOMENT SLAB CONNECTION

REDI-ROCK TYPICAL
FENCE OR PEDESTRIAN
GUARD CONNECTION LOCATIONS

DATE	REVISIONS	BY
04-28-25	SUBMITTAL	M.G.

DATE	REVISIONS	BY

1 WORK DAYS
BEFORE YOU DIG
CALL MISS DIG
1-800-482-7171
(TOLL FREE)

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY AND HAVE NOT BEEN INDEPENDENTLY VERIFIED BY THE OWNER OR ITS REPRESENTATIVE. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL UTILITIES BEFORE COMMENCING WORK, AND SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NOTICE:
THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR JOB SITE SAFETY. IT IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR; NEITHER THE OWNER NOR THE ENGINEER SHALL BE EXPECTED TO ASSUME ANY RESPONSIBILITY FOR SAFETY OF THE WORK, OF PERSONS ENGAGED IN THE WORK, OF ANY NEARBY STRUCTURES, OR OTHER PROPERTY.

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14496 N. SHELDON RD., SUITE 230
PLYMOUTH, MI 49180
Phone: (248)703-4653
Email: bruce@three-oaks.com

DESIGN BY:	D.H.
CHECKED BY:	M.G.
APPROVED BY:	M.G.

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GES-LLC

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MAJED A. EL GHUSSAINI
ENGINEER
No: 046588
LICENSED PROFESSIONAL ENGINEER

SEAL:

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Civil Engineering ♦ Surveying ♦ Consulting
5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-787-0008

PROPOSED REDI-ROCK® RETAINING WALLS
AUBURN ANGARA OAKS
CITY OF ROCHESTER HILLS, OAKALND COUNTY, MI

TYPICAL WALL DETAILS

SCALE: AS NOTED
PROJECT No.: 25-102
SHEET No.: RW-2

SPECIFICATION FOR REDI-ROCK® 28"- 41"- 60" SERIES GRAVITY WALL SYSTEM

PART 1: GENERAL

1.1 SCOPE

WORK INCLUDES FURNISHING AND INSTALLING CONCRETE MODULAR RETAINING WALL UNITS AT THE LOCATIONS AND ELEVATIONS SHOWN ON "GRADING PLAN – SOUTH", PREPARED BY MEGA, INC., DATED 04–01–25.

1.2 REFERENCE STANDARDS

A. ASTM C94 READY–MIXED CONCRETE
B. ASTM C1372 SEGMENTAL RETAINING WALL UNITS
C. FHWA–NHI–10–024 VOLUME I AND GEC 11 DESIGN OF MECHANICALLY STABILIZED EARTH WALLS AND REINFORCED SOIL SLOPES.
D. FHWA–NHI–10–025 VOLUME II AND GEC 11 DESIGN OF MECHANICALLY STABILIZED EARTH WALLS AND REINFORCED SOIL SLOPES.
E. NATIONAL CONCRETE MASONRY ASSOCIATION (NCMA) DESIGN MANUAL FOR SEGMENTAL RETAINING WALLS (ASD), 3RD EDITION.
F. REDI–ROCK DESIGN RESOURCE MANUAL, V20, BY REDI–ROCK INTERNATIONAL, LLC.
G. PRECAST MODULAR BLOCK–DESIGN MANUAL FOR GRAVITY WALLS–VOL 1, BY ASTER BRANDTS, DBA OF REDI–ROCK INTERNATIONAL, LLC., 2022.
H. INTERNATIONAL BUILDING CODE 2018.
I. MICHIGAN BUILDING CODE 2018

1.3 DELIVERY, STORAGE, AND HANDLING

1. CONTRACTOR SHALL CHECK THE MATERIALS UPON DELIVERY TO ASSURE PROPER MATERIAL HAS BEEN RECEIVED.
2. CONTRACTOR SHALL PREVENT EXCESSIVE MUD, WET CEMENT AND LIKE MATERIALS FROM COMING IN CONTACT WITH THE SRW UNITS.
3. CONTRACTOR SHALL PROTECT THE MATERIALS FROM DAMAGE. DAMAGED MATERIAL SHALL NOT BE INCORPORATED IN THE PROJECT.

1.4 DEFINITIONS:

1. PRECAST MODULAR BLOCK (PMB) UNIT – MACHINE–PLACED, "WET CAST" CONCRETE MODULAR BLOCK RETAINING WALL FACING UNIT.
2. DRAINAGE AGGREGATE – CLEAN, CRUSHED STONE PLACED WITHIN AND IMMEDIATELY BEHIND THE PRECAST MODULAR BLOCK UNITS TO FACILITATE DRAINAGE AND REDUCE COMPACTION REQUIREMENTS IMMEDIATELY ADJACENT TO AND BEHIND THE PRECAST MODULAR BLOCK UNITS.
3. UNIT CORE FILL – CLEAN, CRUSHED STONE PLACED WITHIN THE HOLLOW VERTICAL CORE OF A PRECAST MODULAR BLOCK UNIT. TYPICALLY, THE SAME MATERIAL USED FOR DRAINAGE AGGREGATE AS DEFINED ABOVE.
4. FOUNDATION ZONE – SOIL ZONE IMMEDIATELY BENEATH THE LEVELING PAD.
5. RETAINED ZONE – SOIL ZONE IMMEDIATELY BEHIND THE DRAINAGE AGGREGATE AND WALL INFILL FOR WALL SECTIONS DESIGNED AS MODULAR GRAVITY STRUCTURES.
6. LEVELING PAD – HARD, FLAT SURFACE UPON WHICH THE BOTTOM COURSE OF PRECAST MODULAR BLOCKS IS PLACED. THE LEVELING PAD MAY BE CONSTRUCTED WITH CRUSHED STONE OR CAST–IN–PLACE CONCRETE. A LEVELING PAD IS NOT A STRUCTURAL FOOTING.
7. WALL INFILL – THE FILL MATERIAL PLACED AND COMPACTED BETWEEN THE DRAINAGE AGGREGATE AND THE EXCAVATED SOIL FACE IN RETAINING WALL SECTIONS DESIGNED AS MODULAR GRAVITY STRUCTURES.

PART 2: MATERIALS

2.1 WALL UNITS

A. WALL UNITS SHALL BE REDI–ROCK® BLOCKS, COLOR AND TEXTURE FINISH SUBJECT OF OWNER'S APPROVAL, AS PRODUCED BY REDI–WALL, LLC 5700 E. HIGHLAND RD., HOWELL, MI 48843.
B. WALL UNITS SHALL BE MADE WITH READY–MIXED CONCRETE IN ACCORDANCE WITH ASTM C94, LATEST REVISION.
C. EXTERIOR BLOCK DIMENSIONS SHALL BE UNIFORM AND CONSISTENT. MAXIMUM DIMENSIONAL DEVIATIONS SHALL BE 1% EXCLUDING THE ARCHITECTURAL SURFACE. MAXIMUM WIDTH (FACE TO BACK) DEVIATION INCLUDING THE ARCHITECTURAL SURFACE SHALL BE 1.0 INCH.
D. EXPOSED FACE SHALL BE FINISHED AS SPECIFIED. OTHER SURFACES TO BE SMOOTH FORM TYPE. DIME–SIZE BUG HOLES ON THE BLOCK FACE MAY BE PATCHED AND/OR SHAKE–ON COLOR STAIN CAN BE USED TO BLEND INTO THE REMAINDER OF THE BLOCK FACE.

2.2 LEVELING LAYER AND FREE DRAINING BACKFILL

A. LEVELING LAYER SHALL BE MDOT 21AA CRUSHED LIMESTONE COMPACTED TO MIN. 95% OF THE MAX. DRY DENSITY (MODIFIED PROCTOR).
B. FREE DRAINING MATERIAL SHALL BE MDOT 6A CRUSHED LIMESTONE AND SHALL BE PLACED TO A MINIMUM OF 12" WIDTH BEHIND THE BACK OF THE WALL AND SHALL EXTEND VERTICALLY FROM THE BOTTOM OF THE WALL TO AN ELEVATION 4" BELOW THE TOP OF WALL. PEA–GRAVEL IS NOT ALLOWED AS A SUBSTITUTION OF THE DRAINAGE MATERIAL.
C. ANY BACKFILL DUE TO EXCAVATION SHALL CONSIST OF MDOT CLASS II SAND, COMPACTED TO MIN. 95% OF THE MAX. DRY DENSITY (MODIFIED PROCTOR).
D. MIRAFI–180 OR EQUAL. NON–WOVEN GEOTEXTILE FABRIC SHALL BE PLACED BETWEEN THE FREE DRAINING BACKFILL MATERIAL THE AND RETAINED / BACKFILL SOIL.
E. WHERE ADDITIONAL FILL IS NEEDED, CONTRACTOR SHALL SUBMIT SAMPLE AND SPECIFICATIONS TO THE ENGINEER FOR APPROVAL.

2.3 DRAINAGE

A. EXTERNAL DRAINAGE SHALL BE EVALUATED BY THE PROJECT CIVIL ENGINEER.

PART 3: CONSTRUCTION OF WALL SYSTEM

3.1 EXCAVATION

A. CONTRACTOR SHALL EXCAVATE TO THE LINES AND GRADES SHOWN ON THE CONSTRUCTION DRAWINGS.

3.2 FOUNDATION SOIL PREPARATION

A. EXISTING UNSUITABLE SOILS, IF ENCOUNTERED, MUST BE REMOVED FROM BELOW THE LEVELING LAYER AND REPLACED WITH 21AA CRUSHED LIMESTONE OR 1"X3" CRUSHED LIMESTONE. FILL UNDERCUT AND REPLACEMENT MUST EXTEND OUTWARD AND DOWNWARD FROM THE OF LEVELING LAYER ON A SLOPE OF 2V : 1H.
B. IN CASE THE BEARING CAPACITY OF FOUNDATION SOILS DID NOT MEET THE PROJECT SPECIFICATIONS, TO INCREASE THE STRUCTURAL SUPPORT AND TO PREVENT ANY DIFFERENTIAL SETTLEMENTS, INSTALL 18–INCH GEOGRID REINFORCED AGGREGATE MATTRESS, CONSISTING OF 12–INCH OF 1X3 CRUSHED AGGREGATE AND 6–INCH OF 21AA CRUSHED LIMESTONE WRAPPED IN NON–WOVEN GEO–FABRIC, AS SHOWN ON DETAIL ON SHEET RW–2.
C. IN–SITU FOUNDATION SOIL SHALL BE EXAMINED BY THE PROJECT GEOTECHNICAL ENGINEER TO ENSURE THAT THE ACTUAL FOUNDATION SOIL STRENGTH MEETS OR EXCEEDS ASSUMED DESIGN STRENGTH. SOIL NOT MEETING THE REQUIRED STRENGTH SHALL BE REMOVED AND REPLACED WITH ACCEPTABLE, COMPACTED MATERIAL.

3.3 LEVELING LAYER PLACEMENT

A. LEVELING LAYER SHALL BE PLACED AS SHOWN ON THE CONSTRUCTION DRAWINGS.
B. LEVELING LAYER SHALL BE PLACED ON UNDISTURBED SUITABLE NATIVE SOILS OR 1"X3" CRUSHED LIMESTONE OR CRUSHED CONCRETE STABILIZED PAD, AS DIRECTED BY THE PROJECT GEOTECHNICAL ENGINEER.
C. LEVELING LAYER SHALL BE COMPACTED AND SHALL BE CONSTRUCTED TO THE PROPER ELEVATION TO ENSURE THE FINAL ELEVATION SHOWN ON THE PLANS.
D. LEVELING LAYER SHALL HAVE A 6 TO 12 INCHES MINIMUM DEPTH, AS SHOWN ON PLANS. LEVELING PAD DIMENSIONS SHALL EXTEND BEYOND THE BLOCKS IN ALL DIRECTIONS TO A DISTANCE OF AT LEAST 6 TO 12 INCHES, RESPECTIVELY.

3.4 UNIT INSTALLATION

A. THE FIRST COURSE OF WALL UNITS SHALL BE PLACED ON THE PREPARED LEVELING LAYER WITH THE AESTHETIC SURFACE FACING OUT AND THE FRONT EDGES TIGHT TOGETHER. ALL UNITS SHALL BE CHECKED FOR LEVEL AND ALIGNMENT AS THEY ARE PLACED.
B. ENSURE THAT UNITS ARE IN FULL CONTACT WITH LEVELING LAYER. PROPER CARE SHALL BE TAKEN TO DEVELOP STRAIGHT LINES AND SMOOTH CURVES ON BASE COURSE AS PER WALL LAYOUT.
THE BACKFILL IN FRONT AND BACK OF ENTIRE BASE ROW SHALL BE PLACED AND COMPACTED TO FIRMLY LOCK THEM IN PLACE. CHECK ALL UNITS AGAIN FOR LEVEL AND ALIGNMENT. ALL EXCESS MATERIAL SHALL BE SWEPT FROM TOP OF UNITS. PLACE AN (18 INCH X 12 INCH) PIECE OF NON–WOVEN GEOTEXTILE FABRIC IN THE VERTICAL JOINT BETWEEN THE BLOCKS TO PREVENT THE DRAINAGE AGGREGATE AND BACKFILL MATERIAL FROM MIGRATING THROUGH THE VERTICAL JOINTS BETWEEN BLOCKS.
C. INSTALL NEXT COURSE OF WALL UNITS ON TOP OF BASE ROW. POSITION BLOCKS TO BE OFFSET FROM SEAMS OF BLOCKS BELOW. BLOCKS SHALL BE PLACED FULLY FORWARD SO KNOB AND GROOVE ARE ENGAGED. CHECK EACH BLOCK FOR PROPER ALIGNMENT AND LEVEL. BACKFILL TO 12 INCH WIDTH BEHIND BLOCK WITH FREE DRAINING BACKFILL. SPREAD BACKFILL IN UNIFORM LIFTS NOT EXCEEDING 9 INCHES. EMPLOY METHODS USING LIGHTWEIGHT COMPACTION EQUIPMENT THAT WILL NOT DISRUPT THE STABILITY OR BATTER OF THE WALL. HAND–OPERATED PLATE COMPACTION EQUIPMENT SHALL BE USED AROUND THE BLOCK AND WITHIN 3 FEET OF THE WALL TO ACHIEVE CONSOLIDATION.
D. INSTALL EACH SUBSEQUENT COURSE IN LIKE MANNER. REPEAT PROCEDURE TO THE EXTENT OF WALL HEIGHT.
E. ALLOWABLE CONSTRUCTION TOLERANCE AT THE WALL FACE IS 2 DEGREES VERTICALLY AND 1 INCH IN 10 FEET HORIZONTALLY.
F. ALL WALLS SHALL BE INSTALLED IN ACCORDANCE WITH LOCAL BUILDING CODES AND REQUIREMENTS, INCLUDING PROPER FALL PROTECTION. FALL PROTECTION RAILING / FENCING TO BE INSTALLED IN CONFORMANCE WITH LOCAL AND STATE CODES. THE DESIGN OF THE FALL PROTECTION SYSTEM TO BE PERFORMED BY OTHERS AND INSTALLED BY OWNER/ OWNER'S REPRESENTATIVE.

3.5 QUALITY CONTROL

A. OWNER MUST RETAIN SERVICES OR A QUALIFIED PROFESSIONAL TO PERFORM QUALITY ASSURANCE CHECKS OF INSTALLATION'S WORK. THE PROFESSIONAL ENGINEER AND/OR THIRD–PARTY INSPECTION AGENCY SHOULD INSPECT AT MINIMUM THE SUITABILITY OF THE FOUNDATION SOILS, TO CONDUCT TESTS RELATED TO THE SOIL BEARING CAPACITY, TO PERFORM DENSITY TESTING ON LEVELING PAD AND BACKFILL GRANULAR MATERIAL.

3.6 DESIGN OF WALL BASED ON "GRADING PLAN–SOUTH"/ SHEET C–7.2, PREPARED BY MEGA, INC., DATED 04–01–25, AND "GEOTECHNICAL ENGINEERING INVESTIGATION REPORT" PREPARED BY WOLVERINE ENGINEERS & SURVEYORS, INC., DATED 08–21–2018.

3.7 DESIGN PARAMETERS:

3.7.1 DESIGN OF WALL BASED ON THE FOLLOWING PARAMETERS:

	EFFECTIVE FRICTION ANGLE	EFFECTIVE COHESION	MOIST UNIT WT.
BACKFILL/ RETAINED SOIL	32°	0	120 PCF
DRAINAGE FILL	38°	0	115 PCF
FOUNDATION SOIL	28°	100	120 PCF
LEVELING PAD	40°	0	135 PCF

3.7.2 DESIGN SURCHARGE LOADS:
100 PSF LIVE LOAD / CONSTRUCTION, MAINTENANCE;

3.7.3 THE DESIGN SOIL PARAMETERS TO BE VERIFIED AND APPROVED BY THE PROJECT GEOTECHNICAL ENGINEER PRIOR TO CONSTRUCTION OF THE RETAINING WALL.

SOIL BEARING CAPACITY: 2,000 PSF, PER SOIL INVESTIGATION REPORT (SEE CURRENT "ELEVATION VIEW" SHEETS (RW–1) FOR APPLIED BEARING PRESSURE FOR EACH SECTIONS OF THE REDI–ROCK RETAINING WALL).

PART 4: AVAILABILITY

REDI-WALL, LLC
5700 E. HIGHLAND RD.
HOWELL, MI 48843
810–936–1451
MR. BLAINE PICKHOVER

REDI-WALL, LLC
5700 E. HIGHLAND RD.
HOWELL, MI 48843
810–936–1451
MR. BLAINE PICKHOVER

DATE	REVISIONS	BY
04-28-25	SUBMITTAL	M.G.

DATE	REVISIONS	BY

3 WORKING DAYS BEFORE YOU DIG CALL MISS DIG 1–800–482–7171 (TOLL FREE)

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CLIENT:
AUBURN ANGARA OAKS, LLC
14496 N. SHELDON RD., SUITE 230
PLYMOUTH, MI 49180
Phone: (248)703-4653
Email: bruce@three-oaks.com

DESIGN BY:	D.H.
CHECKED BY:	M.G.
APPROVED BY:	M.G.

STATE OF MICHIGAN
MAJED A. EL GHUSSAINI
ENGINEER
No.: 046588
LICENSED PROFESSIONAL ENGINEER
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GES-LLC
Civil Engineering ♦ Surveying ♦ Consulting
5711 SOUTH ASHFORD WAY
YPSILANTI, MI 48197
PHONE: 734-787-0008

PROPOSED REDI-ROCK® RETAINING WALLS
AUBURN ANGARA OAKS
CITY OF ROCHESTER HILLS, OAKALND COUNTY, MI

SPECIFICATIONS & CONSTRUCTION NOTES

SCALE: AS NOTED
PROJECT No.: 25-102
SHEET No.: RW-3

Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-1_6.0 FT HT
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Top block 28	18.00	28.00	120.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00

Setbacks

No.	Setback s [in]
1	0.000

No.	Setback s [in]
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	0.13
2	Block 28	2	0.13
3	Top block 28	1	-

Base

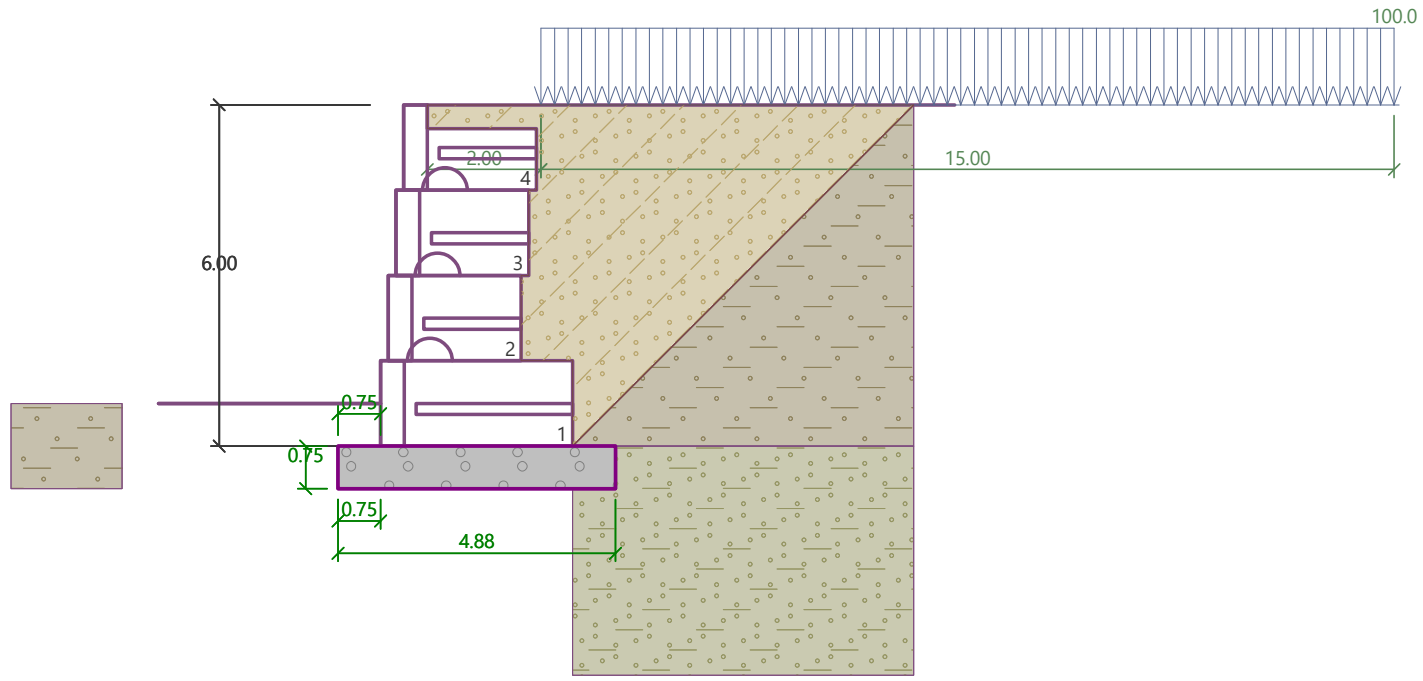
Geometry

Upper setback a_1 = 0.75 ft
Lower setback a_2 = 0.75 ft
Height h = 0.75 ft
Width b = 4.88 ft

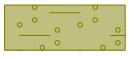
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

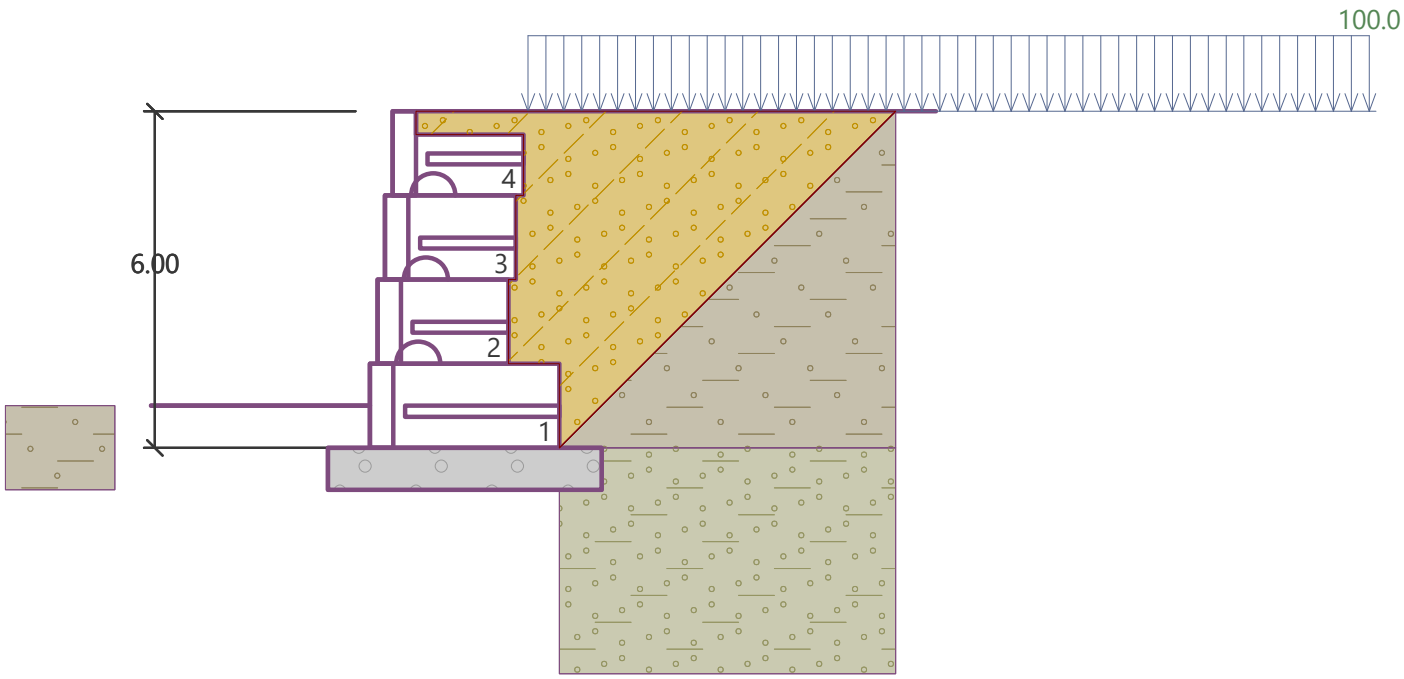
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill	Stage - analysis : 1 - 0



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft
Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	6.00	0.00 .. 6.00	0.00 .. -6.00	RETAINED SOILS	
2	-	6.00 .. ∞	-6.00 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		2.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 1.50 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.76	2251.4	2.30	1.000
FF resistance	-67.4	-0.50	0.1	-0.38	1.000
Weight - earth wedge	0.0	-1.20	61.7	4.38	1.000
Weight - earth wedge	0.0	-2.72	76.7	3.56	1.000
Weight - earth wedge	0.0	-6.54	90.1	2.47	1.000
Active pressure	721.9	-2.31	927.2	4.18	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	135.1	-3.43	102.5	3.99	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 10233.8 lbfft/ft
Overturning moment M_{ovr} = 2100.6 lbfft/ft

Safety factor = 4.87 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2329.62 lbf/ft
Active horizontal force H_{act} = 789.55 lbf/ft

Safety factor = 2.95 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.13	1168.1	1.29	1.000
Weight - earth wedge	0.0	-4.29	90.1	1.59	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Active pressure	284.3	-1.53	90.7	2.47	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	109.9	-2.09	39.1	2.52	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 1973.0 lbfft/ft
Overturning moment M_{ovr} = 664.4 lbfft/ft

Safety factor = 2.97 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7401.32 lbf/ft
Active horizontal force H_{act} = 394.15 lbf/ft

Safety factor = 18.78 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	430.4	3509.70	789.55	0.025	757.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	430.4	3509.70	789.55

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

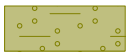
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	6.75 ft
Depth of footing bottom	d	=	1.50 ft
Foundation thickness	t	=	0.75 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length		=	10.00 ft
Strip footing width (x)		=	4.88 ft
Column width in the direction of x		=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	3.66	ft^3/ft
Volume of excavation	=	7.32	ft^3/ft
Volume of fill	=	3.41	ft^3/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	6.00	0.00 .. 6.00	0.00 .. -6.00	RETAINED SOILS	
2	-	6.00 .. ∞	-6.00 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	2624.23	-161.7	-789.55
2	Yes		LC 2	Service	2624.23	-161.7	-789.55

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.12	0.00	757.3	9879.5	15.33	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 409.67 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 7.23 ft
Length of slip surface l_{sp} = 21.16 ft

Design bearing capacity of found. soil R_d = 9879.5 psf
Extreme contact stress σ = 757.3 psf

Factor of safety = 13.05 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.025<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.025<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

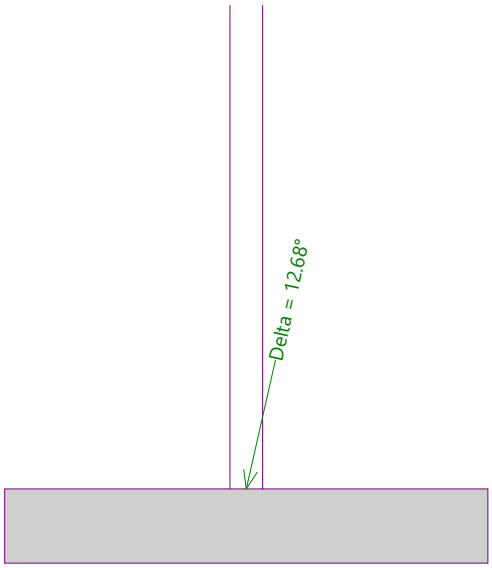
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 53.72 lbf

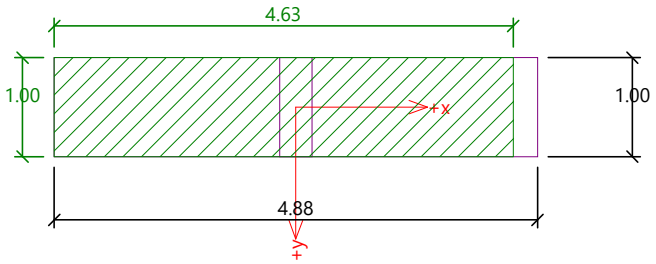
Horizontal bearing capacity R_{dh} = 2383.33 lbf
Extreme horizontal force H = 789.55 lbf

Factor of safety = 3.02 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap. | **Stage - analysis : 1 - 1**





Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 409.67 lbf/ft

Settlement of mid point of longitudinal edge = 0.06 in
Settlement of mid point of transverse edge 1 = 0.09 in
Settlement of mid point of transverse edge 2 = 0.08 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=15.11)
Foundation in the direction of width is rigid (k=1756.43)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.025<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.025<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.09 in
Depth of influence zone = 5.01 ft

Rotation in direction of width = 0.319 (tan*1000); (1.8E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

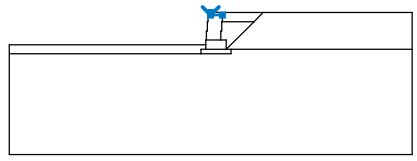
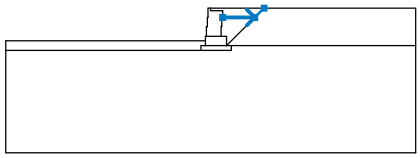
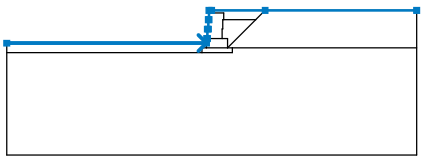
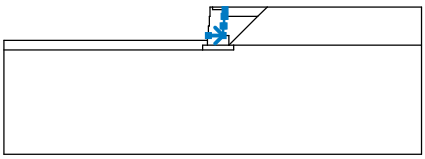
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

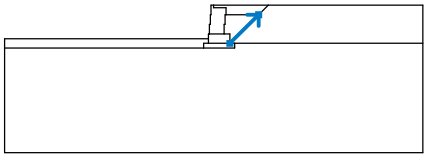
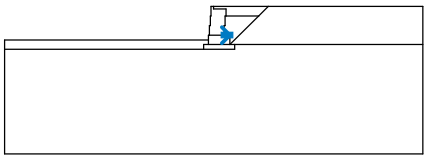
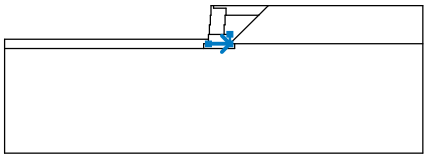
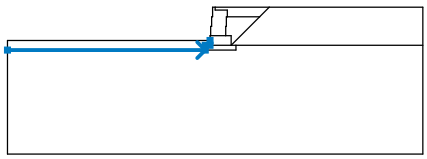
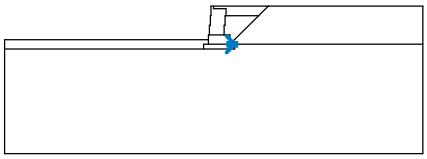
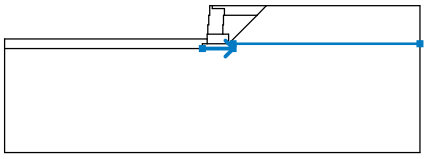
Anchors

Verification methodology : Safety factors (ASD)

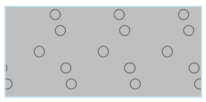
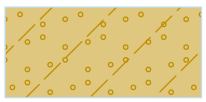
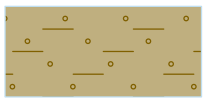
Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

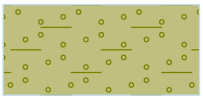
Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		0.00	0.00	0.00	-0.42	1.92	-0.42
2		1.92	-1.50	7.05	-1.50	8.55	0.00
3		-32.80	-5.25	-0.82	-5.25	-0.82	-4.50
		-0.69	-4.50	-0.69	-3.00	-0.55	-3.00
		-0.55	-1.50	-0.42	-1.50	-0.42	0.00
		0.00	0.00	8.55	0.00	32.80	0.00
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				

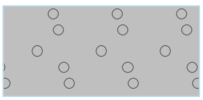
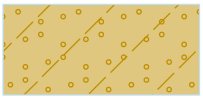
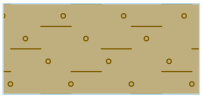
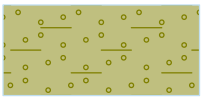
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		2.55	-6.00	7.05	-1.50		
6		1.65	-4.50	2.55	-4.50		
7		-0.82	-6.00	2.55	-6.00	2.55	-4.50
8		-32.80	-6.75	-1.57	-6.75	-1.57	-6.00
		-0.82	-6.00	-0.82	-5.25		
9		2.55	-6.00	3.31	-6.00		
10		-1.57	-6.75	3.31	-6.75	3.31	-6.00
		32.80	-6.00				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 30.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

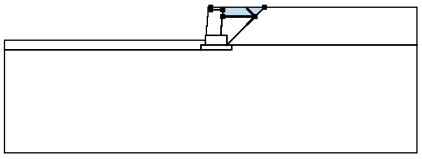
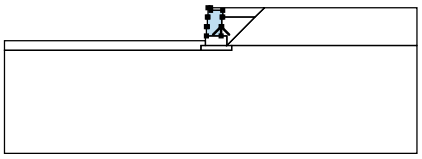
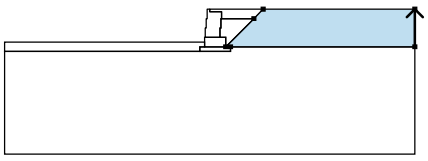
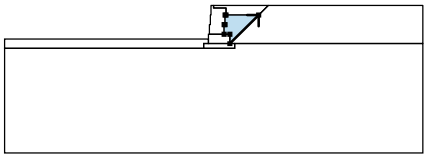
FOUNDATION SOIL

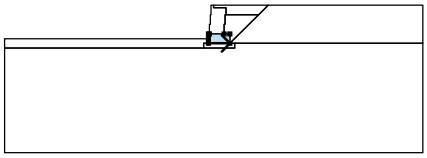
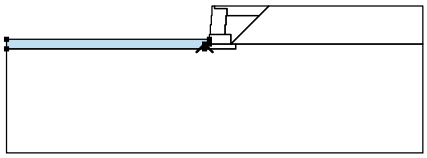
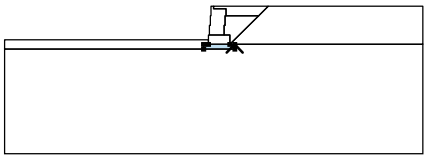
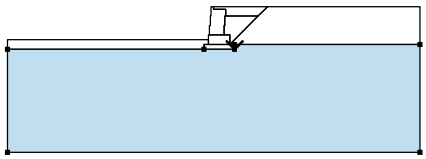
Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 28.00 °
Cohesion of soil :	c_{ef} = 100.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		1.92	-1.50	7.05	-1.50	BACKFILL SOIL-CLASS II SAND
		8.55	0.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
2		1.65	-4.50	1.65	-3.00	Material of structure
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00	-0.69	-4.50	
3		32.80	-6.00	32.80	0.00	RETAINED SOILS
		8.55	0.00	7.05	-1.50	
		2.55	-6.00	3.31	-6.00	
4		2.55	-6.00	7.05	-1.50	BACKFILL SOIL-CLASS II SAND
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
5		-0.82	-6.00	2.55	-6.00	Material of structure
		2.55	-4.50	1.65	-4.50	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-5.25			
6		-1.57	-6.75	-1.57	-6.00	RETAINED SOILS
		-0.82	-6.00	-0.82	-5.25	
		-32.80	-5.25	-32.80	-6.75	
7		3.31	-6.75	3.31	-6.00	LEVELING PAD-21AA
		2.55	-6.00	-0.82	-6.00	
		-1.57	-6.00	-1.57	-6.75	
8		3.31	-6.00	3.31	-6.75	FOUNDATION SOIL
		-1.57	-6.75	-32.80	-6.75	
		-32.80	-23.15	32.80	-23.15	
		32.80	-6.00			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 2.00	l = 15.00		0.00	100.0		lbf/ft^2

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.79	[ft]	Angles :	a_1 =	-32.37	[°]
	z =	5.40	[ft]		a_2 =	64.64	[°]
Radius :	R =	12.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 6761.9 lbf/ft

Slope stability verification (Bishop)

Sum of active forces : F_a = 2604.8 lbf/ft

Sum of passive forces : F_p = 5350.9 lbf/ft

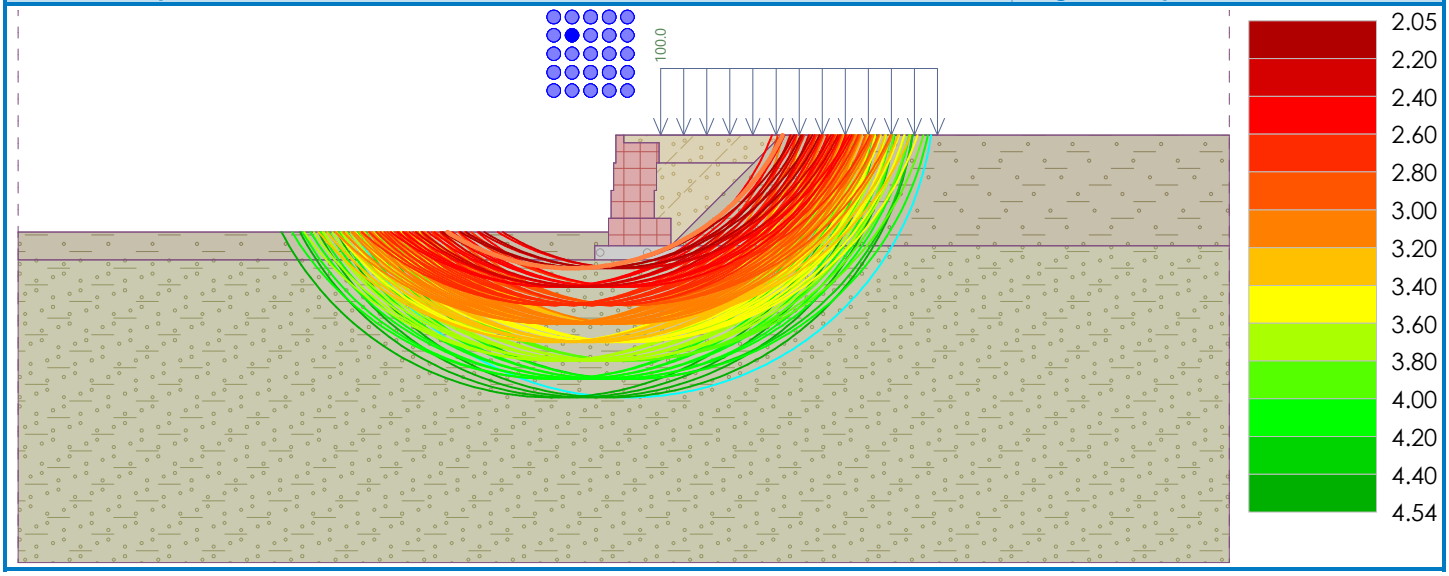
Sliding moment : M_a = 32847.0 lbfft/ft

Resisting moment : M_p = 67474.9 lbfft/ft

Factor of safety = 2.05 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-1_7.5 FT HT
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Top block 28	18.00	28.00	120.00
4	Block R-41 HC	18.00	40.50	110.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00
4	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	0.13
2	Block R-41 HC	1	0.13
3	Block 28	2	0.13
4	Top block 28	1	-

Base

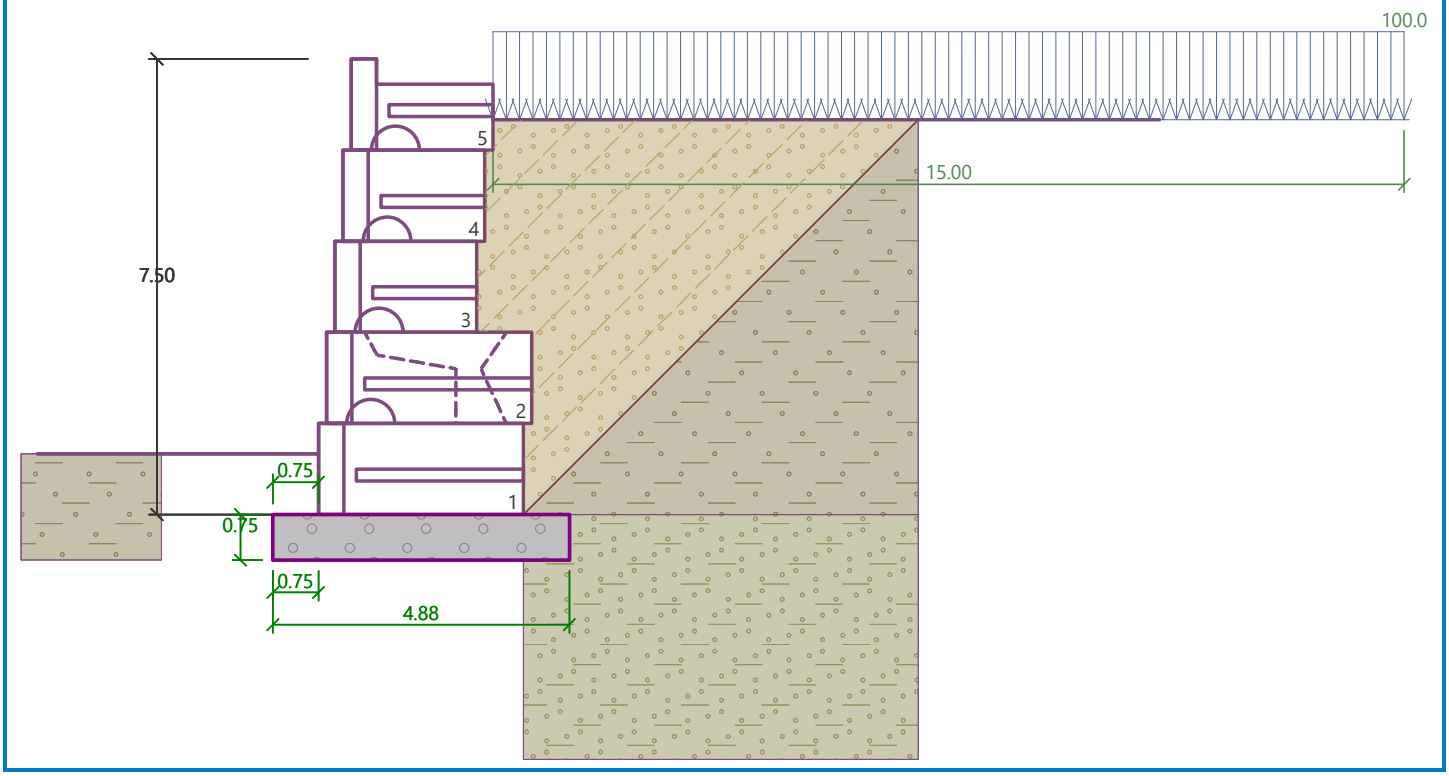
Geometry

Upper setback a_1 = 0.75 ft
Lower setback a_2 = 0.75 ft
Height h = 0.75 ft
Width b = 4.88 ft

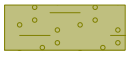
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

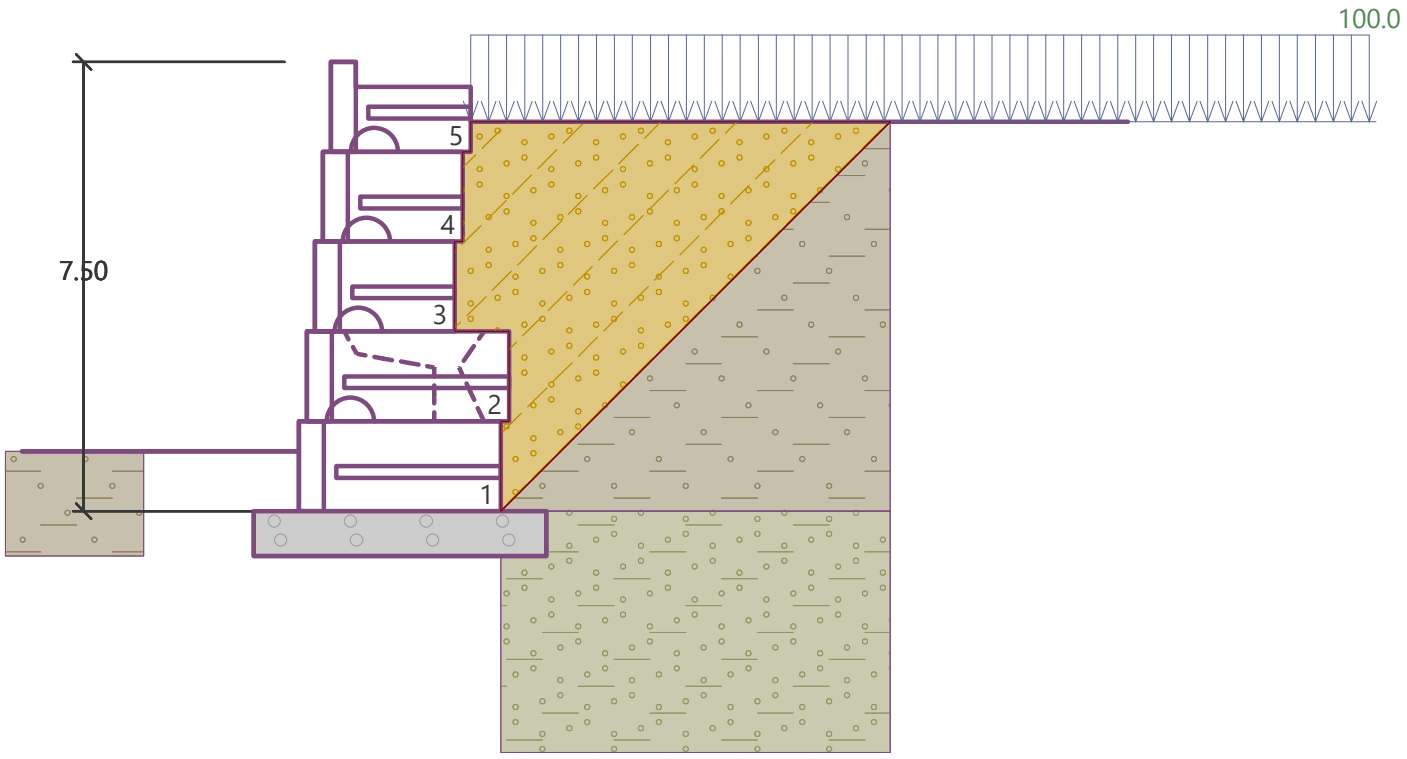
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill | **Stage - analysis : 1 - 0**



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft
Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	6.50	0.00 .. 6.50	0.00 .. -6.50	RETAINED SOILS	
2	-	6.50 .. ∞	-6.50 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.
Depth of terrain below the top of wall h = 1.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		0.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 1.75 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.43	2808.3	2.41	1.000
FF resistance	-91.8	-0.58	0.2	-0.38	1.000
Weight - earth wedge	0.0	-1.17	57.1	4.40	1.000
Weight - earth wedge	0.0	-4.22	76.7	3.70	1.000
Active pressure	816.7	-2.49	886.6	4.32	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	156.8	-3.68	102.8	4.14	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 11562.2 lbfft/ft
Overturning moment M_{ovr} = 2558.2 lbfft/ft

Safety factor = 4.52 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2548.50 lbf/ft
Active horizontal force H_{act} = 881.69 lbf/ft

Safety factor = 2.89 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.30	2332.5	1.66	1.000
FF resistance	-30.0	-0.33	0.0	0.00	1.000
Weight - earth wedge	0.0	-3.47	76.7	2.95	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Active pressure	644.5	-2.22	428.9	3.24	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	150.4	-3.18	76.6	3.17	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 5717.6 lbfft/ft
Overturning moment M_{ovr} = 1900.8 lbfft/ft

Safety factor = 3.01 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2445.71 lbf/ft
Active horizontal force H_{act} = 764.88 lbf/ft

Safety factor = 3.20 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	589.1	3931.59	881.69	0.031	858.4

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	589.1	3931.59	881.69

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

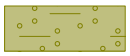
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	7.25 ft
Depth of footing bottom	d	=	1.75 ft
Foundation thickness	t	=	0.75 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	10.00 ft
Strip footing width (x)	=	4.88 ft
Column width in the direction of x	=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	3.66 ft³/ft
Volume of excavation	=	8.54 ft³/ft
Volume of fill	=	4.55 ft³/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	6.50	0.00 .. 6.50	0.00 .. -6.50	RETAINED SOILS	
2	-	6.50 .. ∞	-6.50 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	2909.56	-72.2	-881.69
2	Yes		LC 2	Service	2909.56	-72.2	-881.69

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.15	0.00	858.4	10266.5	16.72	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 546.23 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 7.23 ft
Length of slip surface l_{sp} = 21.16 ft

Design bearing capacity of found. soil R_d = 10266.5 psf
Extreme contact stress σ = 858.4 psf

Factor of safety = 11.96 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.031<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.031<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

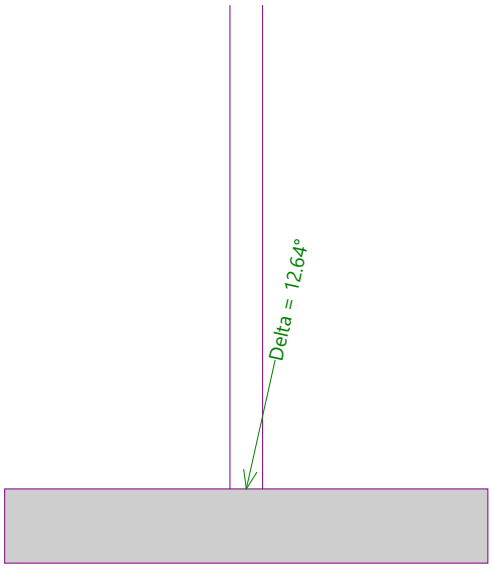
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 65.65 lbf

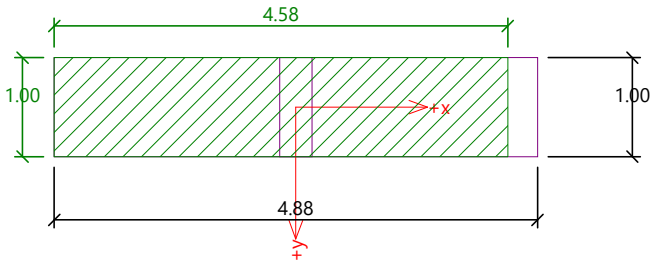
Horizontal bearing capacity R_{dh} = 2614.15 lbf
Extreme horizontal force H = 881.69 lbf

Factor of safety = 2.96 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap. | **Stage - analysis : 1 - 1**





Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 546.23 lbf/ft

Settlement of mid point of longitudinal edge = 0.07 in
Settlement of mid point of transverse edge 1 = 0.11 in
Settlement of mid point of transverse edge 2 = 0.08 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=15.11)
Foundation in the direction of width is rigid (k=1756.43)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.031<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.031<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.10 in
Depth of influence zone = 5.17 ft

Rotation in direction of width = 0.384 (tan*1000); (2.2E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

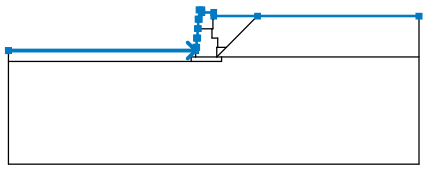
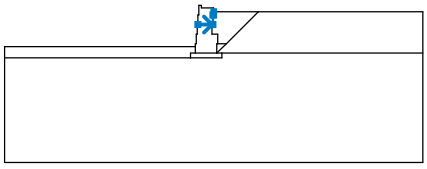
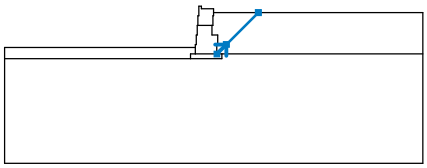
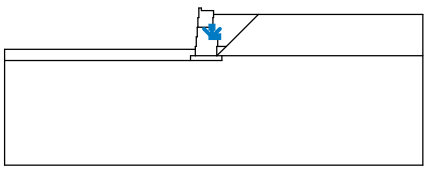
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

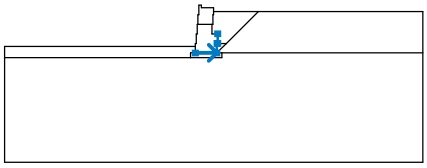
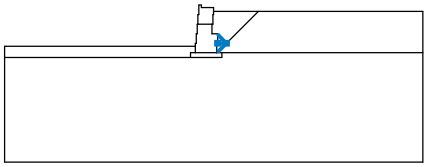
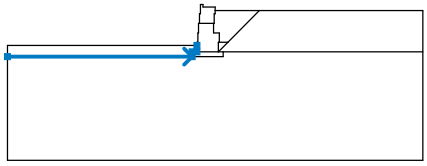
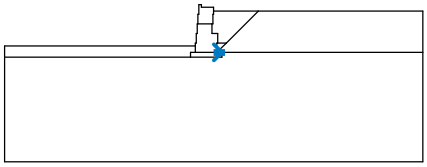
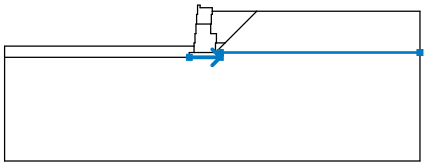
Anchors

Verification methodology : Safety factors (ASD)

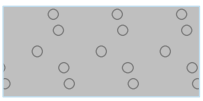
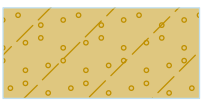
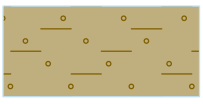
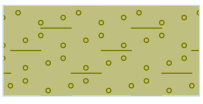
Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

Interface

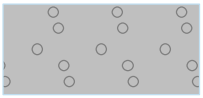
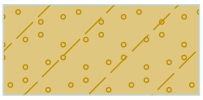
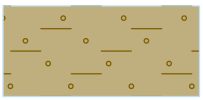
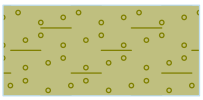
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-5.50	-2.87	-5.50	-2.87	-5.00
		-2.74	-5.00	-2.74	-3.50	-2.60	-3.50
		-2.60	-2.00	-2.47	-2.00	-2.47	-0.50
		-2.33	-0.50	-2.33	1.00	-1.92	1.00
		-1.92	0.58	0.00	0.58	0.00	0.00
		7.00	0.00	32.80	0.00		
2		-2.47	-2.00	-0.27	-2.00	-0.13	-2.00
		-0.13	-0.50	0.00	-0.50	0.00	0.00
3		0.50	-6.50	2.00	-5.00	7.00	0.00
4		-0.27	-2.00	-0.27	-3.50	0.64	-3.50

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-2.87	-6.50	0.50	-6.50	0.50	-5.00
		0.64	-5.00	0.64	-3.50		
6		0.64	-5.00	2.00	-5.00		
7		-32.80	-7.25	-3.62	-7.25	-3.62	-6.50
		-2.87	-6.50	-2.87	-5.50		
8		0.50	-6.50	1.26	-6.50		
9		-3.62	-7.25	1.26	-7.25	1.26	-6.50
		32.80	-6.50				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

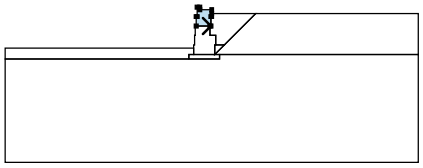
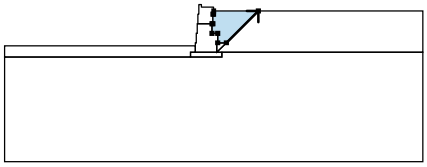
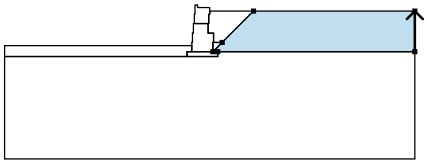
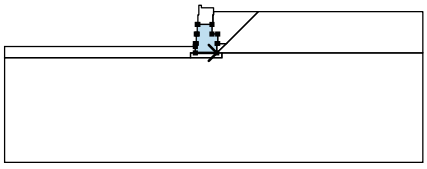
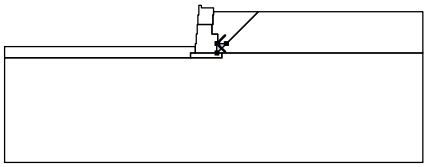
FOUNDATION SOIL

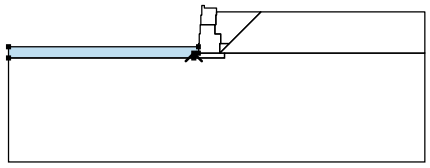
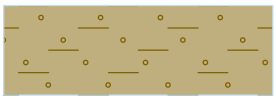
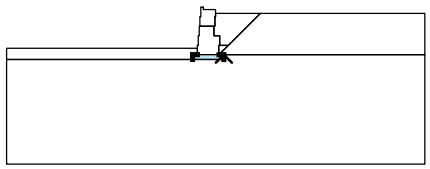
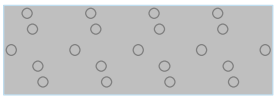
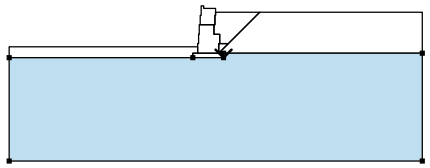
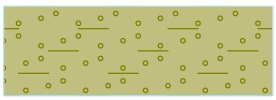
Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 28.00 °
Cohesion of soil :	c_{ef} = 100.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-0.27	-2.00	-0.13	-2.00	Material of structure
		-0.13	-0.50	0.00	-0.50	
		0.00	0.00	0.00	0.58	
		-1.92	0.58	-1.92	1.00	
		-2.33	1.00	-2.33	-0.50	
		-2.47	-0.50	-2.47	-2.00	
2		2.00	-5.00	7.00	0.00	BACKFILL SOIL-CLASS II SAND
		0.00	0.00	0.00	-0.50	
		-0.13	-0.50	-0.13	-2.00	
		-0.27	-2.00	-0.27	-3.50	
		0.64	-3.50	0.64	-5.00	
3		32.80	-6.50	32.80	0.00	RETAINED SOILS
		7.00	0.00	2.00	-5.00	
		0.50	-6.50	1.26	-6.50	
4		-2.87	-6.50	0.50	-6.50	Material of structure
		0.50	-5.00	0.64	-5.00	
		0.64	-3.50	-0.27	-3.50	
		-0.27	-2.00	-2.47	-2.00	
		-2.60	-2.00	-2.60	-3.50	
		-2.74	-3.50	-2.74	-5.00	
		-2.87	-5.00	-2.87	-5.50	
5		0.64	-5.00	0.50	-5.00	BACKFILL SOIL-CLASS II SAND
		0.50	-6.50	2.00	-5.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
6		-3.62	-7.25	-3.62	-6.50	RETAINED SOILS
		-2.87	-6.50	-2.87	-5.50	
		-32.80	-5.50	-32.80	-7.25	
7		1.26	-7.25	1.26	-6.50	LEVELING PAD-21AA
		0.50	-6.50	-2.87	-6.50	
		-3.62	-6.50	-3.62	-7.25	
8		1.26	-6.50	1.26	-7.25	FOUNDATION SOIL
		-3.62	-7.25	-32.80	-7.25	
		-32.80	-23.65	32.80	-23.65	
		32.80	-6.50			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 0.00	l = 15.00		0.00	100.0		lbf/ft²

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-3.79	[ft]	Angles :	a_1 =	-29.03	[°]
	z =	6.40	[ft]		a_2 =	61.95	[°]
Slip surface after grid search.							

Slip surface parameters				
Radius :	R =	13.61	[ft]	
Slip surface after grid search.				

Total weight of soil above the slip surface: 7727.0 lbf/ft

Slope stability verification (Bishop)

Sum of active forces : F_a = 2870.6 lbf/ft

Sum of passive forces : F_p = 5704.2 lbf/ft

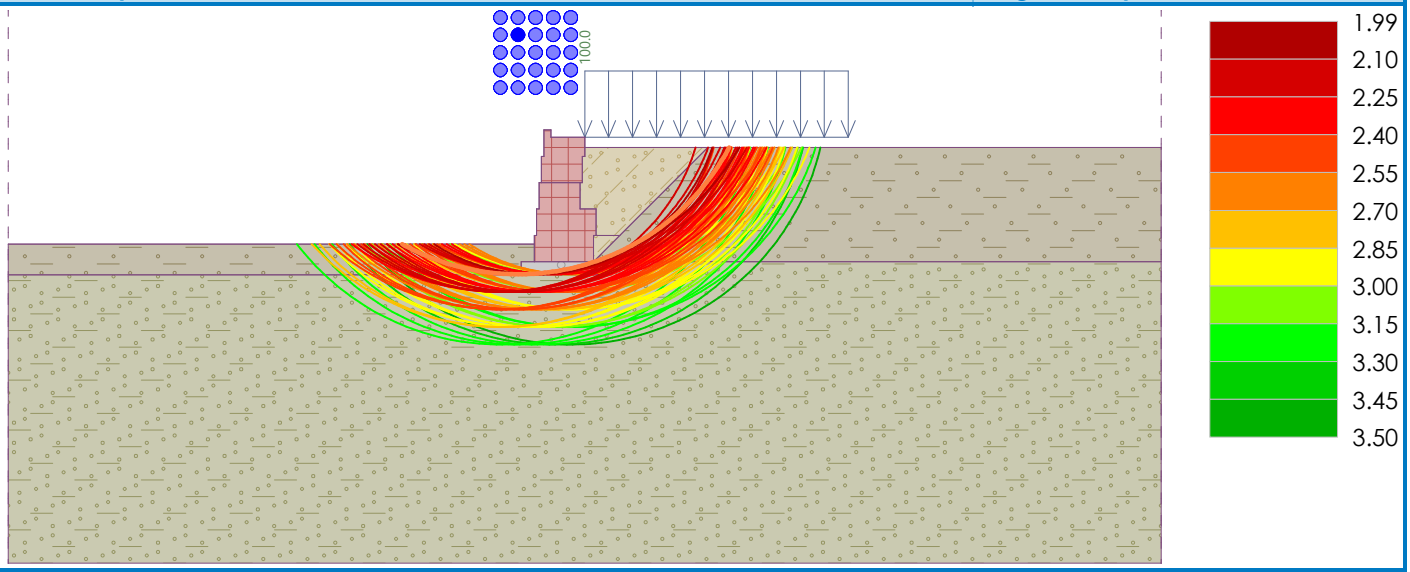
Sliding moment : M_a = 39068.7 lbfft/ft

Resisting moment : M_p = 77634.5 lbfft/ft

Factor of safety = 1.99 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-1_9.0 FT HT_SECTION "A"
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 60	18.00	60.00	130.00
3	Top block 28	18.00	28.00	120.00
4	Block R-41 HC	18.00	40.50	110.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 60	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00
4	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 60	1	0.13
2	Block R-41 HC	2	0.13
3	Block 28	2	0.13
4	Top block 28	1	-

Base

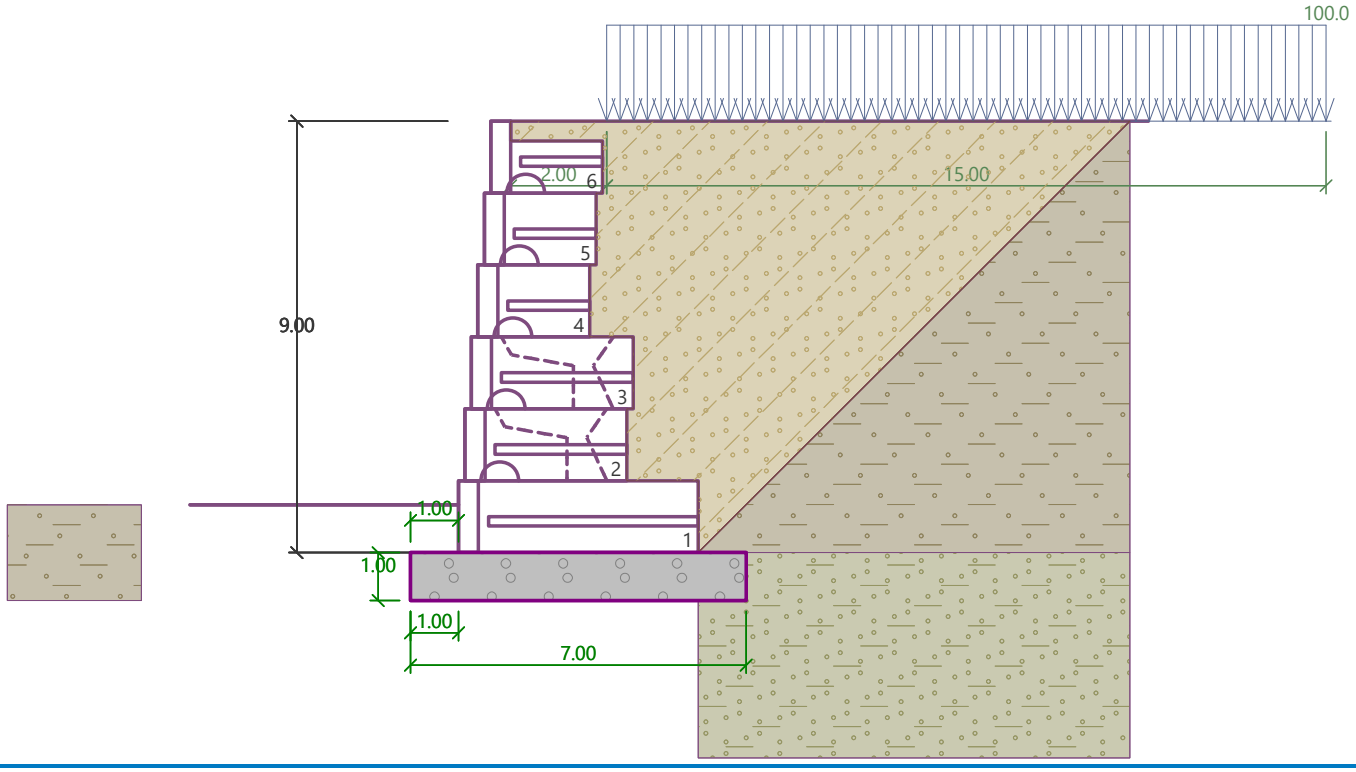
Geometry

Upper setback a_1 = 1.00 ft
Lower setback a_2 = 1.00 ft
Height h = 1.00 ft
Width b = 7.00 ft

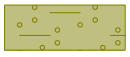
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

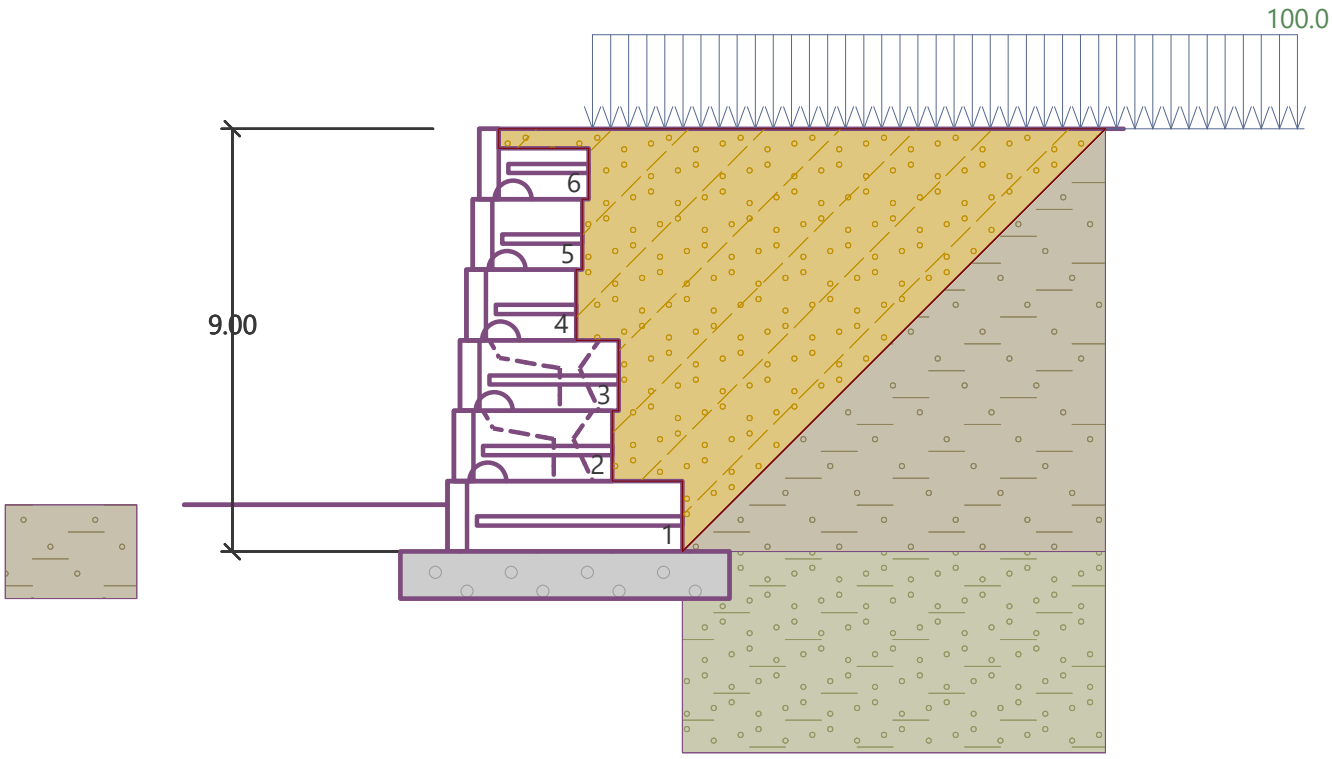
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill | **Stage - analysis : 1 - 0**



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	9.00	0.00 .. 9.00	0.00 .. -9.00	RETAINED SOILS	
2	-	9.00 .. ∞	-9.00 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		2.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 2.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.73	4166.9	3.11	1.000
FF resistance	-119.9	-0.67	0.2	-0.50	1.000
Weight - earth wedge	0.0	-2.91	380.8	5.45	1.000
Weight - earth wedge	0.0	-5.97	76.7	4.08	1.000
Weight - earth wedge	0.0	-9.79	90.1	2.99	1.000
Active pressure	1695.3	-3.39	2447.8	5.69	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	182.8	-5.14	173.8	5.27	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 30463.2 lbfft/ft
Overturning moment M_{ovr} = 6598.1 lbfft/ft

Safety factor = 4.62 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 4551.32 lbf/ft
Active horizontal force H_{act} = 1758.13 lbf/ft

Safety factor = 2.59 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.36	2281.9	1.65	1.000
Weight - earth wedge	0.0	-3.47	76.7	2.95	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-7.29	90.1	1.86	1.000
Active pressure	859.4	-2.55	582.0	3.21	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	169.0	-3.59	87.9	3.12	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 6309.9 lbfft/ft
Overturning moment M_{ovr} = 2797.5 lbfft/ft

Safety factor = 2.26 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7707.96 lbf/ft
Active horizontal force H_{act} = 1028.40 lbf/ft

Safety factor = 7.50 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	1811.4	7336.16	1758.13	0.035	1127.6

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	1811.4	7336.16	1758.13

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

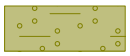
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	10.00 ft
Depth of footing bottom	d	=	2.00 ft
Foundation thickness	t	=	1.00 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length		=	10.00 ft
Strip footing width (x)		=	7.00 ft
Column width in the direction of x		=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	7.00	ft^3/ft
Volume of excavation	=	14.00	ft^3/ft
Volume of fill	=	6.67	ft^3/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	9.00	0.00 .. 9.00	0.00 .. -9.00	RETAINED SOILS	
2	-	9.00 .. ∞	-9.00 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	5625.53	53.3	-1758.13
2	Yes		LC 2	Service	5625.53	53.3	-1758.13

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.25	0.00	1127.6	12640.1	17.84	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 910.00 lbf/ft
Computed weight of overburden Z = 800.63 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 10.37 ft
Length of slip surface l_{sp} = 30.35 ft

Design bearing capacity of found. soil R_d = 12640.1 psf
Extreme contact stress σ = 1127.6 psf

Factor of safety = 11.21 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.035<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.035<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

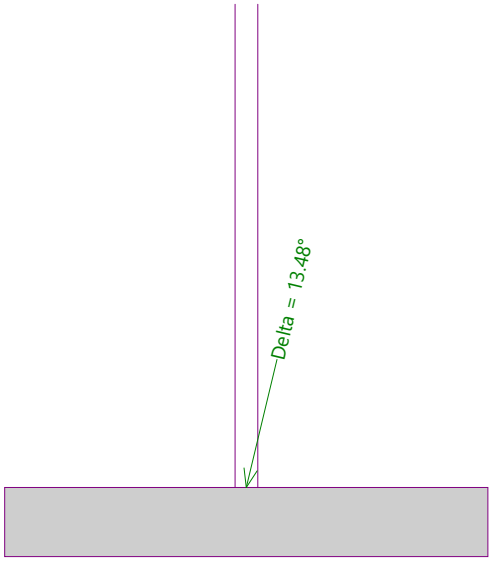
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 95.50 lbf

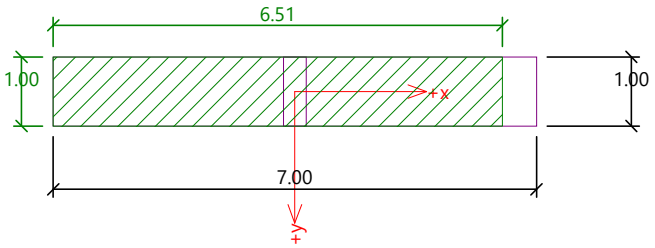
Horizontal bearing capacity R_{dh} = 4646.82 lbf
Extreme horizontal force H = 1758.13 lbf

Factor of safety = 2.64 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap. | **Stage - analysis : 1 - 1**





Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 910.00 lbf/ft
Computed weight of overburden Z = 800.63 lbf/ft

Settlement of mid point of longitudinal edge = 0.13 in
Settlement of mid point of transverse edge 1 = 0.18 in
Settlement of mid point of transverse edge 2 = 0.13 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=12.14)
Foundation in the direction of width is rigid (k=4163.40)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.035<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.035<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.17 in
Depth of influence zone = 6.64 ft

Rotation in direction of width = 0.596 (tan*1000); (3.4E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

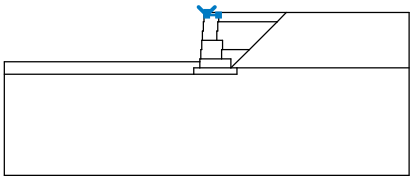
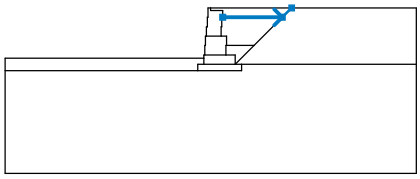
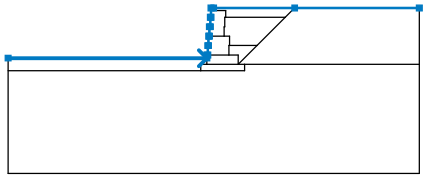
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

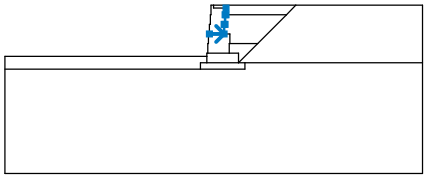
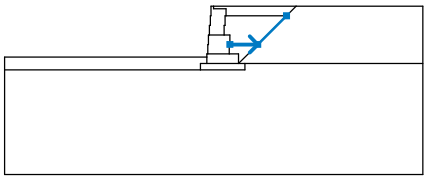
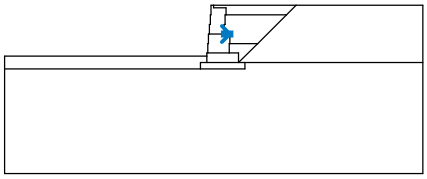
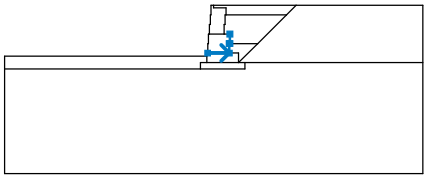
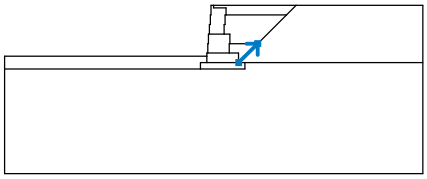
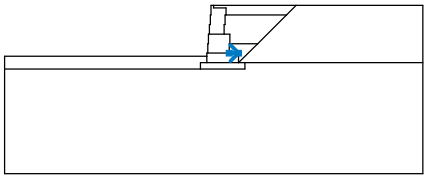
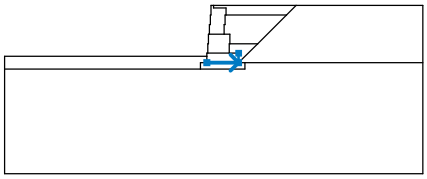
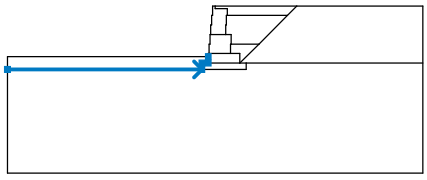
Anchors

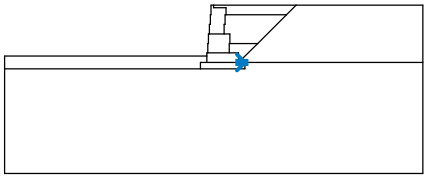
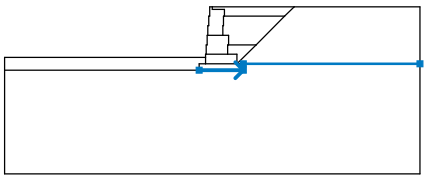
Verification methodology : Safety factors (ASD)

Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		0.00	0.00	0.00	-0.42	1.92	-0.42
2		1.92	-1.50	11.41	-1.50	12.91	0.00
3		-32.80	-8.00	-1.09	-8.00	-1.09	-7.50
		-0.95	-7.50	-0.95	-6.00	-0.82	-6.00
		-0.82	-4.50	-0.69	-4.50	-0.69	-3.00
		-0.55	-3.00	-0.55	-1.50	-0.42	-1.50
		-0.42	0.00	0.00	0.00	12.91	0.00
		32.80	0.00				

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				
5		2.55	-6.00	6.91	-6.00	11.41	-1.50
6		1.65	-4.50	2.55	-4.50		
7		-0.95	-7.50	2.42	-7.50	2.42	-6.00
		2.55	-6.00	2.55	-4.50		
8		3.91	-9.00	6.91	-6.00		
9		2.42	-7.50	3.91	-7.50		
10		-1.09	-9.00	3.91	-9.00	3.91	-7.50
11		-32.80	-10.00	-2.09	-10.00	-2.09	-9.00
		-1.09	-9.00	-1.09	-8.00		

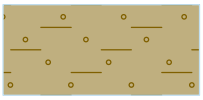
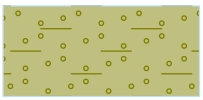
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
12		3.91	-9.00	4.91	-9.00		
13		-2.09	-10.00	4.91	-10.00	4.91	-9.00
		32.80	-9.00				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ = 130.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 40.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ = 110.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 38.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 30.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

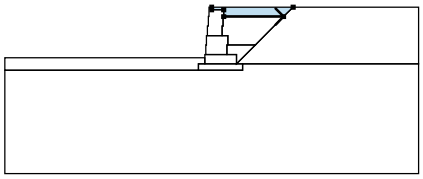
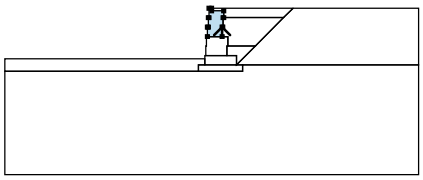
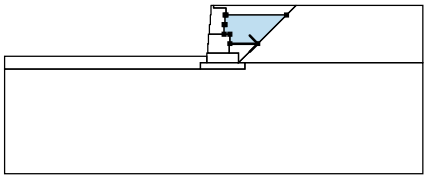
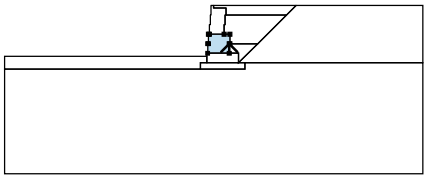
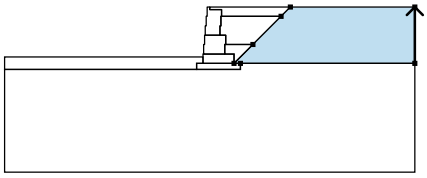
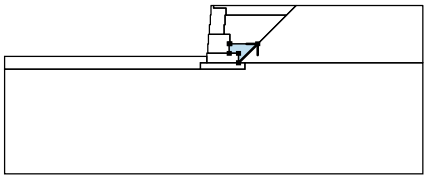
FOUNDATION SOIL

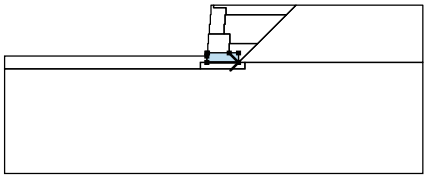
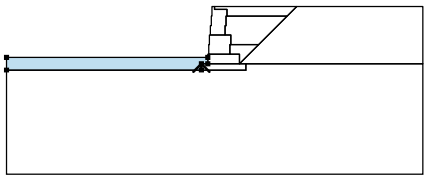
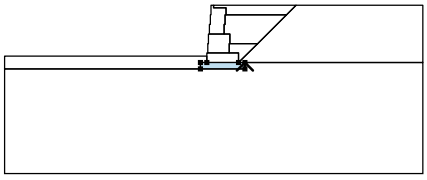
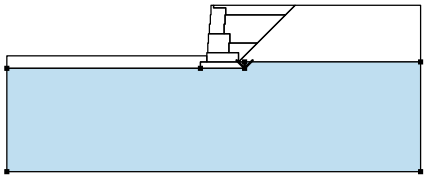
Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 28.00 °
Cohesion of soil :	c_{ef} = 100.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		1.92	-1.50	11.41	-1.50	BACKFILL SOIL-CLASS II SAND
		12.91	0.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
2		1.65	-4.50	1.65	-3.00	Material of structure
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00	-0.69	-4.50	
3		2.55	-6.00	6.91	-6.00	BACKFILL SOIL-CLASS II SAND
		11.41	-1.50	1.92	-1.50	
		1.78	-1.50	1.78	-3.00	
		1.65	-3.00	1.65	-4.50	
		2.55	-4.50			
4		2.42	-7.50	2.42	-6.00	Material of structure
		2.55	-6.00	2.55	-4.50	
		1.65	-4.50	-0.69	-4.50	
		-0.82	-4.50	-0.82	-6.00	
		-0.95	-6.00	-0.95	-7.50	
5		32.80	-9.00	32.80	0.00	RETAINED SOILS
		12.91	0.00	11.41	-1.50	
		6.91	-6.00	3.91	-9.00	
		4.91	-9.00			
6		3.91	-9.00	6.91	-6.00	BACKFILL SOIL-CLASS II SAND
		2.55	-6.00	2.42	-6.00	
		2.42	-7.50	3.91	-7.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		-1.09	-9.00	3.91	-9.00	Material of structure
		3.91	-7.50	2.42	-7.50	
		-0.95	-7.50	-1.09	-7.50	
		-1.09	-8.00			
8		-2.09	-10.00	-2.09	-9.00	RETAINED SOILS
		-1.09	-9.00	-1.09	-8.00	
		-32.80	-8.00	-32.80	-10.00	
9		4.91	-10.00	4.91	-9.00	LEVELING PAD-21AA
		3.91	-9.00	-1.09	-9.00	
		-2.09	-9.00	-2.09	-10.00	
10		4.91	-9.00	4.91	-10.00	FOUNDATION SOIL
		-2.09	-10.00	-32.80	-10.00	
		-32.80	-26.40	32.80	-26.40	
		32.80	-9.00			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 2.00	l = 15.00		0.00	100.0		lbf/ft2

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.79	[ft]	Angles :	a_1 =	-31.93	[°]
	z =	4.40	[ft]		a_2 =	72.47	[°]
Radius :	R =	14.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 12885.7 lbf/ft

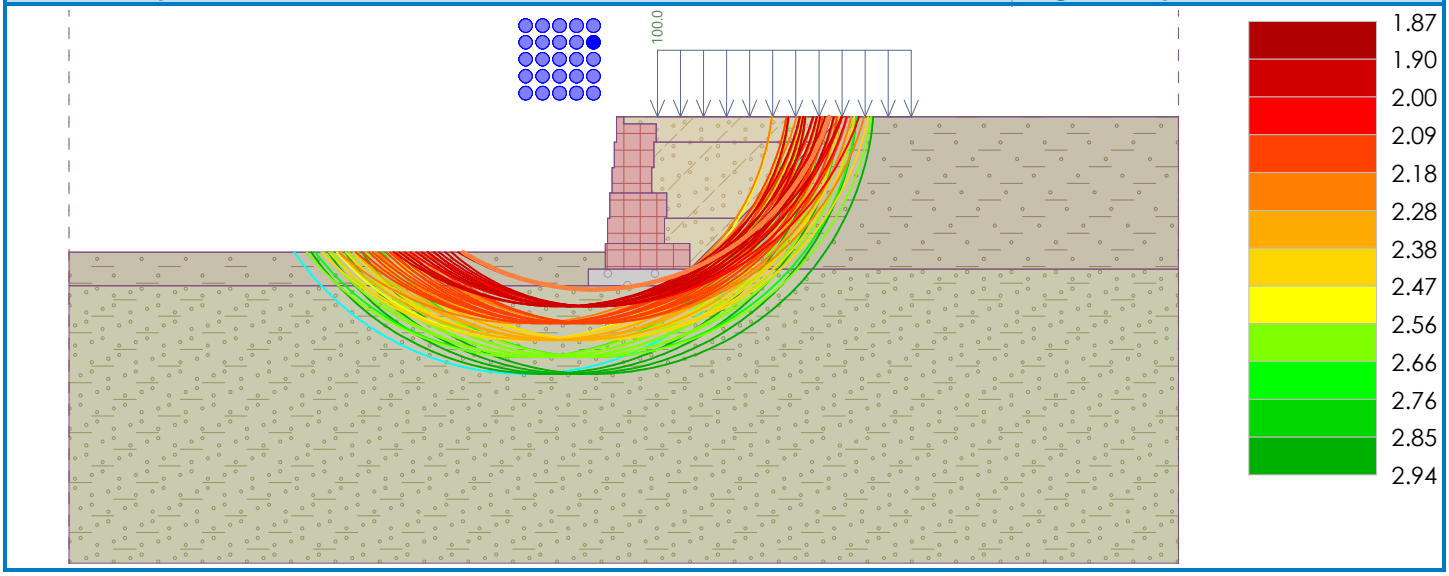
Slope stability verification (Bishop)

Sum of active forces : F_a = 5079.5 lbf/ft
Sum of passive forces : F_p = 9512.3 lbf/ft

Sliding moment : M_a = 74210.9 lbfft/ft
Resisting moment : M_p = 138974.7 lbfft/ft
Factor of safety = 1.87 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-1_9.0 FT HT_SECTION "B"
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Top block 28	18.00	28.00	120.00
4	Block R-41 HC	18.00	40.50	110.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00
4	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	0.13
2	Block R-41 HC	2	0.13
3	Block 28	2	0.13
4	Top block 28	1	-

Base

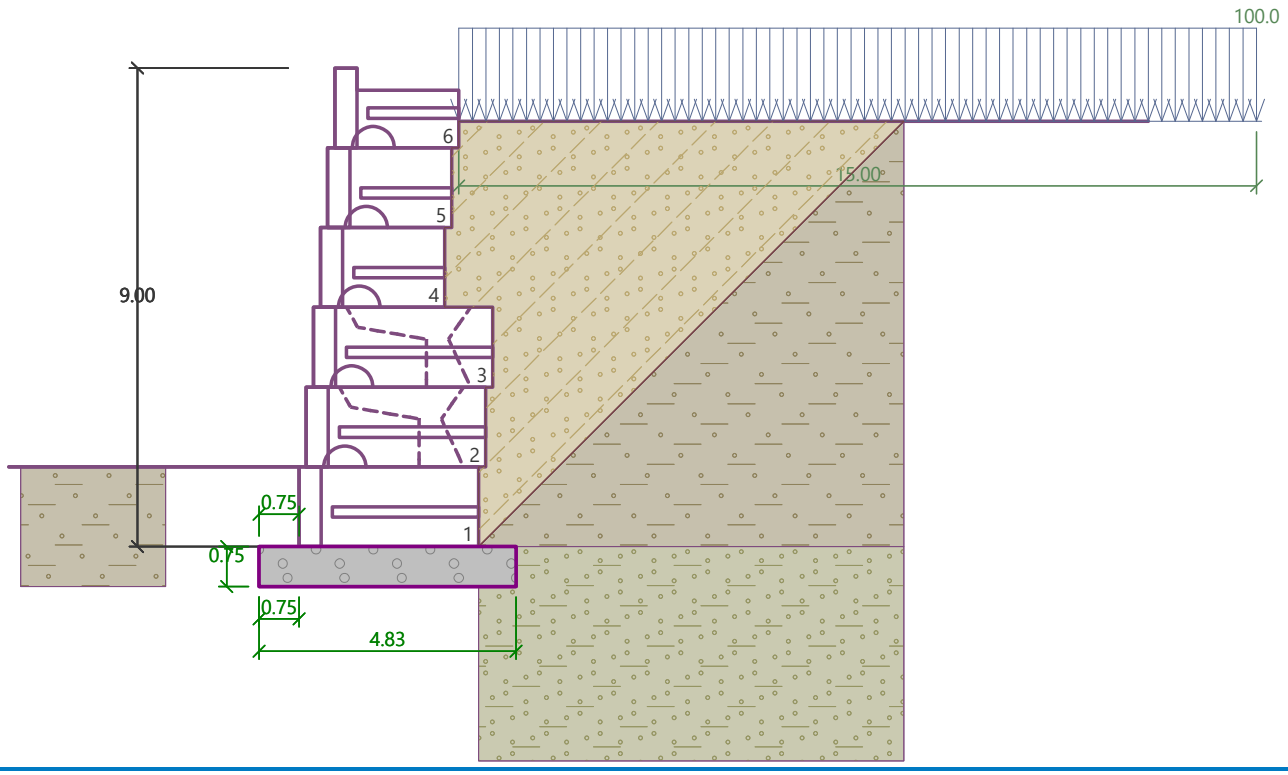
Geometry

Upper setback a_1 = 0.75 ft
Lower setback a_2 = 0.75 ft
Height h = 0.75 ft
Width b = 4.83 ft

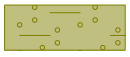
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

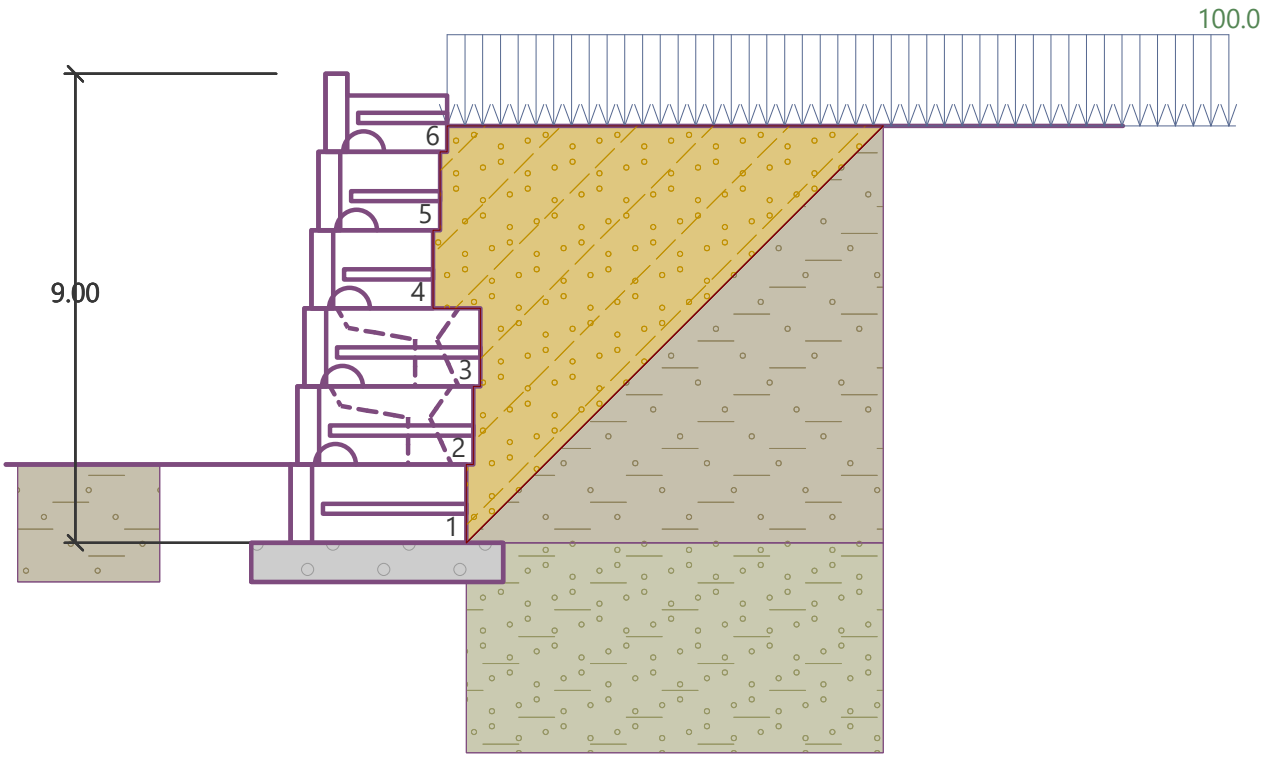
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill | **Stage - analysis : 1 - 0**



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft
Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	8.00	0.00 .. 8.00	0.00 .. -8.00	RETAINED SOILS	
2	-	8.00 .. ∞	-8.00 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.
Depth of terrain below the top of wall h = 1.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		0.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 2.25 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.13	3360.3	2.50	1.000
FF resistance	-151.8	-0.75	0.2	-0.38	1.000
Weight - earth wedge	0.0	-1.13	48.6	4.38	1.000
Weight - earth wedge	0.0	-5.72	76.7	3.83	1.000
Active pressure	1175.4	-2.95	1061.1	4.37	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	197.6	-4.38	113.0	4.21	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 14027.2 lbfft/ft
Overturning moment M_{ovr} = 4215.2 lbfft/ft

Safety factor = 3.33 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2898.82 lbf/ft
Active horizontal force H_{act} = 1221.21 lbf/ft

Safety factor = 2.37 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.00	2889.4	1.77	1.000
FF resistance	-67.5	-0.50	0.0	0.00	1.000
Weight - earth wedge	0.0	-4.97	76.7	3.08	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Active pressure	949.1	-2.74	520.1	3.37	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	189.9	-3.87	88.0	3.31	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 7387.8 lbfft/ft
Overturning moment M_{ovr} = 3303.9 lbfft/ft

Safety factor = 2.24 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2999.12 lbf/ft
Active horizontal force H_{act} = 1071.46 lbf/ft

Safety factor = 2.80 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	1441.6	4659.86	1221.21	0.064	1106.5

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	1441.6	4659.86	1221.21

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

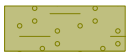
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	8.75 ft
Depth of footing bottom	d	=	2.25 ft
Foundation thickness	t	=	0.75 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length		=	10.00 ft
Strip footing width (x)		=	4.83 ft
Column width in the direction of x		=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	3.62	ft^3/ft
Volume of excavation	=	10.87	ft^3/ft
Volume of fill	=	6.75	ft^3/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	8.00	0.00 .. 8.00	0.00 .. -8.00	RETAINED SOILS	
2	-	8.00 .. ∞	-8.00 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	3378.59	525.6	-1221.21
2	Yes		LC 2	Service	3378.59	525.6	-1221.21

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.31	0.00	1106.5	10779.5	20.53	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 470.92 lbf/ft
Computed weight of overburden Z = 810.34 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 7.16 ft
Length of slip surface l_{sp} = 20.94 ft

Design bearing capacity of found. soil R_d = 10779.5 psf
Extreme contact stress σ = 1106.5 psf

Factor of safety = 9.74 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.064<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.064<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

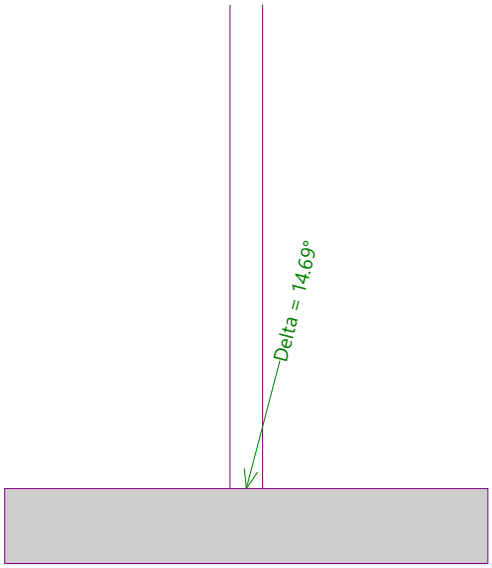
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 89.53 lbf

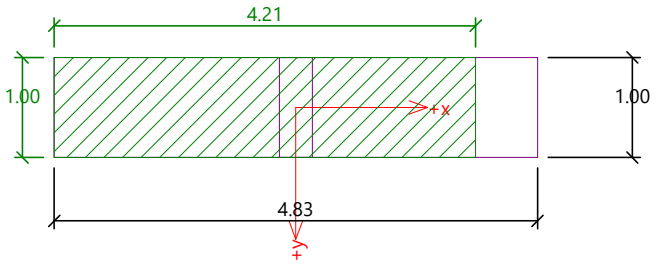
Horizontal bearing capacity R_{dh} = 2988.35 lbf
Extreme horizontal force H = 1221.21 lbf

Factor of safety = 2.45 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - 1





Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 470.92 lbf/ft
Computed weight of overburden Z = 810.34 lbf/ft

Settlement of mid point of longitudinal edge = 0.08 in
Settlement of mid point of transverse edge 1 = 0.13 in
Settlement of mid point of transverse edge 2 = 0.08 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=15.59)
Foundation in the direction of width is rigid (k=1756.43)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.064<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.064<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.11 in
Depth of influence zone = 5.13 ft

Rotation in direction of width = 0.968 (tan*1000); (5.5E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

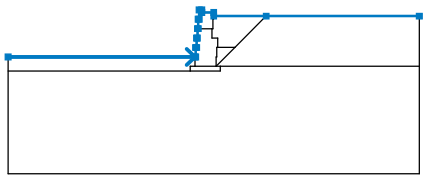
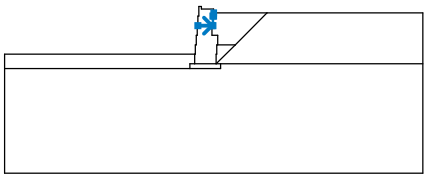
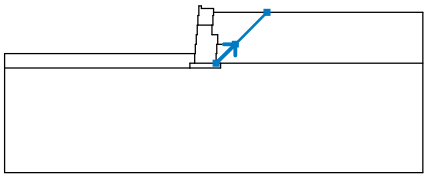
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

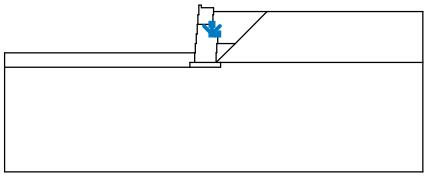
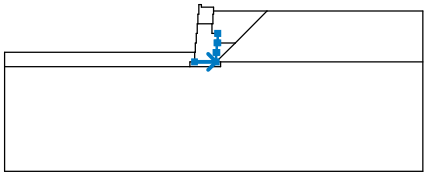
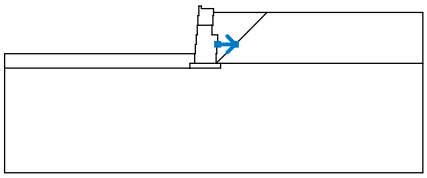
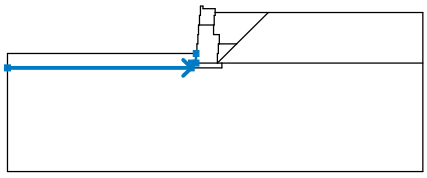
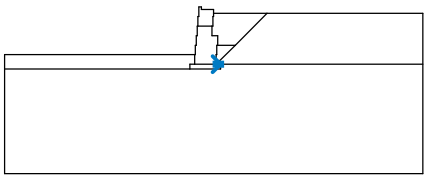
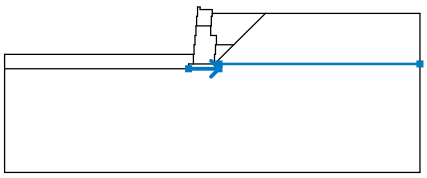
Anchors

Verification methodology : Safety factors (ASD)

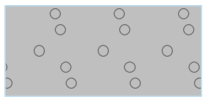
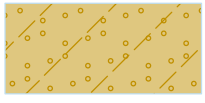
Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

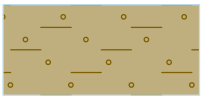
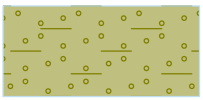
Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-6.50	-3.01	-6.50	-2.87	-6.50
		-2.87	-5.00	-2.74	-5.00	-2.74	-3.50
		-2.60	-3.50	-2.60	-2.00	-2.47	-2.00
		-2.47	-0.50	-2.33	-0.50	-2.33	1.00
		-1.92	1.00	-1.92	0.58	0.00	0.58
		0.00	0.00	8.37	0.00	32.80	0.00
2		-2.47	-2.00	-0.27	-2.00	-0.13	-2.00
		-0.13	-0.50	0.00	-0.50	0.00	0.00
3		0.37	-8.00	3.37	-5.00	8.37	0.00

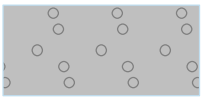
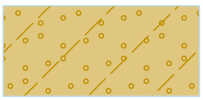
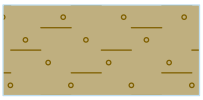
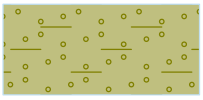
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-0.27	-2.00	-0.27	-3.50	0.64	-3.50
5		-3.01	-8.00	0.37	-8.00	0.37	-6.50
		0.50	-6.50	0.50	-5.00	0.64	-5.00
		0.64	-3.50				
6		0.64	-5.00	3.37	-5.00		
7		-32.80	-8.75	-3.76	-8.75	-3.76	-8.00
		-3.01	-8.00	-3.01	-6.50		
8		0.37	-8.00	1.07	-8.00		
9		-3.76	-8.75	1.07	-8.75	1.07	-8.00
		32.80	-8.00				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb

Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

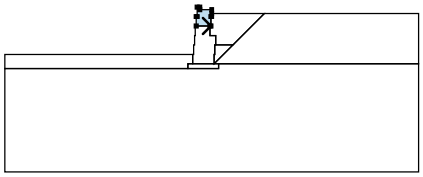
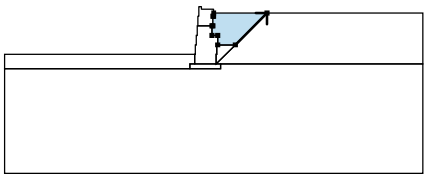
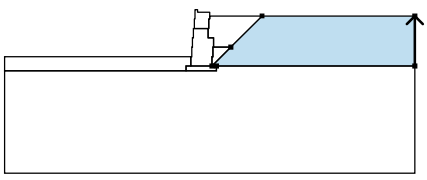
RETAINED SOILS
Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

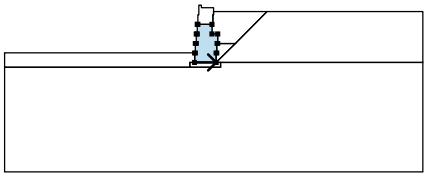
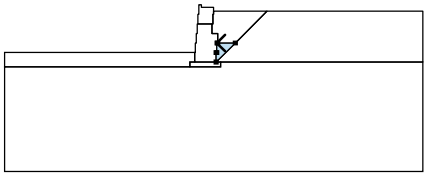
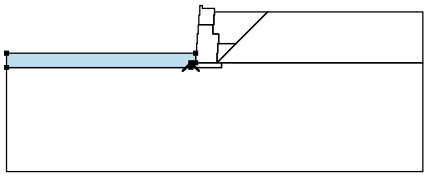
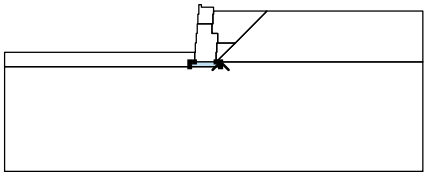
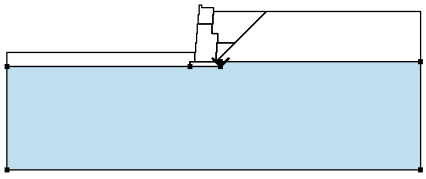
FOUNDATION SOIL
Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 28.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-0.27	-2.00	-0.13	-2.00	Material of structure
		-0.13	-0.50	0.00	-0.50	
		0.00	0.00	0.00	0.58	
		-1.92	0.58	-1.92	1.00	
		-2.33	1.00	-2.33	-0.50	
		-2.47	-0.50	-2.47	-2.00	
2		3.37	-5.00	8.37	0.00	BACKFILL SOIL-CLASS II SAND
		0.00	0.00	0.00	-0.50	
		-0.13	-0.50	-0.13	-2.00	
		-0.27	-2.00	-0.27	-3.50	
		0.64	-3.50	0.64	-5.00	
3		32.80	-8.00	32.80	0.00	RETAINED SOILS
		8.37	0.00	3.37	-5.00	
		0.37	-8.00	1.07	-8.00	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
4		-3.01	-8.00	0.37	-8.00	Material of structure
		0.37	-6.50	0.50	-6.50	
		0.50	-5.00	0.64	-5.00	
		0.64	-3.50	-0.27	-3.50	
		-0.27	-2.00	-2.47	-2.00	
		-2.60	-2.00	-2.60	-3.50	
		-2.74	-3.50	-2.74	-5.00	
		-2.87	-5.00	-2.87	-6.50	
		-3.01	-6.50			
5		0.64	-5.00	0.50	-5.00	BACKFILL SOIL-CLASS II SAND
		0.50	-6.50	0.37	-6.50	
		0.37	-8.00	3.37	-5.00	
6		-3.76	-8.75	-3.76	-8.00	RETAINED SOILS
		-3.01	-8.00	-3.01	-6.50	
		-32.80	-6.50	-32.80	-8.75	
7		1.07	-8.75	1.07	-8.00	LEVELING PAD-21AA
		0.37	-8.00	-3.01	-8.00	
		-3.76	-8.00	-3.76	-8.75	
8		1.07	-8.00	1.07	-8.75	FOUNDATION SOIL
		-3.76	-8.75	-32.80	-8.75	
		-32.80	-25.15	32.80	-25.15	
		32.80	-8.00			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 0.00	l = 15.00		0.00	100.0		lbf/ft2

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-3.79	[ft]	Angles :	α_1 =	-38.27	[°]
	z =	3.40	[ft]		α_2 =	74.36	[°]
Radius :	R =	12.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 10911.1 lbf/ft

Slope stability verification (Bishop)

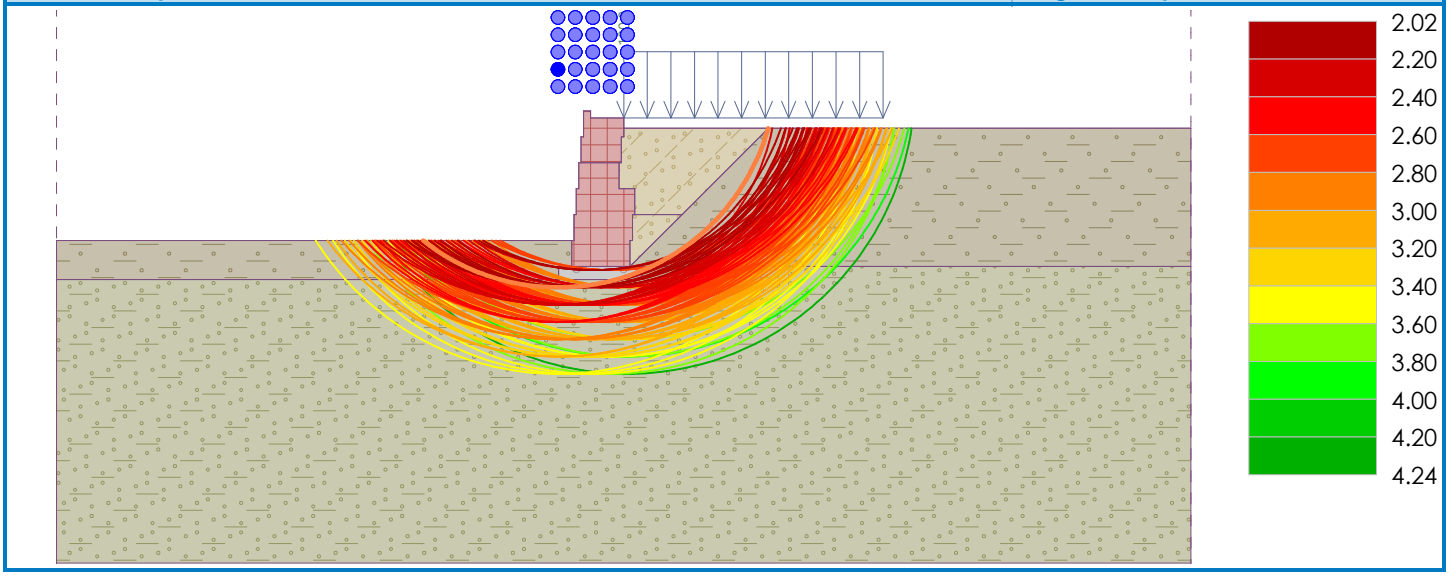
Sum of active forces : F_a = 3947.8 lbf/ft
Sum of passive forces : F_p = 7979.4 lbf/ft

Sliding moment : M_a = 49781.5 lbfft/ft
Resisting moment : M_p = 100620.5 lbfft/ft

Factor of safety = 2.02 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-1_10.5 FT HT
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 60	18.00	60.00	130.00
3	Top block 28	18.00	28.00	120.00
4	Block R-41 HC	18.00	40.50	110.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 60	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00
4	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 60	2	0.13
2	Block R-41 HC	2	0.13
3	Block 28	2	0.13
4	Top block 28	1	-

Base

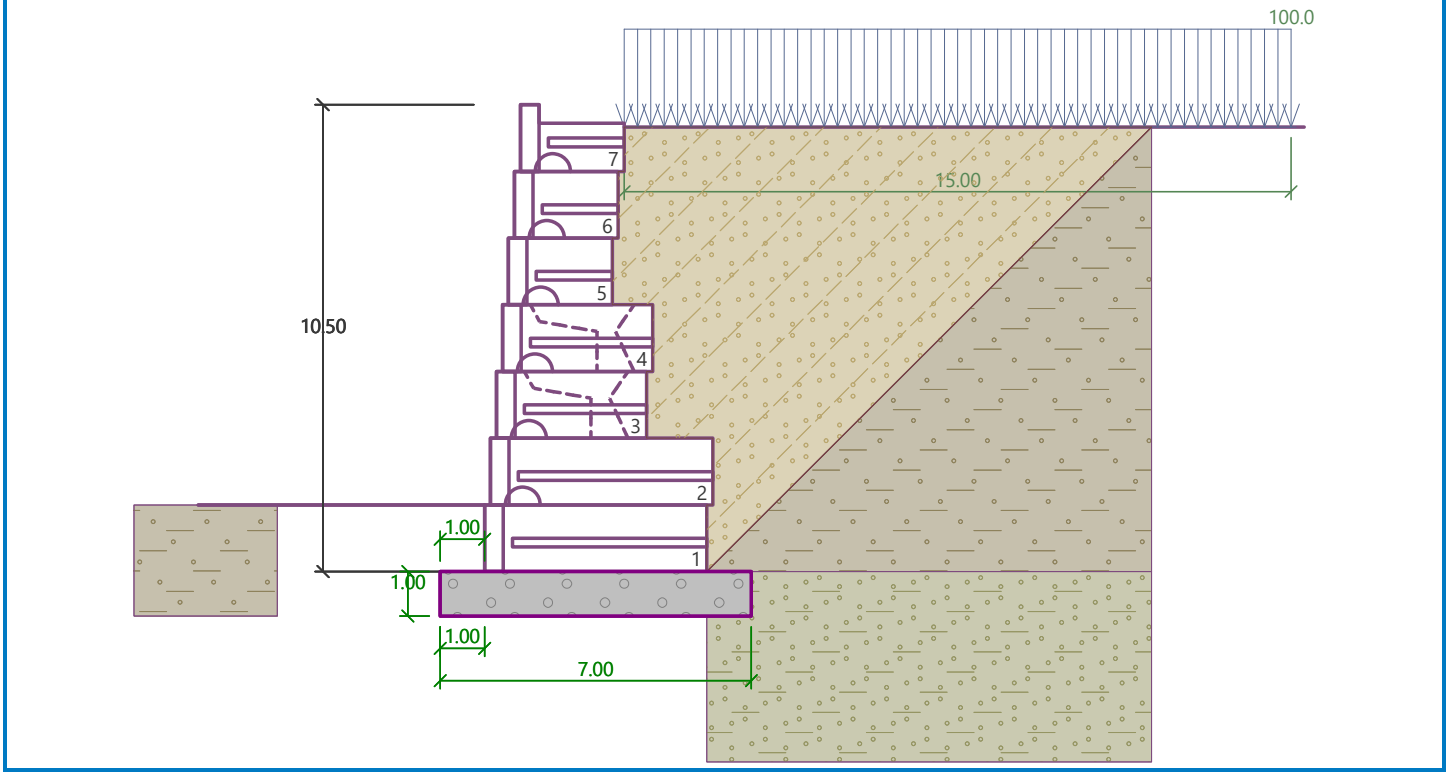
Geometry

Upper setback a_1 = 1.00 ft
Lower setback a_2 = 1.00 ft
Height h = 1.00 ft
Width b = 7.00 ft

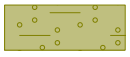
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

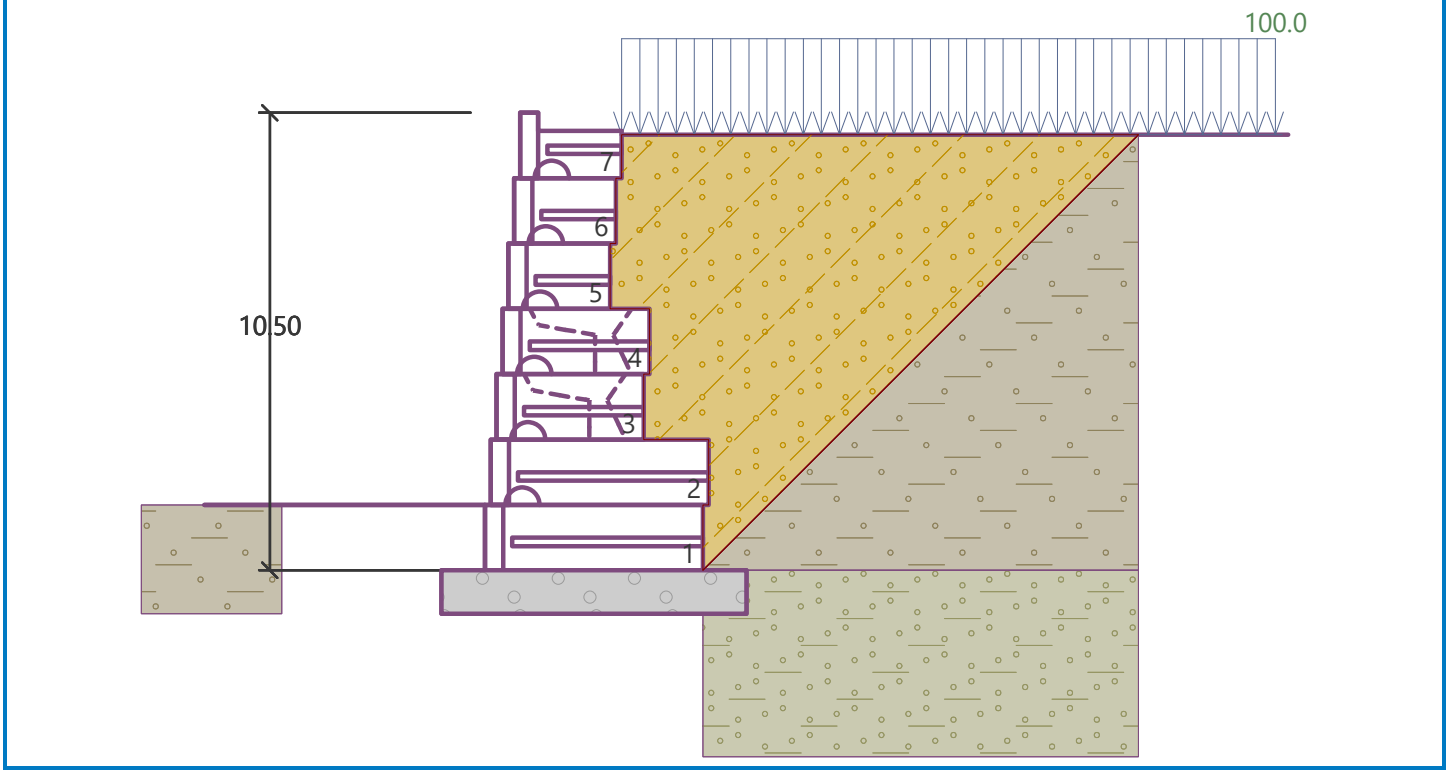
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill | **Stage - analysis : 1 - 0**



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	10.00	0.00 .. 10.00	0.00 .. -10.00	RETAINED SOILS	
2	-	10.00 .. ∞	-10.00 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.
Depth of terrain below the top of wall h = 0.50 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		0.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 2.50 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.30	5141.9	3.27	1.000
FF resistance	-187.4	-0.83	0.2	-0.50	1.000
Weight - earth wedge	0.0	-1.56	100.1	6.36	1.000
Weight - earth wedge	0.0	-4.83	222.5	5.18	1.000
Weight - earth wedge	0.0	-7.47	76.7	4.22	1.000
Active pressure	2006.1	-3.73	2527.5	5.85	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	217.6	-5.60	179.4	5.44	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 34681.4 lbfft/ft
Overturning moment M_{ovr} = 8549.6 lbfft/ft

Safety factor = 4.06 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 5019.32 lbf/ft
Active horizontal force H_{act} = 2036.34 lbf/ft

Safety factor = 2.46 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.36	2281.9	1.65	1.000
Weight - earth wedge	0.0	-3.47	76.7	2.95	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Active pressure	747.8	-2.38	501.6	3.22	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	163.2	-3.46	81.6	3.15	1.000

Verification of most stressed block No. 3

Check for overturning stability

Resisting moment M_{res} = 5874.8 lbfft/ft
Overturning moment M_{ovr} = 2347.1 lbfft/ft

Safety factor = 2.50 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7574.73 lbf/ft
Active horizontal force H_{act} = 911.00 lbf/ft

Safety factor = 8.31 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	2737.3	8248.29	2036.34	0.047	1301.8

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	2737.3	8248.29	2036.34

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

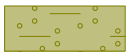
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	11.00 ft
Depth of footing bottom	d	=	2.50 ft
Foundation thickness	t	=	1.00 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	10.00 ft
Strip footing width (x)	=	7.00 ft
Column width in the direction of x	=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	7.00 ft³/ft
Volume of excavation	=	17.50 ft³/ft
Volume of fill	=	10.01 ft³/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	10.00	0.00 .. 10.00	0.00 .. -10.00	RETAINED SOILS	
2	-	10.00 .. ∞	-10.00 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	6137.35	701.0	-2036.34
2	Yes		LC 2	Service	6137.35	701.0	-2036.34

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.33	0.00	1301.8	13352.8	19.50	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 910.00 lbf/ft
Computed weight of overburden Z = 1200.94 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 10.37 ft
Length of slip surface l_{sp} = 30.35 ft

Design bearing capacity of found. soil R_d = 13352.8 psf
Extreme contact stress σ = 1301.8 psf

Factor of safety = 10.26 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.047<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.047<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

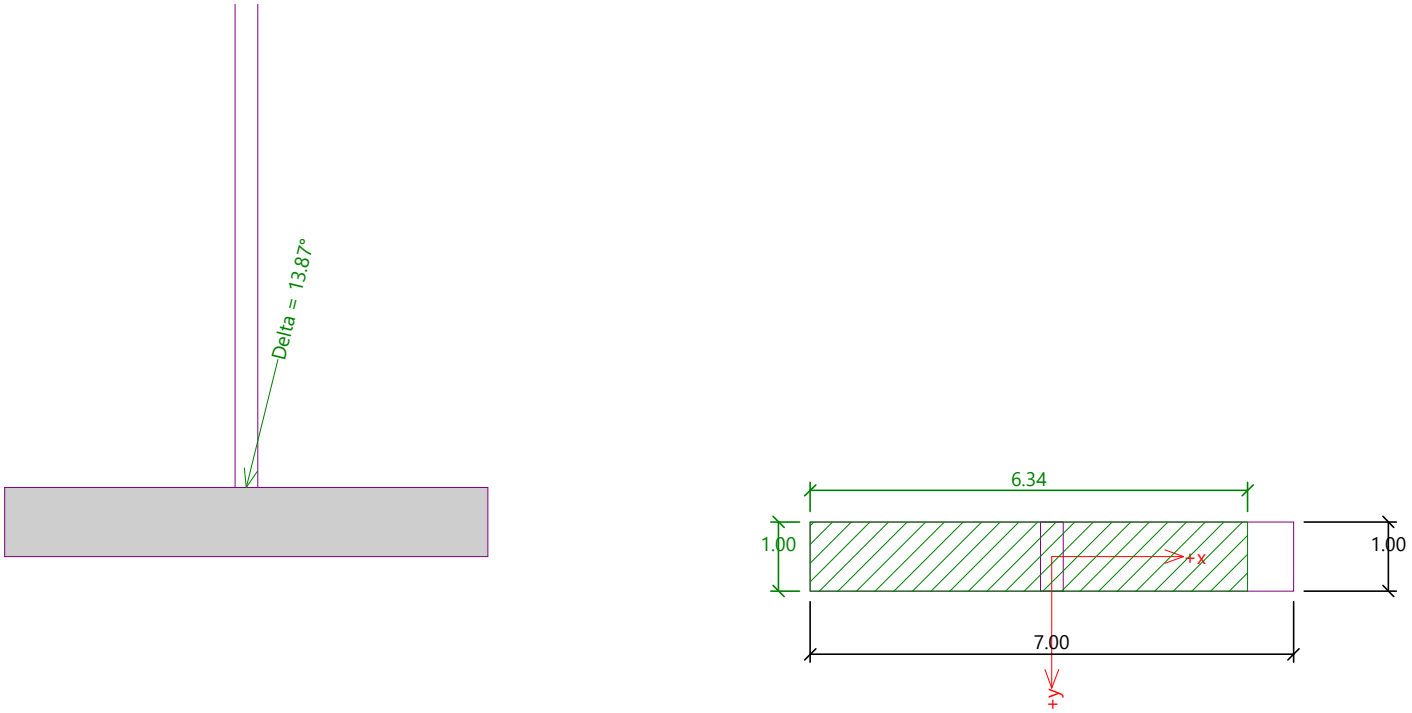
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 127.33 lbf

Horizontal bearing capacity R_{dh} = 5146.65 lbf
Extreme horizontal force H = 2036.34 lbf

Factor of safety = 2.53 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - 1



Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 910.00 lbf/ft
Computed weight of overburden Z = 1200.94 lbf/ft

Settlement of mid point of longitudinal edge = 0.14 in
Settlement of mid point of transverse edge 1 = 0.20 in
Settlement of mid point of transverse edge 2 = 0.13 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=12.14)
Foundation in the direction of width is rigid (k=4163.40)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.047<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.047<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.18 in
Depth of influence zone = 6.59 ft

Rotation in direction of width = 0.854 (tan*1000); (4.9E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

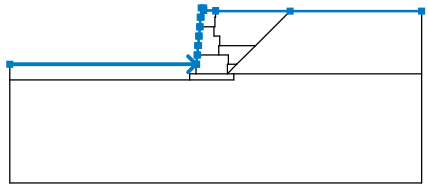
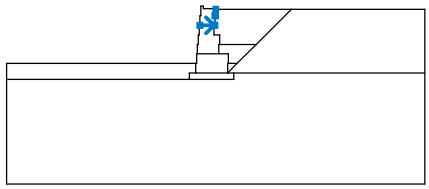
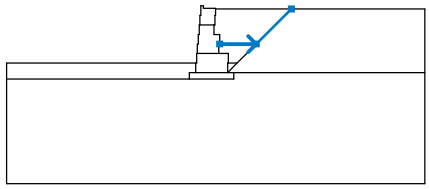
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

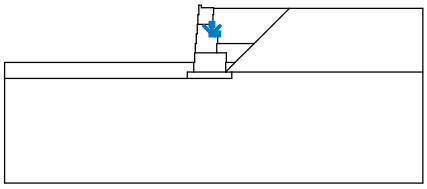
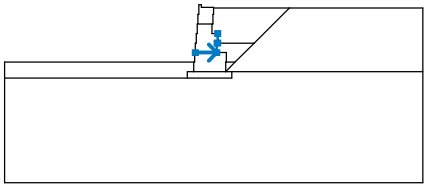
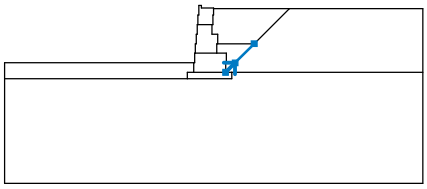
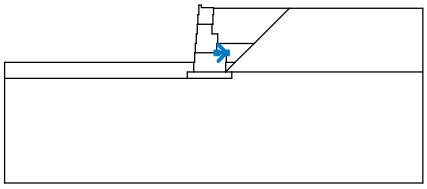
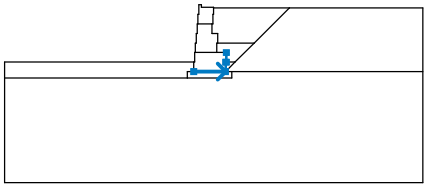
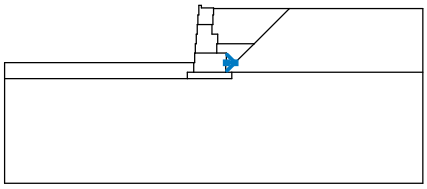
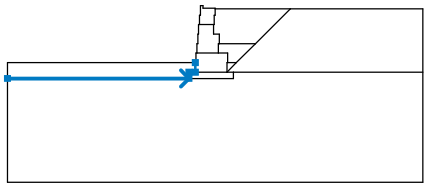
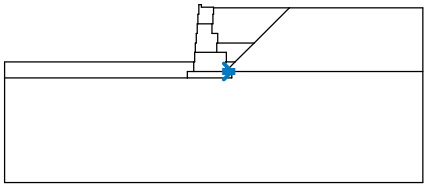
Anchors

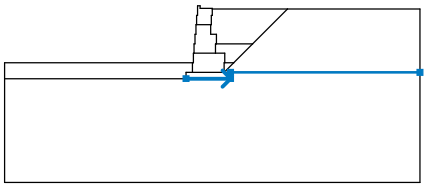
Verification methodology : Safety factors (ASD)

Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-8.50	-3.14	-8.50	-3.01	-8.50
		-3.01	-7.00	-2.87	-7.00	-2.87	-5.50
		-2.74	-5.50	-2.74	-4.00	-2.60	-4.00
		-2.60	-2.50	-2.47	-2.50	-2.47	-1.00
		-2.33	-1.00	-2.33	0.50	-1.92	0.50
		-1.92	0.08	0.00	0.08	0.00	0.00
		11.86	0.00	32.80	0.00		
2		-2.47	-2.50	-0.27	-2.50	-0.13	-2.50
		-0.13	-1.00	0.00	-1.00	0.00	0.00
3		0.64	-5.50	6.36	-5.50	11.86	0.00

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-0.27	-2.50	-0.27	-4.00	0.64	-4.00
5		-2.87	-7.00	0.50	-7.00	0.50	-5.50
		0.64	-5.50	0.64	-4.00		
6		1.86	-10.00	3.36	-8.50	6.36	-5.50
7		0.50	-7.00	1.99	-7.00		
8		-3.14	-10.00	1.86	-10.00	1.86	-8.50
		1.99	-8.50	1.99	-7.00		
9		1.99	-8.50	3.36	-8.50		
10		-32.80	-11.00	-4.14	-11.00	-4.14	-10.00
		-3.14	-10.00	-3.14	-8.50		
11		1.86	-10.00	2.86	-10.00		

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
12		-4.14	-11.00	2.86	-11.00	2.86	-10.00
		32.80	-10.00				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ = 130.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 40.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ = 110.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 38.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 32.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

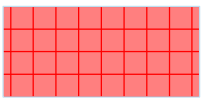
RETAINED SOILS

Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 30.00 °
Cohesion of soil :	c_{ef} = 0.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

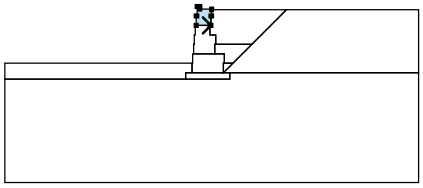
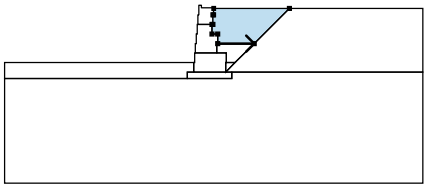
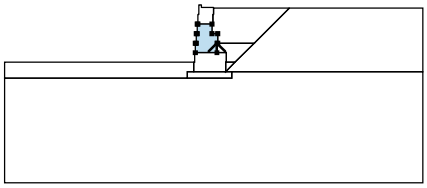
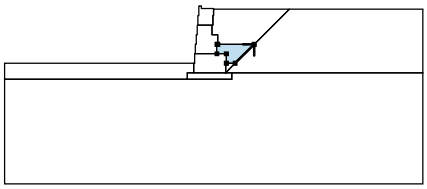
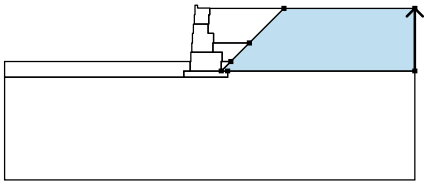
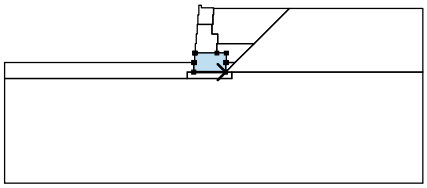
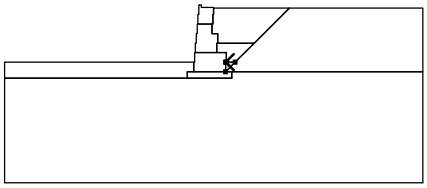
FOUNDATION SOIL

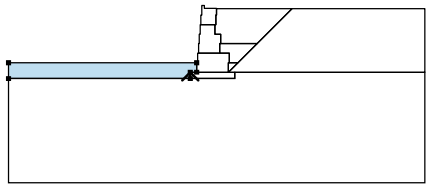
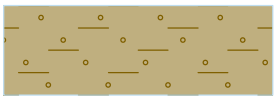
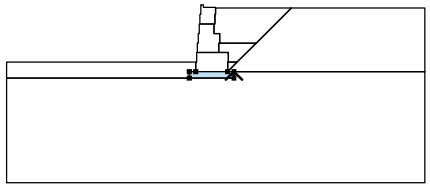
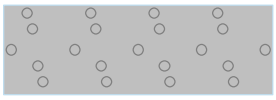
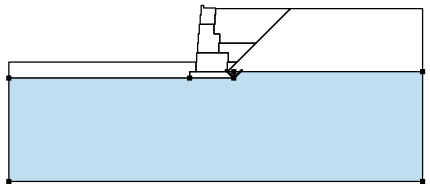
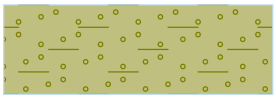
Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 28.00 °
Cohesion of soil :	c_{ef} = 100.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-0.27	-2.50	-0.13	-2.50	Material of structure
		-0.13	-1.00	0.00	-1.00	
		0.00	0.00	0.00	0.08	
		-1.92	0.08	-1.92	0.50	
		-2.33	0.50	-2.33	-1.00	
		-2.47	-1.00	-2.47	-2.50	
2		0.64	-5.50	6.36	-5.50	BACKFILL SOIL-CLASS II SAND
		11.86	0.00	0.00	0.00	
		0.00	-1.00	-0.13	-1.00	
		-0.13	-2.50	-0.27	-2.50	
		-0.27	-4.00	0.64	-4.00	
3		0.50	-7.00	0.50	-5.50	Material of structure
		0.64	-5.50	0.64	-4.00	
		-0.27	-4.00	-0.27	-2.50	
		-2.47	-2.50	-2.60	-2.50	
		-2.60	-4.00	-2.74	-4.00	
		-2.74	-5.50	-2.87	-5.50	
		-2.87	-7.00			
4		3.36	-8.50	6.36	-5.50	BACKFILL SOIL-CLASS II SAND
		0.64	-5.50	0.50	-5.50	
		0.50	-7.00	1.99	-7.00	
		1.99	-8.50			
5		32.80	-10.00	32.80	0.00	RETAINED SOILS
		11.86	0.00	6.36	-5.50	
		3.36	-8.50	1.86	-10.00	
		2.86	-10.00			
6		-3.14	-10.00	1.86	-10.00	Material of structure
		1.86	-8.50	1.99	-8.50	
		1.99	-7.00	0.50	-7.00	
		-2.87	-7.00	-3.01	-7.00	
		-3.01	-8.50	-3.14	-8.50	
7		1.99	-8.50	1.86	-8.50	BACKFILL SOIL-CLASS II SAND
		1.86	-10.00	3.36	-8.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
8		-4.14	-11.00	-4.14	-10.00	RETAINED SOILS
		-3.14	-10.00	-3.14	-8.50	
		-32.80	-8.50	-32.80	-11.00	
9		2.86	-11.00	2.86	-10.00	LEVELING PAD-21AA
		1.86	-10.00	-3.14	-10.00	
		-4.14	-10.00	-4.14	-11.00	
10		2.86	-10.00	2.86	-11.00	FOUNDATION SOIL
		-4.14	-11.00	-32.80	-11.00	
		-32.80	-27.40	32.80	-27.40	
		32.80	-10.00			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 0.00	l = 15.00		0.00	100.0		lbf/ft2

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-3.79	[ft]	Angles :	a_1 =	-35.46	[°]
	z =	3.40	[ft]		a_2 =	76.54	[°]
Radius :	R =	14.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 14984.0 lbf/ft

Slope stability verification (Bishop)

Sum of active forces : F_a = 5769.7 lbf/ft

Sum of passive forces : F_p = 10942.0 lbf/ft

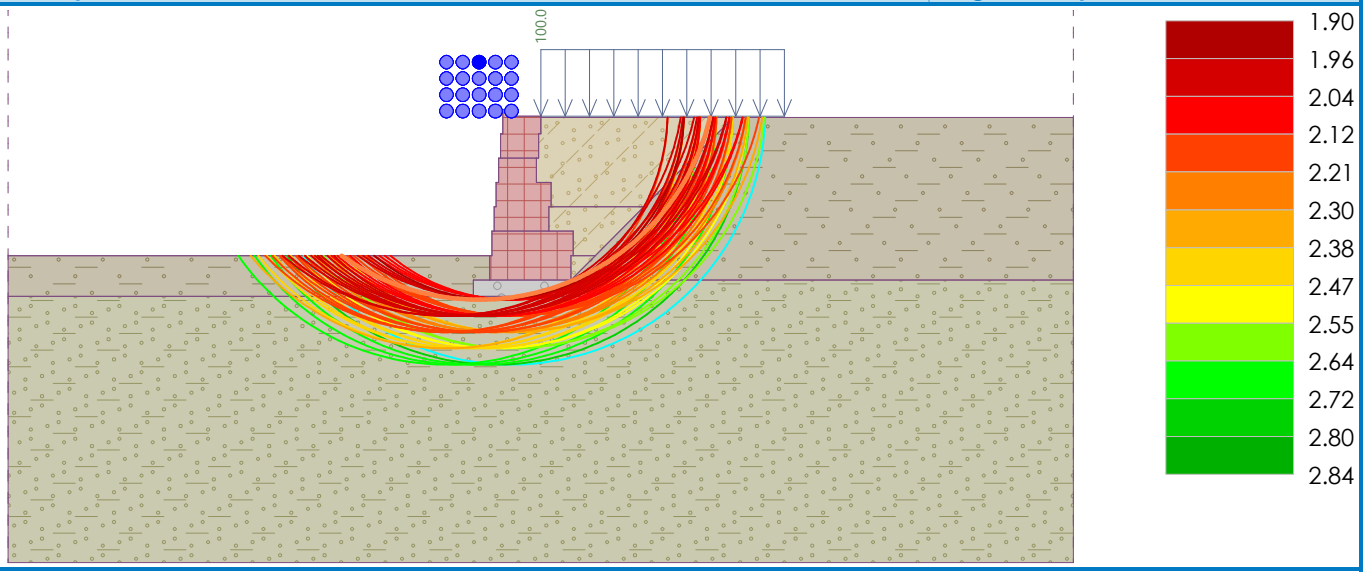
Sliding moment : M_a = 84296.0 lbfft/ft

Resisting moment : M_p = 159862.9 lbfft/ft

Factor of safety = 1.90 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-1_12.0 FT HT
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 60	18.00	60.00	130.00
3	Top block 28	18.00	28.00	120.00
4	Block R-41 HC	18.00	40.50	110.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 60	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00
4	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 60	2	0.13
2	Block R-41 HC	3	0.13
3	Block 28	2	0.13
4	Top block 28	1	-

Base

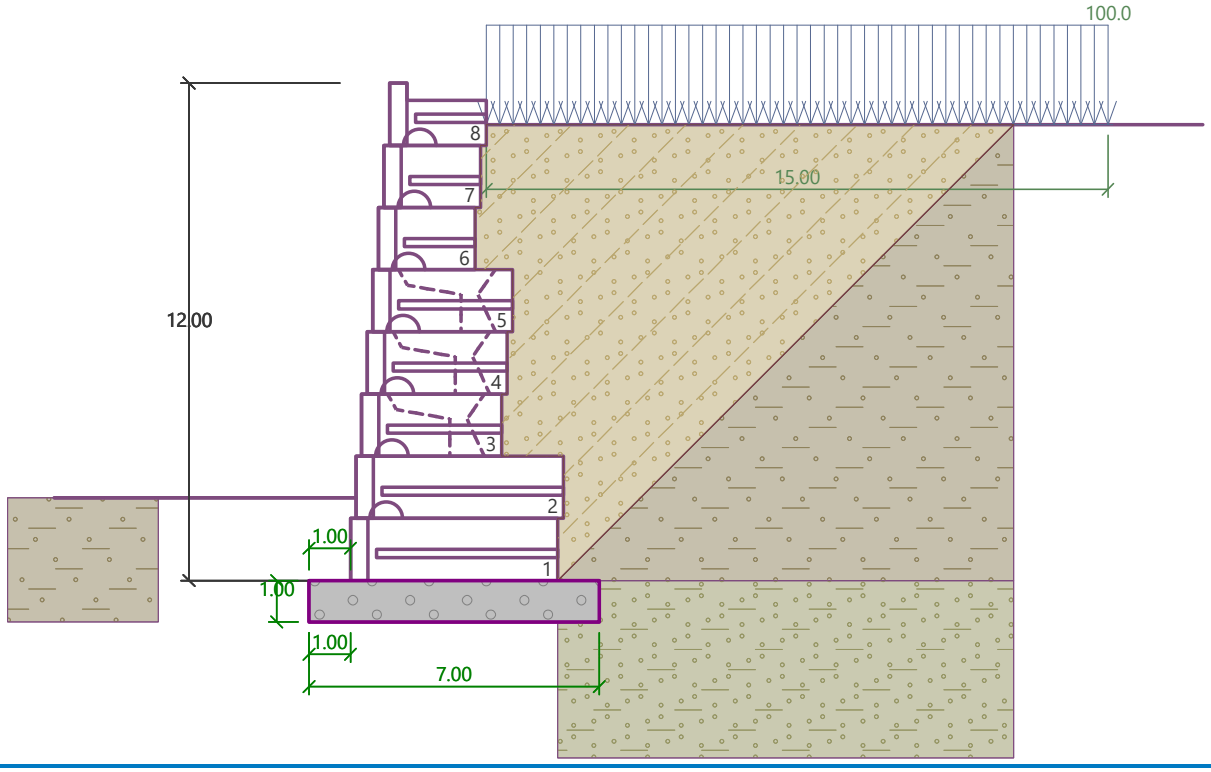
Geometry

Upper setback a_1 = 1.00 ft
Lower setback a_2 = 1.00 ft
Height h = 1.00 ft
Width b = 7.00 ft

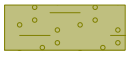
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

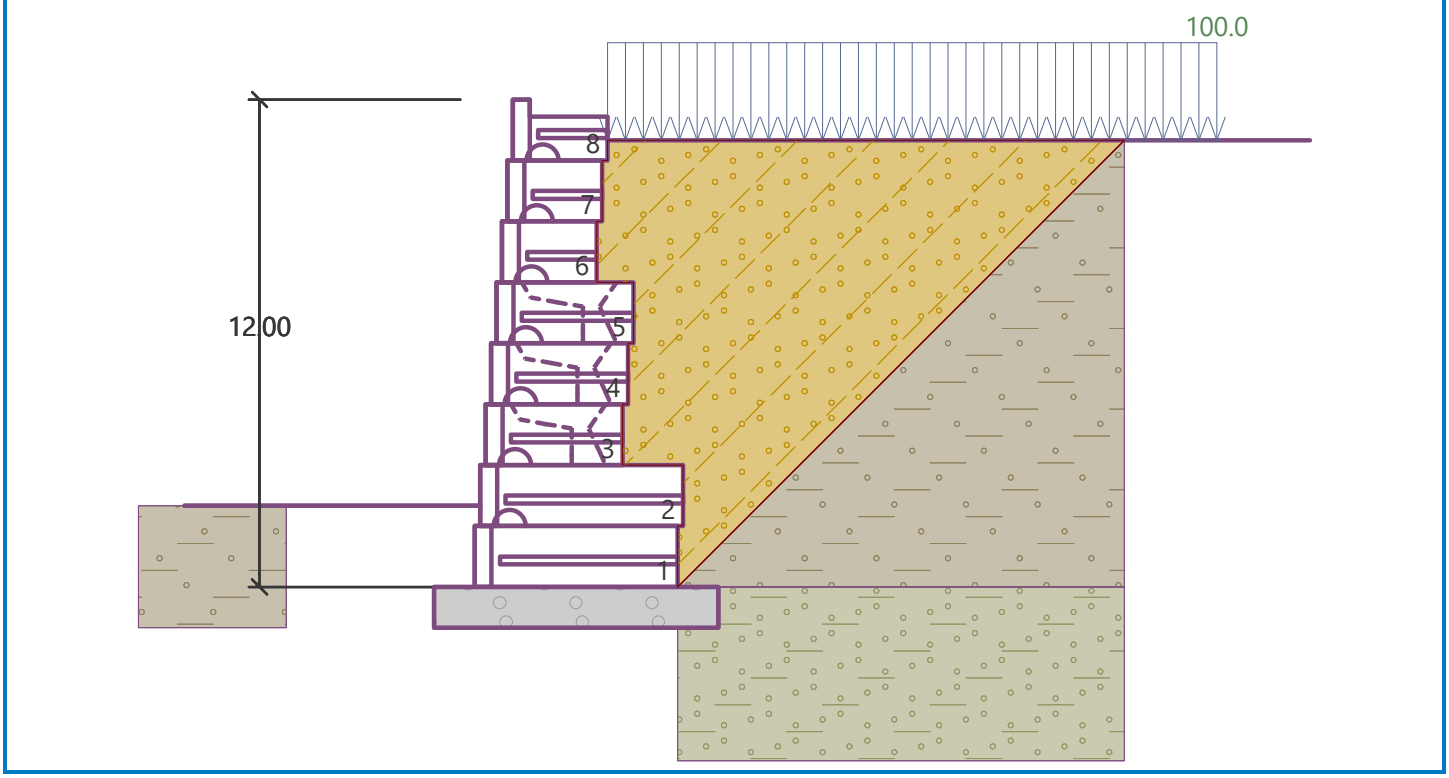
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill | **Stage - analysis : 1 - 0**



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft
Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	11.00	0.00 .. 11.00	0.00 .. -11.00	RETAINED SOILS	
2	-	11.00 .. ∞	-11.00 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.
Depth of terrain below the top of wall h = 1.00 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		0.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 3.00 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.95	5698.8	3.29	1.000
FF resistance	-269.8	-1.00	0.4	-0.52	1.000
Weight - earth wedge	0.0	-1.56	100.1	6.36	1.000
Weight - earth wedge	0.0	-4.81	217.0	5.19	1.000
Weight - earth wedge	0.0	-8.97	76.7	4.35	1.000
Active pressure	2369.2	-4.01	2815.1	5.89	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	244.8	-6.12	185.9	5.48	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 38456.0 lbfft/ft
Overturning moment M_{ovr} = 10729.1 lbfft/ft

Safety factor = 3.58 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 5445.15 lbf/ft
Active horizontal force H_{act} = 2344.15 lbf/ft

Safety factor = 2.32 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-4.05	2838.8	1.77	1.000
Weight - earth wedge	0.0	-4.97	76.7	3.08	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Active pressure	949.1	-2.74	520.1	3.37	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	189.9	-3.87	88.0	3.31	1.000

Verification of most stressed block No. 3

Check for overturning stability

Resisting moment M_{res} = 7302.4 lbfft/ft
Overturning moment M_{ovr} = 3337.7 lbfft/ft

Safety factor = 2.19 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 8013.21 lbf/ft
Active horizontal force H_{act} = 1138.91 lbf/ft

Safety factor = 7.04 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	4102.1	9093.99	2344.15	0.064	1491.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	4102.1	9093.99	2344.15

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

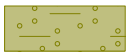
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	12.00 ft
Depth of footing bottom	d	=	3.00 ft
Foundation thickness	t	=	1.00 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	10.00 ft
Strip footing width (x)	=	7.00 ft
Column width in the direction of x	=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	7.00 ft³/ft
Volume of excavation	=	21.00 ft³/ft
Volume of fill	=	13.34 ft³/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	11.00	0.00 .. 11.00	0.00 .. -11.00	RETAINED SOILS	
2	-	11.00 .. ∞	-11.00 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	6582.73	1758.0	-2344.15
2	Yes		LC 2	Service	6582.73	1758.0	-2344.15

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.45	0.00	1491.3	13996.8	21.31	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 910.00 lbf/ft
Computed weight of overburden Z = 1601.26 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 10.37 ft
Length of slip surface l_{sp} = 30.35 ft

Design bearing capacity of found. soil R_d = 13996.8 psf
Extreme contact stress σ = 1491.3 psf

Factor of safety = 9.39 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.064<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.064<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

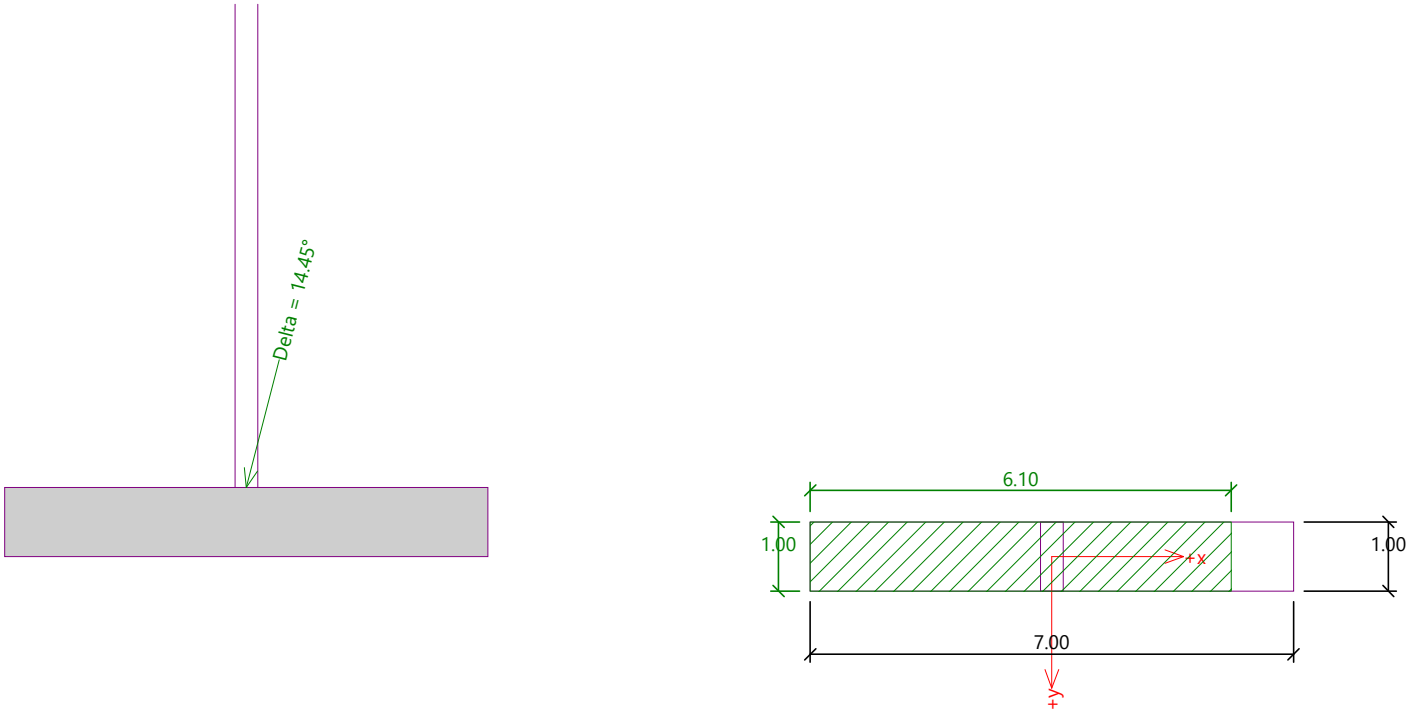
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 159.16 lbf

Horizontal bearing capacity R_{dh} = 5604.30 lbf
Extreme horizontal force H = 2344.15 lbf

Factor of safety = 2.39 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - 1



Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 910.00 lbf/ft
Computed weight of overburden Z = 1601.26 lbf/ft

Settlement of mid point of longitudinal edge = 0.15 in
Settlement of mid point of transverse edge 1 = 0.22 in
Settlement of mid point of transverse edge 2 = 0.12 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=12.14)
Foundation in the direction of width is rigid (k=4163.40)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.064<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.064<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.19 in
Depth of influence zone = 6.47 ft

Rotation in direction of width = 1.230 (tan*1000); (7.0E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

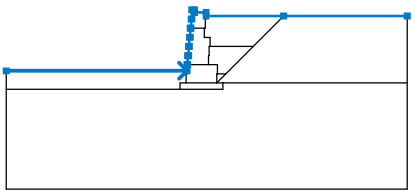
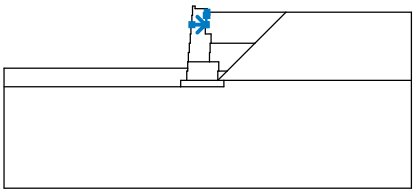
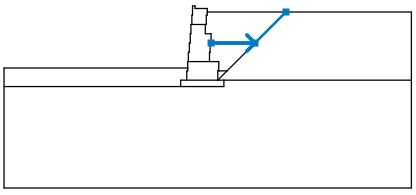
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

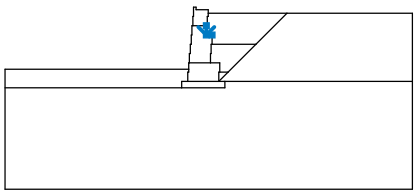
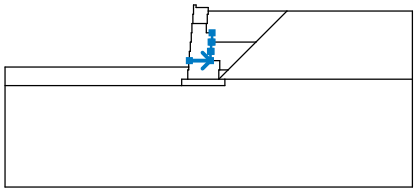
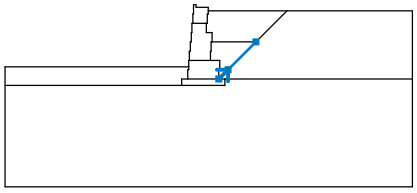
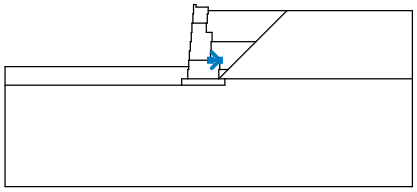
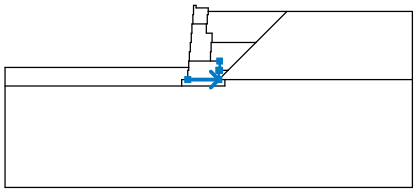
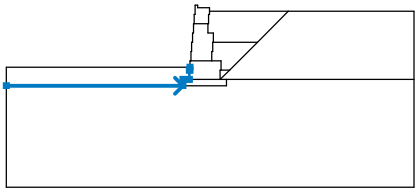
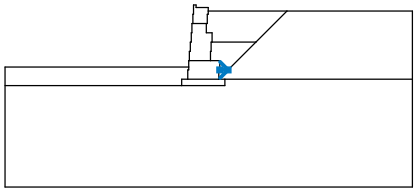
Anchors

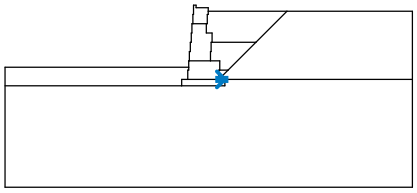
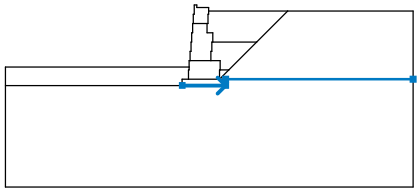
Verification methodology : Safety factors (ASD)

Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-9.00	-3.14	-9.00	-3.14	-8.00
		-3.01	-8.00	-3.01	-6.50	-2.87	-6.50
		-2.87	-5.00	-2.74	-5.00	-2.74	-3.50
		-2.60	-3.50	-2.60	-2.00	-2.47	-2.00
		-2.47	-0.50	-2.33	-0.50	-2.33	1.00
		-1.92	1.00	-1.92	0.58	0.00	0.58
		0.00	0.00	12.73	0.00	33.00	0.00
2		-2.47	-2.00	-0.27	-2.00	-0.13	-2.00
		-0.13	-0.50	0.00	-0.50	0.00	0.00
3		0.64	-5.00	7.73	-5.00	12.73	0.00

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
4		-0.27	-2.00	-0.27	-3.50	0.64	-3.50
5		-3.01	-8.00	0.37	-8.00	0.37	-6.50
		0.50	-6.50	0.50	-5.00	0.64	-5.00
		0.64	-3.50				
6		1.73	-11.00	3.23	-9.50	7.73	-5.00
7		0.37	-8.00	1.86	-8.00		
8		-3.27	-11.00	1.73	-11.00	1.73	-9.50
		1.86	-9.50	1.86	-8.00		
9		-32.80	-12.00	-4.27	-12.00	-4.27	-11.00
		-3.27	-11.00	-3.27	-9.50	-3.14	-9.50
		-3.14	-9.00				
10		1.86	-9.50	3.23	-9.50		

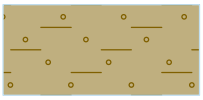
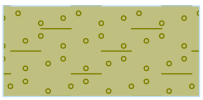
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
11		1.73	-11.00	2.73	-11.00		
12		-4.27	-12.00	2.73	-12.00	2.73	-11.00
		33.00	-11.00				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

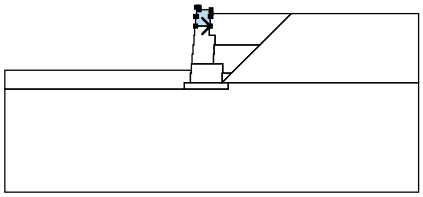
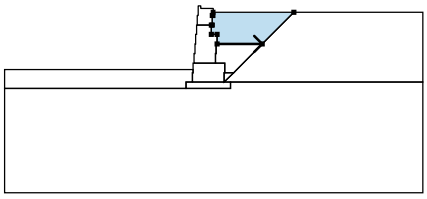
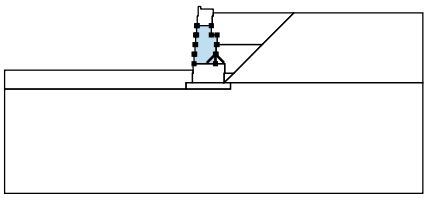
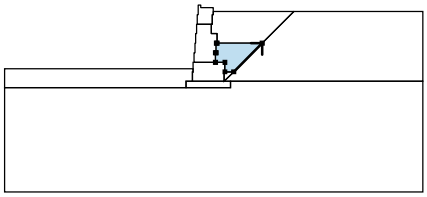
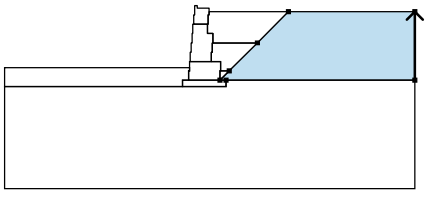
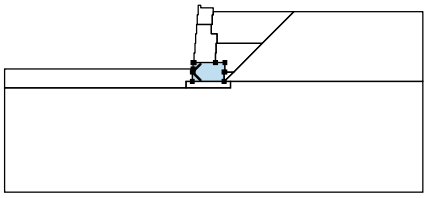
FOUNDATION SOIL

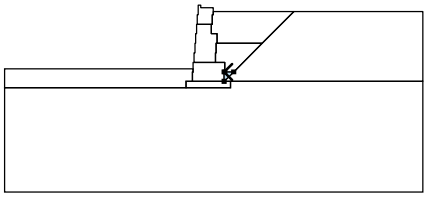
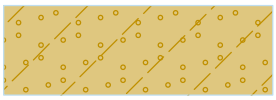
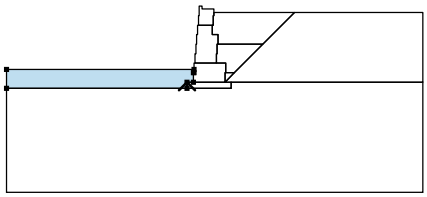
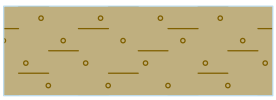
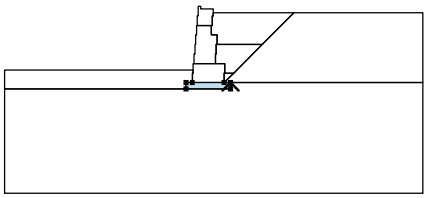
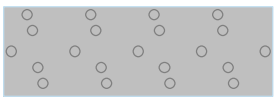
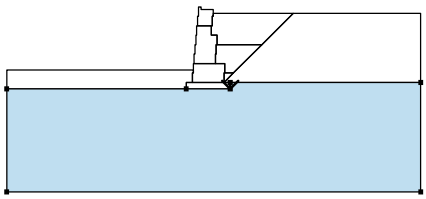
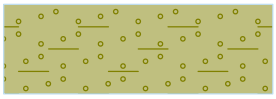
Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 28.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-0.27	-2.00	-0.13	-2.00	Material of structure
		-0.13	-0.50	0.00	-0.50	
		0.00	0.00	0.00	0.58	
		-1.92	0.58	-1.92	1.00	
		-2.33	1.00	-2.33	-0.50	
		-2.47	-0.50	-2.47	-2.00	
2		0.64	-5.00	7.73	-5.00	BACKFILL SOIL-CLASS II SAND
		12.73	0.00	0.00	0.00	
		0.00	-0.50	-0.13	-0.50	
		-0.13	-2.00	-0.27	-2.00	
		-0.27	-3.50	0.64	-3.50	
3		0.37	-8.00	0.37	-6.50	Material of structure
		0.50	-6.50	0.50	-5.00	
		0.64	-5.00	0.64	-3.50	
		-0.27	-3.50	-0.27	-2.00	
		-2.47	-2.00	-2.60	-2.00	
		-2.60	-3.50	-2.74	-3.50	
		-2.74	-5.00	-2.87	-5.00	
		-2.87	-6.50	-3.01	-6.50	
		-3.01	-8.00			
4		3.23	-9.50	7.73	-5.00	BACKFILL SOIL-CLASS II SAND
		0.64	-5.00	0.50	-5.00	
		0.50	-6.50	0.37	-6.50	
		0.37	-8.00	1.86	-8.00	
		1.86	-9.50			
5		33.00	-11.00	33.00	0.00	RETAINED SOILS
		12.73	0.00	7.73	-5.00	
		3.23	-9.50	1.73	-11.00	
		2.73	-11.00			
6		-3.14	-9.50	-3.27	-9.50	Material of structure
		-3.27	-11.00	1.73	-11.00	
		1.73	-9.50	1.86	-9.50	
		1.86	-8.00	0.37	-8.00	
		-3.01	-8.00	-3.14	-8.00	
		-3.14	-9.00			

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		1.86	-9.50	1.73	-9.50	BACKFILL SOIL-CLASS II SAND
		1.73	-11.00	3.23	-9.50	
8		-4.27	-12.00	-4.27	-11.00	RETAINED SOILS
		-3.27	-11.00	-3.27	-9.50	
		-3.14	-9.50	-3.14	-9.00	
		-32.80	-9.00	-32.80	-12.00	
9		2.73	-12.00	2.73	-11.00	LEVELING PAD-21AA
		1.73	-11.00	-3.27	-11.00	
		-4.27	-11.00	-4.27	-12.00	
10		2.73	-11.00	2.73	-12.00	FOUNDATION SOIL
		-4.27	-12.00	-32.80	-12.00	
		-32.80	-28.40	33.00	-28.40	
		33.00	-11.00			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 0.00	l = 15.00		0.00	100.0		lbf/ft2

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-3.79	[ft]	Angles :	a_1 =	-40.17	[°]
	z =	1.40	[ft]		a_2 =	84.10	[°]
Radius :	R =	13.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 16492.0 lbf/ft

Slope stability verification (Bishop)

Sum of active forces : F_a = 6245.3 lbf/ft

Sum of passive forces : F_p = 12055.8 lbf/ft

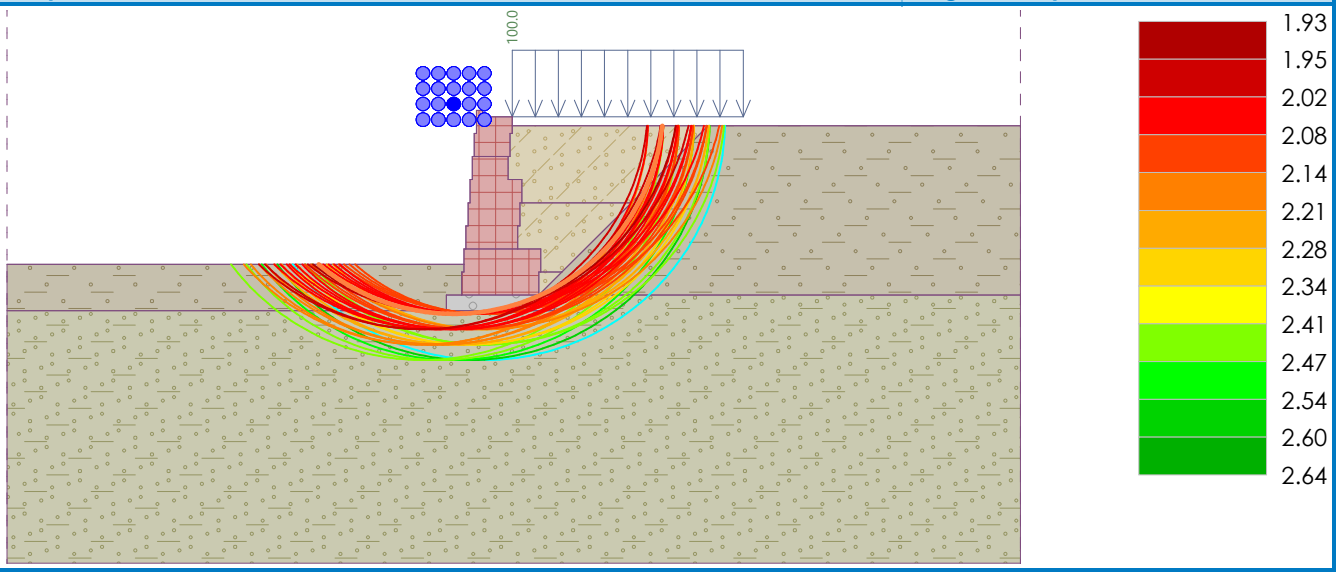
Sliding moment : M_a = 84998.3 lbfft/ft

Resisting moment : M_p = 164079.0 lbfft/ft

Factor of safety = 1.93 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-2_6.0 FT HT
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Top block 28	18.00	28.00	120.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00

Setbacks

No.	Setback s [in]
1	0.000

No.	Setback s [in]
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	0.13
2	Block 28	2	0.13
3	Top block 28	1	-

Base

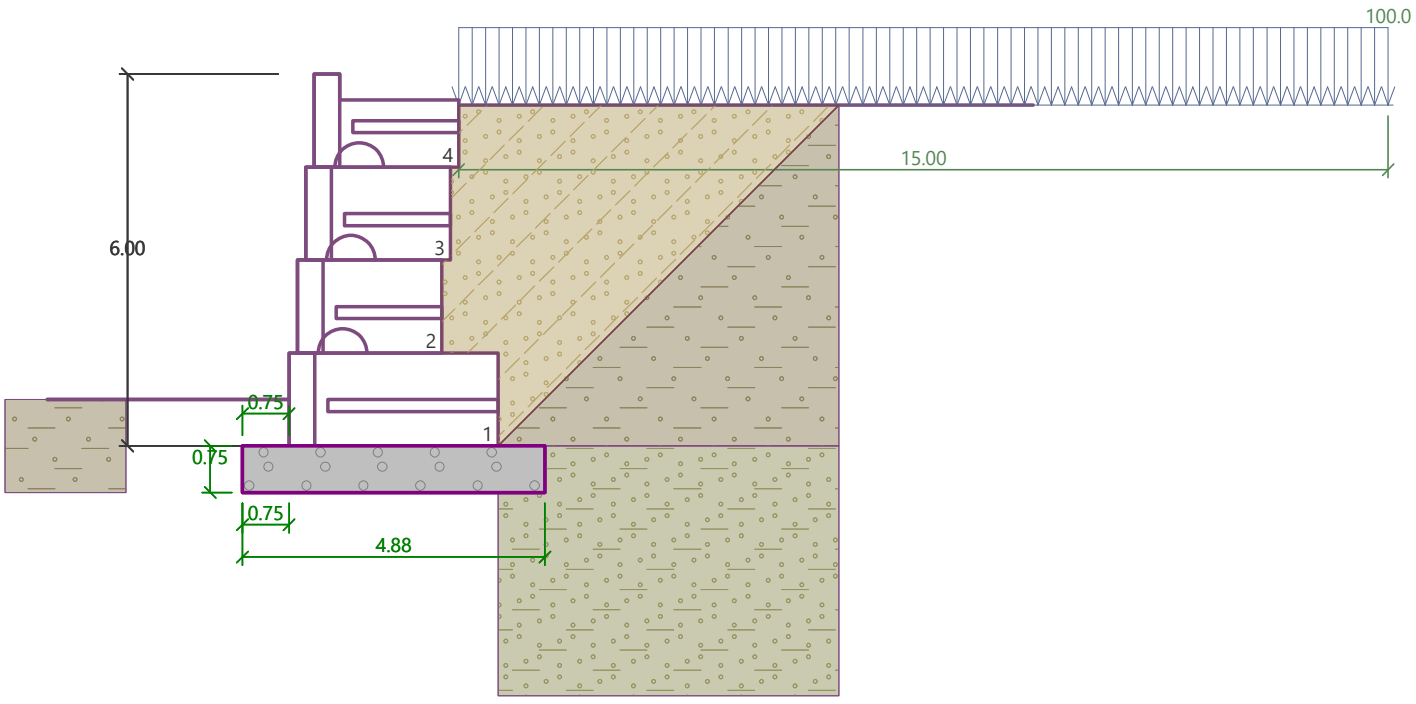
Geometry

Upper setback a_1 = 0.75 ft
Lower setback a_2 = 0.75 ft
Height h = 0.75 ft
Width b = 4.88 ft

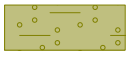
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

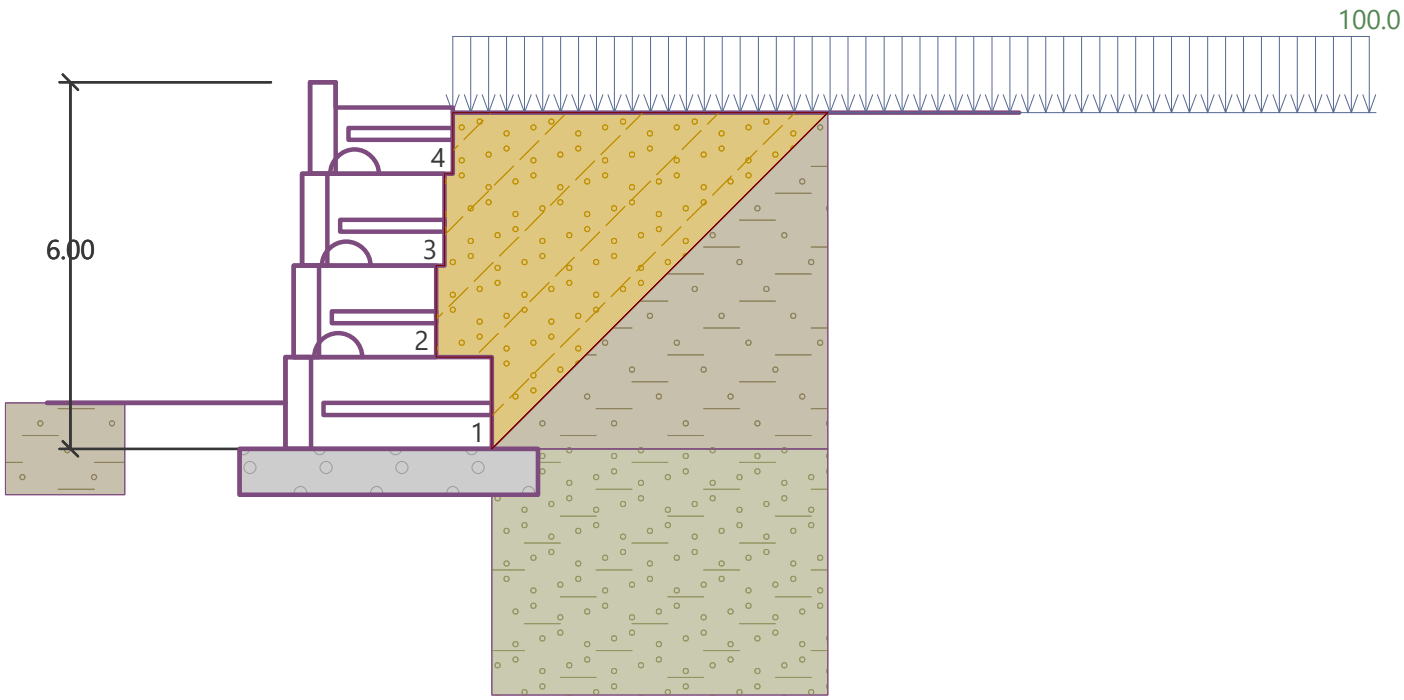
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill	Stage - analysis : 1 - 0



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	5.50	0.00 .. 5.50	0.00 .. -5.50	RETAINED SOILS	
2	-	5.50 .. ∞	-5.50 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.
Depth of terrain below the top of wall h = 0.50 ft.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		0.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 1.50 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.76	2251.4	2.30	1.000
FF resistance	-67.4	-0.50	0.1	-0.38	1.000
Weight - earth wedge	0.0	-1.20	61.7	4.38	1.000
Weight - earth wedge	0.0	-2.72	76.7	3.56	1.000
Active pressure	613.2	-2.18	810.9	4.20	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	129.2	-3.29	96.2	4.02	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 9520.4 lbfft/ft
Overturning moment M_{ovr} = 1725.4 lbfft/ft

Safety factor = 5.52 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2225.91 lbf/ft
Active horizontal force H_{act} = 674.93 lbf/ft

Safety factor = 3.30 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-2.13	1168.1	1.29	1.000
Active pressure	223.0	-1.35	66.3	2.46	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	103.8	-1.98	32.7	2.51	1.000

Verification of most stressed block No. 2

Check for overturning stability

Resisting moment M_{res} = 1752.4 lbfft/ft
Overturning moment M_{ovr} = 505.5 lbfft/ft

Safety factor = 3.47 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 7284.67 lbf/ft
Active horizontal force H_{act} = 326.84 lbf/ft

Safety factor = 22.29 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	249.8	3297.04	674.93	0.016	697.3

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	249.8	3297.04	674.93

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

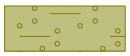
Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard
Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight :	γ	=	130.0 pcf
Angle of internal friction :	φ_{ef}	=	40.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	65000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	135.0 pcf

DRAINAGE LAYER-6A

Unit weight :	γ	=	110.0 pcf
Angle of internal friction :	φ_{ef}	=	38.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	30000.0 psi
Poisson's ratio :	ν	=	0.20
Saturated unit weight :	γ_{sat}	=	110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	32.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Oedometric modulus :	E_{oed}	=	1500.0 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

RETAINED SOILS

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	30.00 °
Cohesion of soil :	c_{ef}	=	0.0 psf
Deformation modulus :	E_{def}	=	3600.0 psi
Poisson's ratio :	ν	=	0.28
Saturated unit weight :	γ_{sat}	=	125.0 pcf

FOUNDATION SOIL

Unit weight :	γ	=	120.0 pcf
Angle of internal friction :	φ_{ef}	=	28.00 °
Cohesion of soil :	c_{ef}	=	100.0 psf
Oedometric modulus :	E_{oed}	=	1203.5 psi
Saturated unit weight :	γ_{sat}	=	125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	6.25 ft
Depth of footing bottom	d	=	1.50 ft
Foundation thickness	t	=	0.75 ft
Incl. of finished grade	s_1	=	0.00 °
Incl. of footing bottom	s_2	=	0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length	=	10.00 ft
Strip footing width (x)	=	4.88 ft
Column width in the direction of x	=	0.33 ft

Inserted loading is considered per unit length of continuous footing span.

Volume of strip footing	=	3.66 ft³/ft
Volume of excavation	=	7.32 ft³/ft
Volume of fill	=	3.41 ft³/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	5.50	0.00 .. 5.50	0.00 .. -5.50	RETAINED SOILS	
2	-	5.50 .. ∞	-5.50 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	2411.56	-256.4	-674.93
2	Yes		LC 2	Service	2411.56	-256.4	-674.93

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.08	0.00	697.3	9973.5	13.98	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 409.67 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 7.23 ft
Length of slip surface l_{sp} = 21.16 ft

Design bearing capacity of found. soil R_d = 9973.5 psf
Extreme contact stress σ = 697.3 psf

Factor of safety = 14.30 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.016<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.016<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

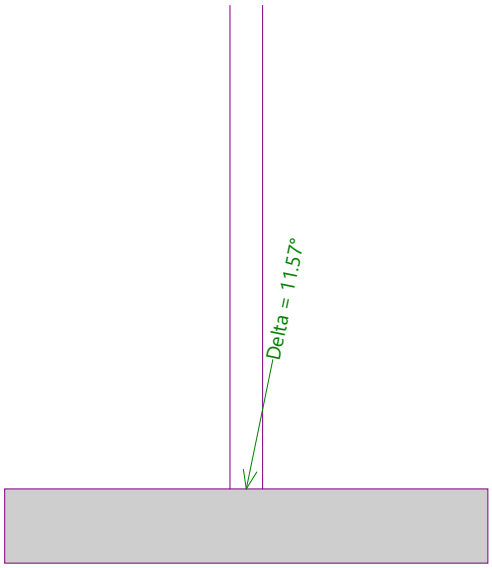
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 53.72 lbf

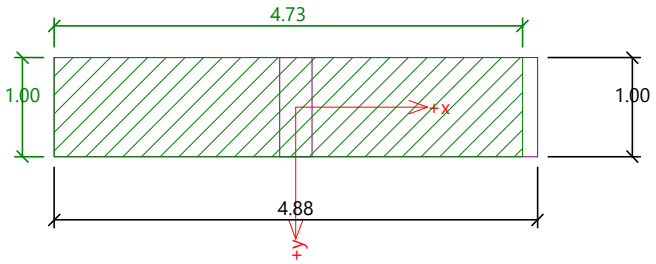
Horizontal bearing capacity R_{dh} = 2279.63 lbf
Extreme horizontal force H = 674.93 lbf

Factor of safety = 3.38 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap. | **Stage - analysis : 1 - 1**





Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 409.67 lbf/ft

Settlement of mid point of longitudinal edge = 0.06 in
Settlement of mid point of transverse edge 1 = 0.08 in
Settlement of mid point of transverse edge 2 = 0.07 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=15.11)
Foundation in the direction of width is rigid (k=1756.43)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.016<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.016<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.08 in
Depth of influence zone = 4.85 ft

Rotation in direction of width = 0.190 (tan*1000); (1.1E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

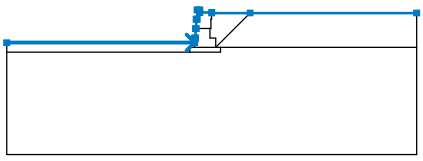
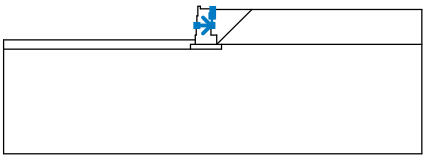
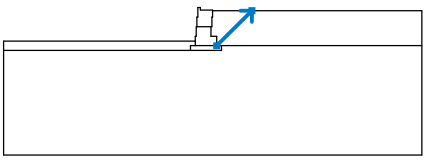
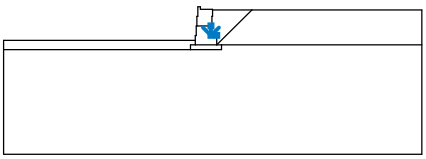
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

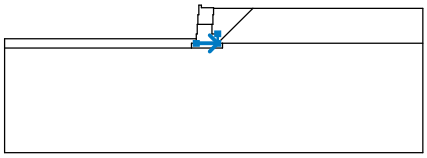
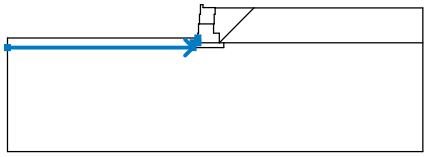
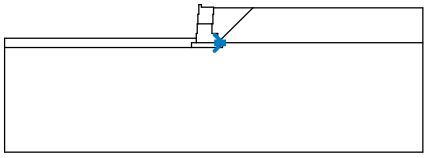
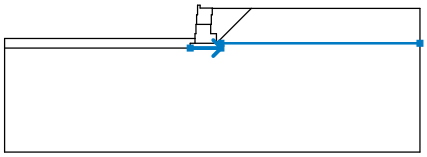
Anchors

Verification methodology : Safety factors (ASD)

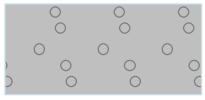
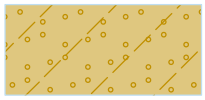
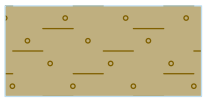
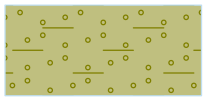
Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

Interface

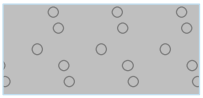
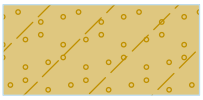
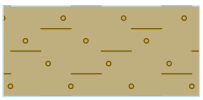
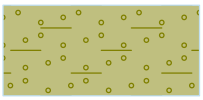
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		-32.80	-4.75	-2.74	-4.75	-2.74	-4.00
		-2.60	-4.00	-2.60	-2.50	-2.47	-2.50
		-2.47	-1.00	-2.33	-1.00	-2.33	0.50
		-1.92	0.50	-1.92	0.08	0.00	0.08
		0.00	0.00	6.14	0.00	32.80	0.00
2		-2.47	-2.50	-0.27	-2.50	-0.13	-2.50
		-0.13	-1.00	0.00	-1.00	0.00	0.00
3		0.64	-5.50	6.14	0.00		
4		-0.27	-2.50	-0.27	-4.00	0.64	-4.00

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		-2.74	-5.50	0.64	-5.50	0.64	-4.00
6		-32.80	-6.25	-3.49	-6.25	-3.49	-5.50
		-2.74	-5.50	-2.74	-4.75		
7		0.64	-5.50	1.39	-5.50		
8		-3.49	-6.25	1.39	-6.25	1.39	-5.50
		32.80	-5.50				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

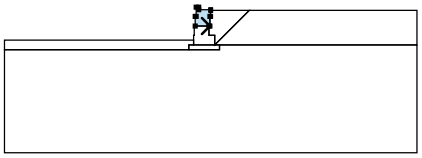
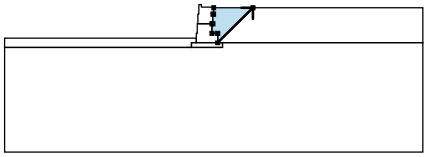
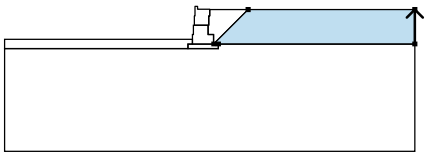
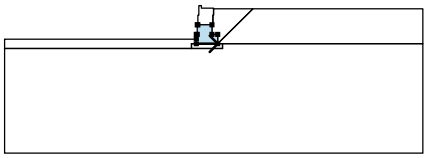
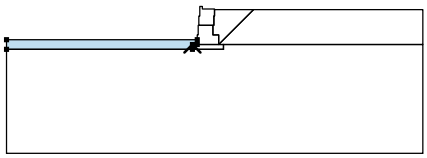
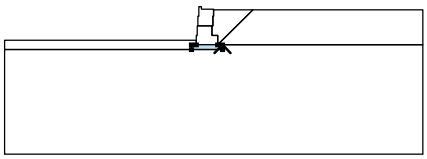
FOUNDATION SOIL

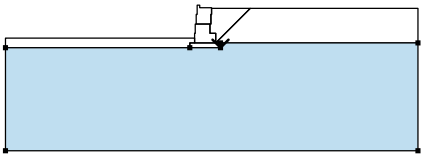
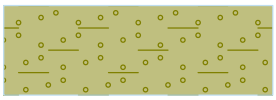
Unit weight :	γ = 120.0 pcf
Stress-state :	effective
Shear strength :	Mohr-Coulomb
Angle of internal friction :	φ_{ef} = 28.00 °
Cohesion of soil :	c_{ef} = 100.0 psf
Saturated unit weight :	γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		-0.27	-2.50	-0.13	-2.50	Material of structure
		-0.13	-1.00	0.00	-1.00	
		0.00	0.00	0.00	0.08	
		-1.92	0.08	-1.92	0.50	
		-2.33	0.50	-2.33	-1.00	
		-2.47	-1.00	-2.47	-2.50	
2		0.64	-5.50	6.14	0.00	BACKFILL SOIL-CLASS II SAND
		0.00	0.00	0.00	-1.00	
		-0.13	-1.00	-0.13	-2.50	
		-0.27	-2.50	-0.27	-4.00	
		0.64	-4.00			
3		32.80	-5.50	32.80	0.00	RETAINED SOILS
		6.14	0.00	0.64	-5.50	
		1.39	-5.50			
4		-2.74	-5.50	0.64	-5.50	Material of structure
		0.64	-4.00	-0.27	-4.00	
		-0.27	-2.50	-2.47	-2.50	
		-2.60	-2.50	-2.60	-4.00	
		-2.74	-4.00	-2.74	-4.75	
5		-3.49	-6.25	-3.49	-5.50	RETAINED SOILS
		-2.74	-5.50	-2.74	-4.75	
		-32.80	-4.75	-32.80	-6.25	
6		1.39	-6.25	1.39	-5.50	LEVELING PAD-21AA
		0.64	-5.50	-2.74	-5.50	
		-3.49	-5.50	-3.49	-6.25	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
7		1.39	-5.50	1.39	-6.25	FOUNDATION SOIL
		-3.49	-6.25	-32.80	-6.25	
		-32.80	-22.65	32.80	-22.65	
		32.80	-5.50			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 0.00	l = 15.00		0.00	100.0		lbf/ft2

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-2.79	[ft]	Angles :	a_1 =	-29.04	[°]
	z =	5.40	[ft]		a_2 =	62.28	[°]
Radius :	R =	11.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 6028.3 lbf/ft

Slope stability verification (Bishop)

Sum of active forces : F_a = 2197.5 lbf/ft

Sum of passive forces : F_p = 4712.4 lbf/ft

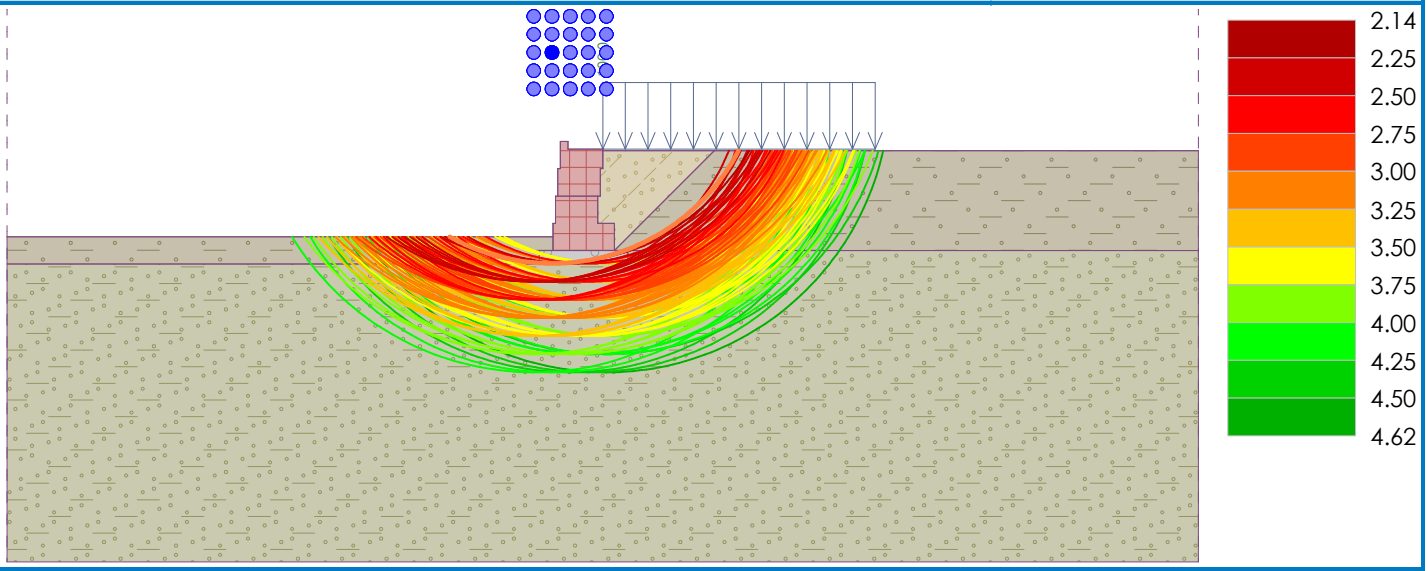
Sliding moment : M_a = 25513.0 lbfft/ft

Resisting moment : M_p = 54711.2 lbfft/ft

Factor of safety = 2.14 > 1.50

Slope stability ACCEPTABLE

Name : Analysis | **Stage - analysis : 1 - 1**



Analysis of Redi Rock wall

Input data

Project : AUBURN ANGARA OAKS
Section : WALL-2_7.5 FT HT
Description : REDI-ROCK RETAINING WALL
Client : AUBURN ANGARA OAKS, LLC
Author : DH / GES-LLC
Date : 4/27/2025
Project ID : RW_25-102
Project number : 25-102

Settings

NCMA - SRW Design Manual

Wall analysis

Verification methodology : Safety factors (ASD)
Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Mazindrani (Rankine)
Earthquake analysis : NCMA - SRW
Shape of earth wedge : Calculate as skew
Allowable eccentricity : 0.333
Internal stability : Standard - straight slip surface
Reduction coeff. of contact first block - base : 1.00

Safety factors			
Permanent design situation			
Safety factor for overturning :	SF_o =	2.00	[–]
Safety factor for sliding resistance :	SF_s =	1.50	[–]
Safety factor for bearing capacity :	SF_b =	2.00	[–]
Safety factor for sliding along geo-reinforcement :	SF_{sr} =	1.50	[–]
Safety factor for geo-reinforcement strength :	SF_{st} =	1.50	[–]
Safety factor for pull out resistance of geo-reinf. :	SF_{po} =	1.50	[–]
Safety factor for connection strength :	SF_{con} =	1.50	[–]

Blocks

No.	Description	Block height h [in]	Block width w [in]	Unit weight γ [pcf]
1	Block 28	18.00	28.00	120.00
2	Block 41	18.00	40.50	120.00
3	Top block 28	18.00	28.00	120.00
4	Block R-41 HC	18.00	40.50	110.00

No.	Description	Shear bearing capacity of joint F_{min} [lbf/ft]	Max. shear strength F_{max} [lbf/ft]	Block friction f [°]
1	Block 28	6061.00	11276.00	44.00
2	Block 41	6061.00	11276.00	44.00
3	Top block 28	6061.00	11276.00	44.00
4	Block R-41 HC	5358.00	12906.00	37.00

Setbacks

No.	Setback s [in]
1	0.000
2	0.033
3	0.135
4	0.781
5	1.385

Geometry

No. group	Description	Count	Setback s [in]
1	Block 41	1	0.13
2	Block R-41 HC	1	0.13
3	Block 28	2	0.13
4	Top block 28	1	-

Base

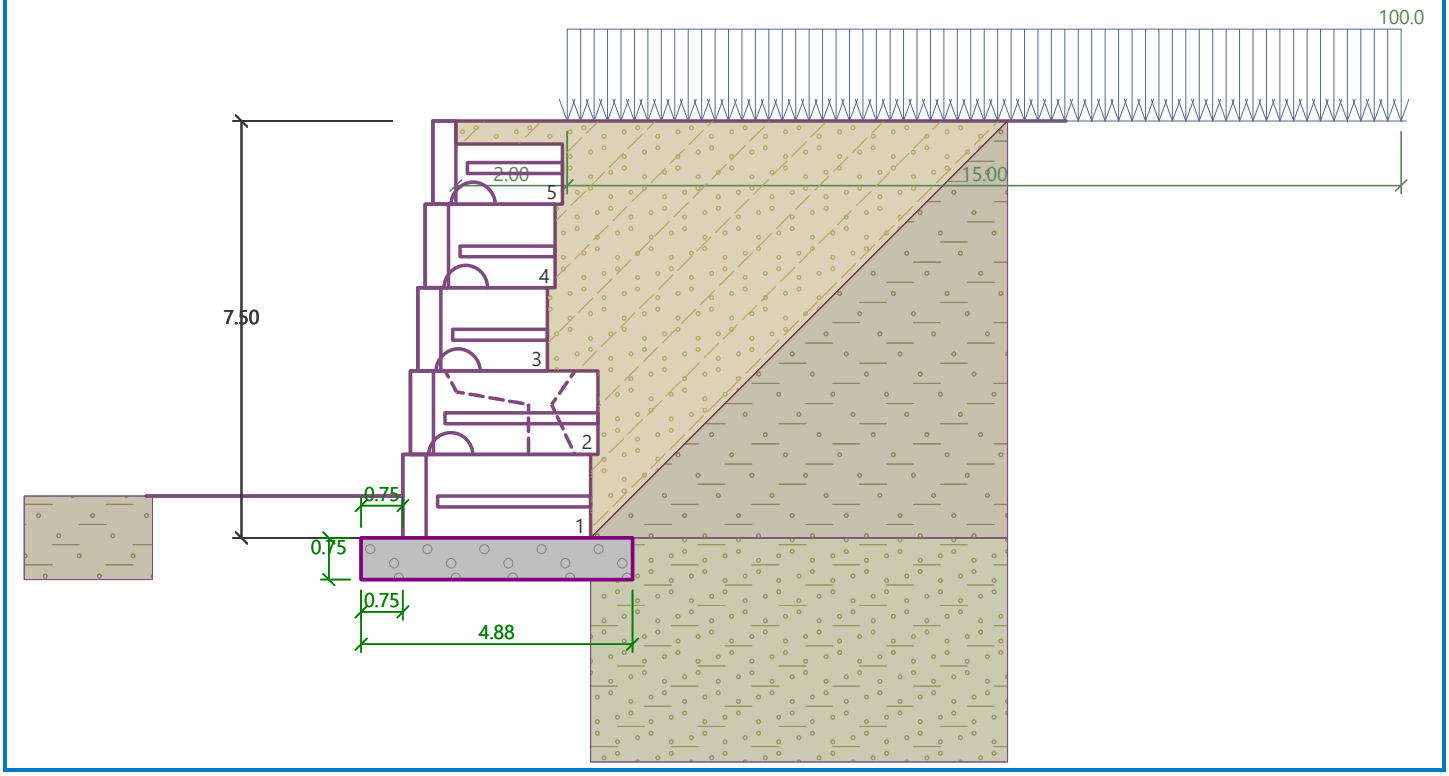
Geometry

Upper setback a_1 = 0.75 ft
Lower setback a_2 = 0.75 ft
Height h = 0.75 ft
Width b = 4.88 ft

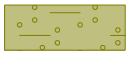
Material

Soil creating foundation - LEVELING PAD-21AA

Name : Base | **Stage - analysis : 1 - 0**



Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 26.60 °
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 25.30 °
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 21.33 °
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Angle of friction struc.-soil : δ = 20.00 °
Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

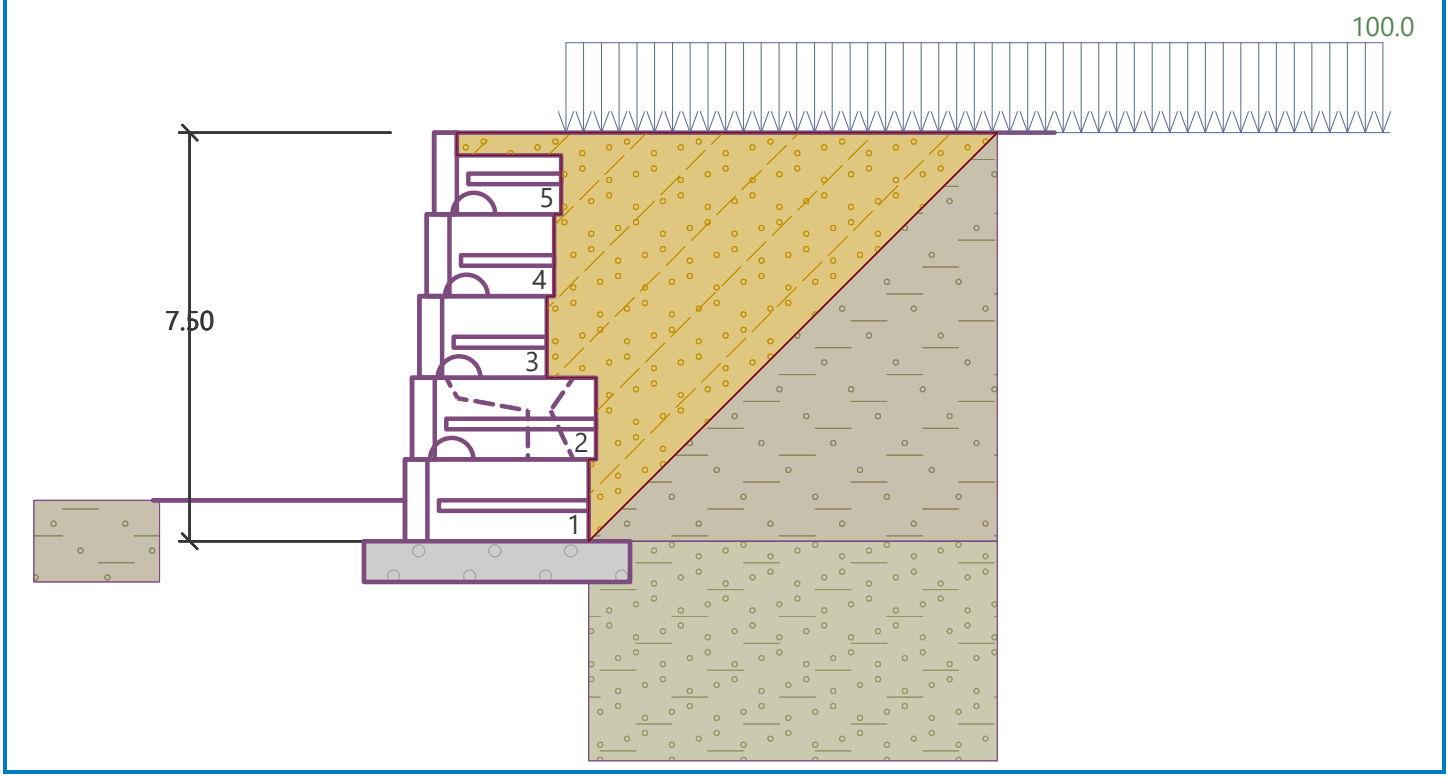
Unit weight : γ = 120.0 pcf
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °

Cohesion of soil : c_{ef} = 100.0 psf
Angle of friction struc.-soil : δ = 18.67 °
Saturated unit weight : γ_{sat} = 125.0 pcf

Backfill

Assigned soil : BACKFILL SOIL-CLASS II SAND
Slope = 45.00 °

Name : Backfill | **Stage - analysis : 1 - 0**



Geological profile and assigned soils

Position information
Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	7.50	0.00 .. 7.50	0.00 .. -7.50	RETAINED SOILS	
2	-	7.50 .. ∞	-7.50 .. -	FOUNDATION SOIL	

Terrain profile

Terrain behind the structure is flat.

Water influence

Ground water table is located below the structure.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [lbf/ft²]	Mag.2 [lbf/ft²]	Ord.x x [ft]	Length l [ft]	Depth z [ft]
1	Yes		variable	100.00		2.00	15.00	on terrain

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - RETAINED SOILS
Soil thickness in front of structure h = 1.50 ft

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
Reduction of soil/soil friction angle : do not reduce

Verification No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.43	2808.3	2.41	1.000
FF resistance	-67.4	-0.50	0.1	-0.38	1.000
Weight - earth wedge	0.0	-1.17	57.1	4.40	1.000
Weight - earth wedge	0.0	-4.22	76.7	3.70	1.000
Weight - earth wedge	0.0	-8.04	90.1	2.61	1.000
Active pressure	1068.7	-2.79	1120.2	4.28	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	175.4	-4.10	114.0	4.08	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 12803.2 lbfft/ft
Overturning moment M_{ovr} = 3663.6 lbfft/ft

Safety factor = 3.49 > 2.00
Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 2696.95 lbf/ft
Active horizontal force H_{act} = 1176.59 lbf/ft

Safety factor = 2.29 > 1.50
Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Dimensioning No. 1

Forces acting on construction

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - wall	0.0	-3.30	2332.5	1.66	1.000
FF resistance	-16.9	-0.25	0.0	0.00	1.000

Name	F_{hor} [lbf/ft]	App.Pt. z [ft]	F_{vert} [lbf/ft]	App.Pt. x [ft]	Design coefficient
Weight - earth wedge	0.0	-3.47	76.7	2.95	1.000
Weight - earth wedge	0.0	-7.29	90.1	1.86	1.000
Active pressure	859.4	-2.55	582.0	3.21	1.000
LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE	169.0	-3.59	87.9	3.12	1.000

Verification of most stressed block No. 1

Check for overturning stability

Resisting moment M_{res} = 6395.3 lbfft/ft
Overturning moment M_{ovr} = 2793.3 lbfft/ft

Safety factor = 2.29 > 2.00
Joint for overturning stability is SATISFACTORY

Check for slip

Resisting horizontal force H_{res} = 2659.21 lbf/ft
Active horizontal force H_{act} = 1011.57 lbf/ft

Safety factor = 2.63 > 1.50
Joint for verification is SATISFACTORY

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]	Eccentricity [–]	Stress [psf]
1	1270.5	4266.44	1176.59	0.061	995.8

Service load acting at the center of footing bottom

No.	Moment [lbfft/ft]	Norm. force [lbf/ft]	Shear Force [lbf/ft]
1	1270.5	4266.44	1176.59

Spread footing verification

Input data

Settings

NCMA - SRW Design Manual

Materials and standards

Concrete structures : ACI 318-19

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Verification methodology : Safety factors (ASD)
Analysis for drained conditions : NCMA
Analysis of uplift : Standard

Allowable eccentricity : 0.333

Safety factors			
Permanent design situation			
Safety factor for vertical bearing capacity :	SF_v =	2.00	[–]
Safety factor for sliding resistance :	SF_h =	1.50	[–]

Basic soil parameters

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [psf]	γ [pcf]	γ_{su} [pcf]	δ [°]
1	LEVELING PAD-21AA		40.00	0.0	130.00	72.50	26.60
2	DRAINAGE LAYER-6A		38.00	0.0	110.00	47.50	25.30
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.00	62.50	21.33
4	RETAINED SOILS		30.00	0.0	120.00	62.50	20.00
5	FOUNDATION SOIL		28.00	100.0	120.00	62.50	18.67

All soils are considered as cohesionless for at rest pressure analysis.

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Deformation modulus : E_{def} = 65000.0 psi
Poisson's ratio : ν = 0.20
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Deformation modulus : E_{def} = 30000.0 psi
Poisson's ratio : ν = 0.20
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND

Unit weight : γ = 120.0 pcf
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Oedometric modulus : E_{oed} = 1500.0 psi
Saturated unit weight : γ_{sat} = 125.0 pcf

RETAINED SOILS

Unit weight : γ = 120.0 pcf
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Deformation modulus : E_{def} = 3600.0 psi
Poisson's ratio : ν = 0.28

Saturated unit weight : γ_{sat} = 125.0 pcf

FOUNDATION SOIL

Unit weight : γ = 120.0 pcf
Angle of internal friction : φ_{ef} = 28.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Oedometric modulus : E_{oed} = 1203.5 psi
Saturated unit weight : γ_{sat} = 125.0 pcf

Foundation

Foundation type: strip footing

Depth from original ground surface h_z = 8.25 ft
Depth of footing bottom d = 1.50 ft
Foundation thickness t = 0.75 ft
Incl. of finished grade s_1 = 0.00 °
Incl. of footing bottom s_2 = 0.00 °

Overburden

Type: input unit weight
Unit weight of soil above foundation = 120.00 pcf

Geometry of structure

Foundation type: strip footing

Overall strip footing length = 10.00 ft
Strip footing width (x) = 4.88 ft
Column width in the direction of x = 0.33 ft

Inserted loading is considered per unit length of continuous footing span.
Volume of strip footing = 3.66 ft³/ft
Volume of excavation = 7.32 ft³/ft
Volume of fill = 3.41 ft³/ft

Geological profile and assigned soils

Position information

Terrain elevation = 0.00 ft

Geological profile and assigned soils

No.	Thickness of layer t [ft]	Depth z [ft]	Elevation [ft]	Assigned soil	Pattern
1	7.50	0.00 .. 7.50	0.00 .. -7.50	RETAINED SOILS	
2	-	7.50 .. ∞	-7.50 .. -	FOUNDATION SOIL	

Load

No.	Load new	Load change	Name	Type	N [lbf/ft]	M_y [lbfft/ft]	H_x [lbf/ft]
1	Yes		LC 1	Design	3380.97	388.1	-1176.59
2	Yes		LC 2	Service	3380.97	388.1	-1176.59

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

Verification No. 1

Load case verification

Name	e_x [ft]	e_y [ft]	σ [psf]	R_d [psf]	Utilization [%]	Is satisfactory
LC 1	-0.30	0.00	995.8	9528.0	20.90	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 409.67 lbf/ft

Vertical bearing capacity check

Shape of contact stress : rectangle
Most unfavorable load case No. 1. (LC 1)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 7.23 ft
Length of slip surface l_{sp} = 21.16 ft

Design bearing capacity of found. soil R_d = 9528.0 psf
Extreme contact stress σ = 995.8 psf

Factor of safety = 9.57 > 2.00
Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.061<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.061<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

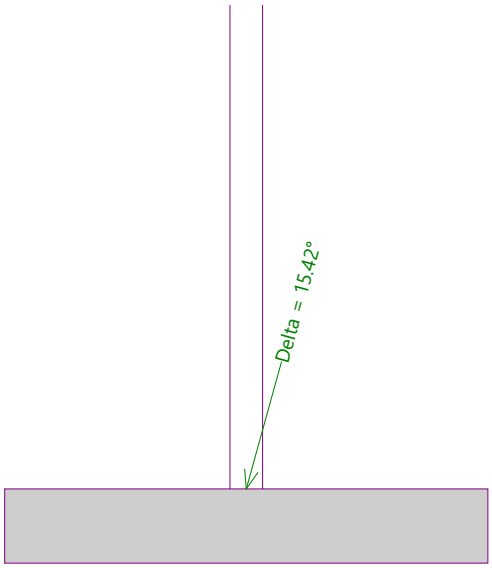
Most unfavorable load case No. 1. (LC 1)
Earth resistance: at rest
Design magnitude of earth resistance S_{pd} = 53.72 lbf

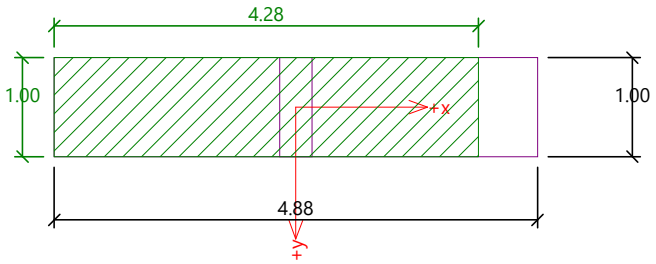
Horizontal bearing capacity R_{dh} = 2750.66 lbf
Extreme horizontal force H = 1176.59 lbf

Factor of safety = 2.34 > 1.50
Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

Name : Bearing cap.	Stage - analysis : 1 - 1





Verification No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient κ_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.
Computed self weight of strip foundation G = 475.80 lbf/ft
Computed weight of overburden Z = 409.67 lbf/ft

Settlement of mid point of longitudinal edge = 0.09 in
Settlement of mid point of transverse edge 1 = 0.14 in
Settlement of mid point of transverse edge 2 = 0.09 in

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 749.9 psi
Foundation in the longitudinal direction is rigid (k=15.11)
Foundation in the direction of width is rigid (k=1756.43)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.061<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.061<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 0.12 in
Depth of influence zone = 5.59 ft

Rotation in direction of width = 0.919 (tan*1000); (5.3E-02 °)

Slope stability analysis

Input data (Construction stage 1)

Project

Settings

NCMA - SRW Design Manual

Stability analysis

Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

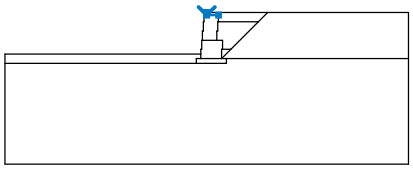
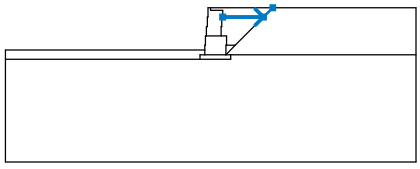
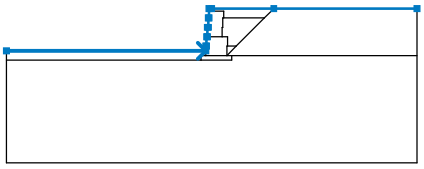
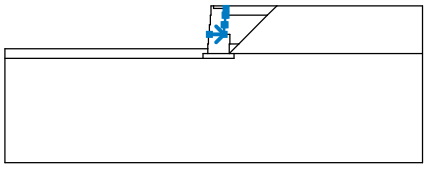
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

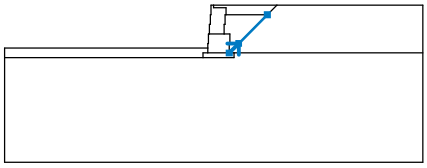
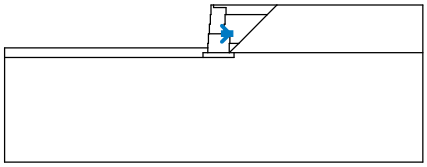
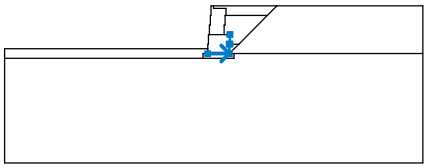
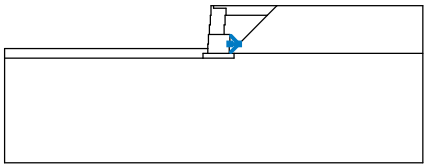
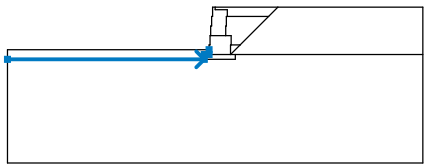
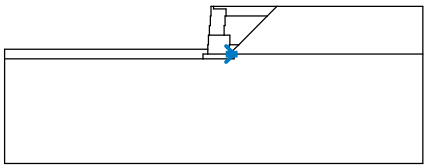
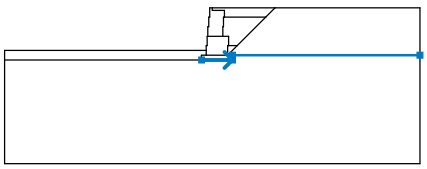
Anchors

Verification methodology : Safety factors (ASD)

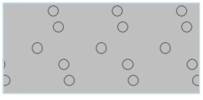
Safety factors			
Safety factor for steel strength :	SF_t =	1.50	[–]
Safety factor for pull out resistance (soil) :	SF_e =	1.50	[–]
Safety factor for pull out resistance (grouting) :	SF_c =	1.50	[–]

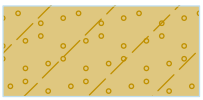
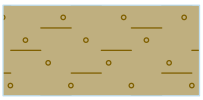
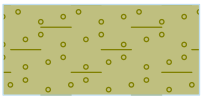
Interface

No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
1		0.00	0.00	0.00	-0.42	1.92	-0.42
2		1.92	-1.50	8.42	-1.50	9.92	0.00
3		-32.80	-6.75	-0.95	-6.75	-0.95	-6.00
		-0.82	-6.00	-0.82	-4.50	-0.69	-4.50
		-0.69	-3.00	-0.55	-3.00	-0.55	-1.50
		-0.42	-1.50	-0.42	0.00	0.00	0.00
		9.92	0.00	32.80	0.00		
4		-0.69	-4.50	1.65	-4.50	1.65	-3.00
		1.78	-3.00	1.78	-1.50	1.92	-1.50
		1.92	-0.42				

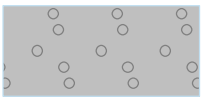
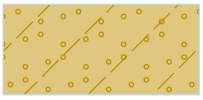
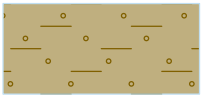
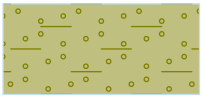
No.	Interface location	Coordinates of interface points [ft]					
		x	z	x	z	x	z
5		2.42	-7.50	3.92	-6.00	8.42	-1.50
6		1.65	-4.50	2.55	-4.50		
7		-0.95	-7.50	2.42	-7.50	2.42	-6.00
		2.55	-6.00	2.55	-4.50		
8		2.55	-6.00	3.92	-6.00		
9		-32.80	-8.25	-1.70	-8.25	-1.70	-7.50
		-0.95	-7.50	-0.95	-6.75		
10		2.42	-7.50	3.18	-7.50		
11		-1.70	-8.25	3.18	-8.25	3.18	-7.50
		32.80	-7.50				

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
1	LEVELING PAD-21AA		40.00	0.0	130.0

No.	Name	Pattern	Φ_{ef} [°]	c_{ef} [psf]	γ [pcf]
2	DRAINAGE LAYER-6A		38.00	0.0	110.0
3	BACKFILL SOIL-CLASS II SAND		32.00	0.0	120.0
4	RETAINED SOILS		30.00	0.0	120.0
5	FOUNDATION SOIL		28.00	100.0	120.0

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [pcf]	γ_s [pcf]	n [–]
1	LEVELING PAD-21AA		135.0		
2	DRAINAGE LAYER-6A		110.0		
3	BACKFILL SOIL-CLASS II SAND		125.0		
4	RETAINED SOILS		125.0		
5	FOUNDATION SOIL		125.0		

Soil parameters

LEVELING PAD-21AA

Unit weight : γ = 130.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 135.0 pcf

DRAINAGE LAYER-6A

Unit weight : γ = 110.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb

Angle of internal friction : φ_{ef} = 38.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 110.0 pcf

BACKFILL SOIL-CLASS II SAND
Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

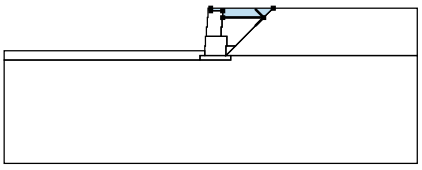
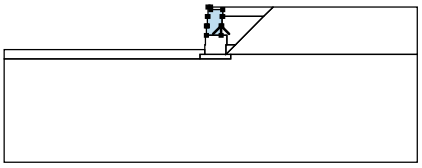
RETAINED SOILS
Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

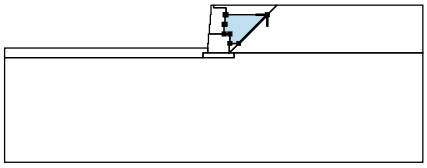
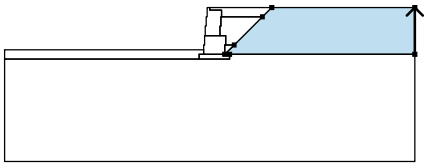
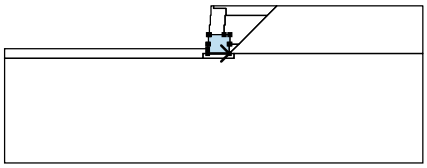
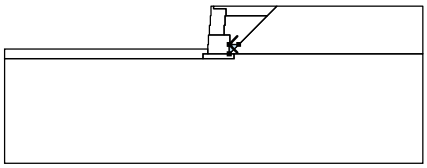
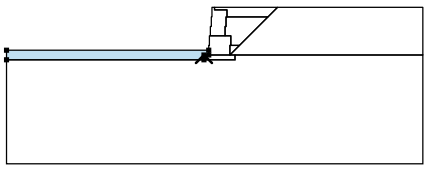
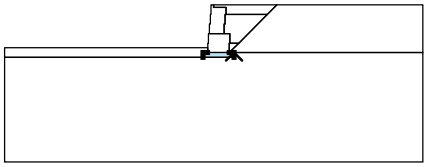
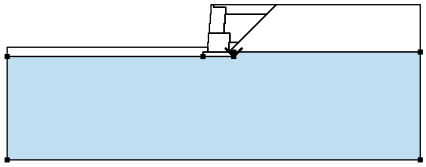
FOUNDATION SOIL
Unit weight : γ = 120.0 pcf
Stress-state : effective
Shear strength : Mohr-Coulomb
Angle of internal friction : φ_{ef} = 28.00 °
Cohesion of soil : c_{ef} = 100.0 psf
Saturated unit weight : γ_{sat} = 125.0 pcf

Rigid Bodies

No.	Name	Sample	γ [pcf]
1	Material of structure		120.0

Assigning and surfaces

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
1		1.92	-1.50	8.42	-1.50	BACKFILL SOIL-CLASS II SAND
		9.92	0.00	0.00	0.00	
		0.00	-0.42	1.92	-0.42	
2		1.65	-4.50	1.65	-3.00	Material of structure
		1.78	-3.00	1.78	-1.50	
		1.92	-1.50	1.92	-0.42	
		0.00	-0.42	0.00	0.00	
		-0.42	0.00	-0.42	-1.50	
		-0.55	-1.50	-0.55	-3.00	
		-0.69	-3.00	-0.69	-4.50	

No.	Surface position	Coordinates of surface points [ft]				Assigned soil
		x	z	x	z	
3		3.92	-6.00	8.42	-1.50	BACKFILL SOIL-CLASS II SAND
		1.92	-1.50	1.78	-1.50	
		1.78	-3.00	1.65	-3.00	
		1.65	-4.50	2.55	-4.50	
		2.55	-6.00			
4		32.80	-7.50	32.80	0.00	RETAINED SOILS
		9.92	0.00	8.42	-1.50	
		3.92	-6.00	2.42	-7.50	
		3.18	-7.50			
5		-0.95	-7.50	2.42	-7.50	Material of structure
		2.42	-6.00	2.55	-6.00	
		2.55	-4.50	1.65	-4.50	
		-0.69	-4.50	-0.82	-4.50	
		-0.82	-6.00	-0.95	-6.00	
		-0.95	-6.75			
6		2.55	-6.00	2.42	-6.00	BACKFILL SOIL-CLASS II SAND
		2.42	-7.50	3.92	-6.00	
7		-1.70	-8.25	-1.70	-7.50	RETAINED SOILS
		-0.95	-7.50	-0.95	-6.75	
		-32.80	-6.75	-32.80	-8.25	
8		3.18	-8.25	3.18	-7.50	LEVELING PAD-21AA
		2.42	-7.50	-0.95	-7.50	
		-1.70	-7.50	-1.70	-8.25	
9		3.18	-7.50	3.18	-8.25	FOUNDATION SOIL
		-1.70	-8.25	-32.80	-8.25	
		-32.80	-24.65	32.80	-24.65	
		32.80	-7.50			

Surcharge

No.	Type	Type of action	Location z [ft]	Origin x [ft]	Length l [ft]	Width b [ft]	Slope a [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	Magnitude unit
1	strip	variable	on terrain	x = 2.00	l = 15.00		0.00	100.0		lbf/ft²

Surcharges

No.	Name
1	LIVE LOAD SURCHARGE - CONSTRUCTION, MAINTENANCE

Water

Water type : No water

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Construction stage 1)

Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-1.79	[ft]	Angles :	α_1 =	-26.78	[°]
	z =	5.40	[ft]		α_2 =	66.62	[°]
Radius :	R =	13.61	[ft]				
Slip surface after grid search.							

Total weight of soil above the slip surface: 8679.4 lbf/ft

Slope stability verification (Bishop)

Sum of active forces : F_a = 3579.7 lbf/ft

Sum of passive forces : F_p = 6266.0 lbf/ft

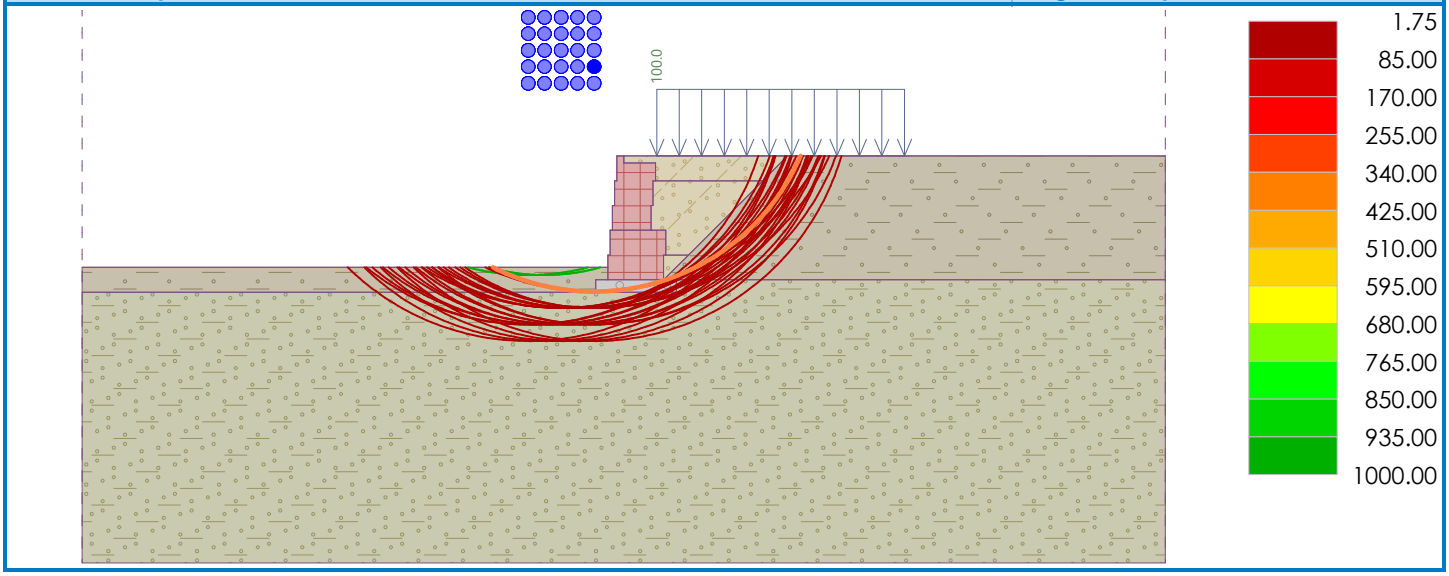
Sliding moment : M_a = 48720.0 lbfft/ft

Resisting moment : M_p = 85280.5 lbfft/ft

Factor of safety = 1.75 > 1.50

Slope stability ACCEPTABLE

Name : Analysis	Stage - analysis : 1 - 1



GES-LLC
Civil Engineering ♦ Surveying ♦ Consulting

REDI-ROCK®
RETAINING WALLS

FENCE POST CALCULATIONS

DESIGN PARAMETERS:

Unit weight of concrete	γ_C =	143	pcf	(per Redi-Rock)
Unit weight of soil	γ_S =	120	pcf	(soil behind block)
Friction angle of soil	φ_S =	32	°	(soil behind block)
Fence post load	F_c =	200	lb	(point load)
Fence post load	F_U =	50	plf	(uniform load)
Post height	H =	3.50	ft.	(above grade / block)
Arm of driving moment	a =	5.00	ft.	(fence post arm)
Depth of soil bellow grade	h =	1.50	ft.	
Unit weight of infill soil	γ_{INFILL} =	110.00	pcf	(MDOT 6A crushed limestone)
Friction angle of infill soil	φ_{INFILL} =	38.00	°	(MDOT 6A crushed limestone)

REDI-ROCK BLOCK PARAMETERS:

Block Type	Length (L_b) (inch)	Width (W_b) (inch)	Height (h_b) (inch)	Volume* (ft^3)	Weight* (pcf)	C.G.** (inch)	Infill soil* Vol. (ft^3)	Infill soil* Wt. (lb)	Total Wt.*** (lb)
6" Cap	46.125	28.50	6.00	4.56	650	14.25	0.00	0.00	650
R-28 T	46.125	28.00	18.00	8.57	1,230	13.10	2.74	301.40	1,531
R-24 F-ST	46.125	24.00	18.00	9.61	1,350	12.00	0.00	0.00	1,350
R-24 F-SG	46.125	24.00	18.00	7.35	1,050	12.00	2.30	253.00	1,303
R-28 M	46.125	24.00	18.00	11.28	1,610	10.10	0.00	0.00	1,610
R-28 PCM	46.125	24.00	18.00	10.62	1,520	9.80	0.72	79.20	1,599
R-41 M	46.125	40.50	18.00	16.14	2,310	20.10	0.00	0.00	2,310
R-41 HC	46.125	40.50	18.00	11.58	1,690	18.50	2.15	236.50	1,927

* Volume/ weight of blocks and Infil Soil per Redi-Rock Block Library

** Center of Gravity (C.G.) measured from front of block

*** Total weight represent the weight of block (Wt_b) and the weight of infill soil (Wt_{INFILL})

OUTPUT RESULTS / CALCULATIONS:

1. ACTIVE LATERAL EARTH PRESSURE PER UNIT WIDTH OF WALL:

Coefficient of active earth pressure (k_a)

k_a = 0.29 $\quad k_a = (1-\sin\varphi)/(1+\sin\varphi)$

Lateral Earth Pressure (P_a)

P_a = 39.03 plf $\quad P_a = 1/2 * k_a * \gamma_s * h^2$

2. DRIVING / OVERTURNING MOMENT

$M_{OT-POST}$ = 250.00 ft-lb/ft $\quad M_{OT-POST} = F_U * a$

$M_{OT-SOIL}$ = 19.52 ft-lb/ft $\quad M_{OT-SOIL} = 1/3 * h * P_a$

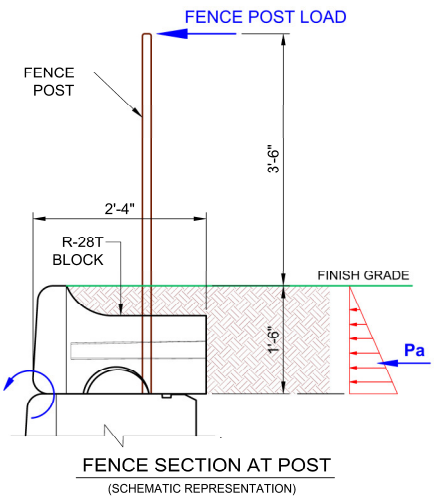
M_{OT} = **269.52** ft-lb/ft $\quad M_{OT} = M_{OT-POST} + M_{OT-SOIL}$

3. RESISTING MOMENT

M_{RES} = **434.93** ft-lb/ft $\quad M_{RES} = (Wt_b + Wt_{INFILL}) * CG_{avg} / L_b$

4. FACTOR OF SAFETY ON OVERTURNING

FS_{OT} = **1.61** OK $\quad FS_{OT} = M_{RES} / M_{OT} > 1.5$



FENCE SECTION AT POST
(SCHEMATIC REPRESENTATION)

AUBURN ANGARA OAKS
CHARLEVOIX CONDOMINIUMS
RENDERING

Accessibility notes

1. MBC Section 1101.2, 1109.1 - Per ICC A117.1, door-opening force. Fire doors shall have the minimum opening force allowable by the appropriate administrative authority. The force for pushing or pulling open doors other than fire doors shall be as follows:
   A. Interior hinged door: 5.0 pounds (22.2n) maximum
   B. Interior sliding or folding doors: 5.0 pounds (22.2n) maximum
   C. Exterior hinged, sliding or folding door: 10 pounds (44.4 n) maximum.
   D. Exception: interior or exterior automatic doors complying with Section 404.3 of ICC A117.1. These forces do not apply to the forces required to retract latch bolts or disengage other devices that hold the door in a closed position.
2. Section 1111 - International Symbol Of Accessibility. Where the international symbol of accessibility is required, it shall be proportioned complying with ICC A117.1 figure 703.6.3.1. All interior and exterior signs depicting the international symbol of accessibility shall be white on a blue background. Signs indicating each accessible parking space shall be mounted per Section 502.7.
3. All dwelling units are designed to be compliant with Type 'B' standards per ICC A117.1 Section 1004. See Unit Plans, and Sheet A5.11 for specifics.
4. All non-dwelling unit areas are designed to be compliant with the general full accessibility standard per ICC A117.1.

Accessible elevator

1. For the elevator, the following is required:
   1.1. A two way communication system shall be provided at the elevator landing on each accessible floor that is one or more stories above or below the story of exit discharge complying with Sections 100 9.8.1 and 1009.8.2. General Contractor to coordinate this system with alarm service provider. Note - this system is NOT generally provided by the Elevator Supplier/Installer.
   1.2. This elevator is NOT required to be an Accesible Means of Egress per Section 1009.2.1 .
   1.3. This elevator shall be provided with Emergency Signs per the requirements of Section 3002.3 .
   1.4. The elevator is NOT required to be sized to accommodate a 24"x84" stretcher , per criteria given in Section 3002.4.
   1.5. The elevator is NOT required to be identified by an international symbol for emergency medical services (Star of Life) per criteria given in Section 3002.4.

Wood Trusses

1. The Truss Manufacturer shall provide a truss placement diagram that identifies the proposed location for each individually designated truss and references the corresponding truss design drawing.
2. The truss placement diagram shall be provided as part of the truss submittal package. The truss placement diagram shall be coordinated by the truss manufacturer .
3. Truss/joist shop drawing submittal shall be coordinated with and shall show all bathtub, shower & toilet drains and all mechanical shafts. Adjust joist spacing and/or add joists & headers to clear plumbing & mechanical. See similar note on Structural. Coordinate specific drain requirements with General Contractor.

Fire protection system

1. At a minimum all buildings to have an NFPA 13 (**NOT* 13R*) approved automatic monitored sprinkler system complying with MBC Section 903.3.1.1.
2. All units, corridors, patios, balconies, decks, enclosed areas and stair areas to be sprinkled. All areas of the Lobby, Fitness Center, and all other common and utility spaces are to be sprinkled.
3. Refer also to the requirements of the 2015 Michigan Building Code, and City of Ann Arbor and State of Michigan Codes and Ordinances.
4. Provide emergency responder radio system per MBC Section 915. Refer also to project note on this sheet.

Consultant information

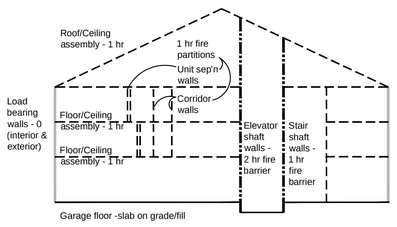
1. Refer to Civil, Temporary Earth Retention System/Shoring, and Landscape drawings for the location and design of all retaining walls, if any (exclusive of actual building foundations) on the site.
2. Refer to Civil Engineer's drawings for all grading, finish floor elevations, site dimensional control, drainage and utility work for the entire site.
3. Refer to the Landscape Architect's and/or Civil Engineer's drawings for accessible routes connecting common site elements and public ways in accordance with ICC-A117.1-2009 and ADA requirements.
4. Refer to Landscape Architect's and/or Civil Engineer's drawings for all existing trees and plant material to remain and all new trees and plant material to be added.
5. Refer to Landscape Architect's and/or Civil Engineer's and MEP site plan drawings for the location, design and coordination of all exterior site lighting.
6. Refer to Civil Engineer's drawings for all off-site work.
7. Refer to Structural Engineer's drawings for all structural work.
8. Refer to MEP Engineer's drawings for all MEP work.
9. Coordinate all utilities that connect between Building and Site to ensure no gaps in scope of work between trades and/or subcontractors.
10. Mechanical, Electrical, Plumbing, and Fire Suppression Drawings and Specifications to be submitted as Deferred Submittals per MBC Section 107.3.4.1

Building Codes included by reference from 2021 Michigan Building Code (MBC)

All work shall be performed in accordance with the requirements of the 201 5 Michigan Building Code, all refernced codes and standards, and any additional amendments/ requirements set forth by the City of Ann Arbor, Michigan including all applicable federal codes and laws.

Applicable codes:

- 2021 Michigan Building Code
  -- and as listed in MBC Chapter 35 Referenced Standards :
- 2021 Michigan Mechanical Code
- 2023 NEC with all relevant State Amendments
- 2021 Michigan Plumbing Code
- 2015 International Fuel Gas Code (IFGC)
- 2021 International Fire Code (IFC)
- 2021 Michigan Commercial Energy Code Rules - part 10 with ANSI/ ASHRE/ IESNA standard 90.1- 2019
- 2017 ICC A117.1 & Michigan Barrier Free Design Law of Public Act 1 of 1966 as amended
- 2019 NFPA 13 Standard for the Installation of Sprinkler Systems
- 2013 NFPA 72 Fire Alarm Code



Fire Rating
0 Hour
1 Hour
2 Hour

Project Notes:

1. The minimum separation between building exterior walls is based on Section 705.5, Table 705.8 and Table 602.
   A. Per Section 705.2.2, projections from walls of Type V construction shall be of any approved material.
2. Net floor area per unit is defined as the interior area in the dwelling units measured between the unit side finish faces of the stud walls forming the perimeter of the unit.
3. Provide a supervised NFPA 13 fire sprinkler system compliant w/ Section 903.3.1.1. Provide audible sprinkler flow alarms on the exterior and interior per code and the local fire department. Supervision and alarms to meet Section 903.4, 903.4.1 and 903.4.2.
4. Sprinkler systems shall be monitored by an approved supervising station per Section 901.6.1 and 903.4.
5. Fire sprinkler drawings submitted by the Design-Build Fire Suppression Subcontractor shall be first submitted to the Owner for Review and Approval, then to the City for approval. The City approved set shall then be sent to the Owner & Architect prior to installing system.
6. All building usable space including sleeping units, corridors, exterior stairs, interior stairs, electrical closets, utility room are to be sprinkled with a NFPA 13 sprinkler system compliant w/ Section 903.3.1.1. Refer to Section 903.2.8, 903.2.10, 903.3.1.1. Insulate pipes as required.
7. Sprinkler pipes are not allowed in furr downs.
8. Required smoke alarms shall be interconnected with the fire alarm system in accordance with NFPA 72.
9. *Required smoke alarms are to receive primary power from the building wiring.*
10. A fire/smoke alarm system is required per Section 907.2.9 and shall be monitored per Section 907.6.6.
11. A two way communication system shall be provided at the elevator landing on each accessible floor that is one or more stories above or below the story of exit discharge , complying with Sections 1009 8.1 and 1007.8.2. (presumed to be connected to monitored alarm system Service Provider). Seen note at Accessible Elevator Notes.
12. In R-2 occupancies, manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.1 and the occupant notification appliances will automatically activate throughout the notification zones upon sprinkler water flow per Section 907.2.9.1 exception #2 (use group R-2),.
13. Per Section 907.5.2.2 emergency voice/alarm communication systems required by code shall be designed and installed per NPFA 72.
14. Per Section 907.5.2.3 in Group R-2 occupancies required to have a fire alarm system, all dwelling units shall be provided with the capability to support visible alarm notification devices in accordance with Chapter 10 of ICC/A117.1.
15. In Group R occupancies provide carbon monoxide alarms per Section 915.1.
16. Fire Department Connections (FDC) shall be provided in accordance with Section 912. The Fire Department Connection shall be located within 50'-0" of the fire lane or public street. Refer to Site Plan. FDCs shall meet the requirements of Section 912, shall be visible from the street, accessible to the fire department, provide a minimum 36"x36"x78" high clearance and have signage per Section 912.5.
17. A fire hydrant must be located within a minimum of 100' from the FDC.
18. A fire hydrant must be located within 750' from all points in the first floor of the building.
19. The 200' fire hose lay rule is to any point on the 1st floor of a building from a fire lane or public street.
20. Fire extinguishers - Section 906.1 Exception allows the provision of (1) type 1-A/10-B:C fire extinguisher per dwelling unit at R-2 occupancy, and no others required at 1st and 2nd floors.
    For S occupancies, type 2-A/10-B:C portable fire extinguishers are to be provided per Section 906, and Table 906.3(1). Locate so that a fire extinguisher is not more than 75' from any point on the floor. Maximum floor area per extinguisher @ Ordinary Hazard per unit of 'A' is 1,500 s.f. X 2-A = 3,000 s.f. Cabinets shall be recessed in the wall and not extend more than 4" into the corridor or room. Coordinate locations and quantities with local fire marshal.
21. Fire equipment room requires signage per Section 914.2.
22. Emergency responder radio coverage shall be provided in all new buildings per Section 916, in accordance with Section 510 of the International Fire Code.
23. Section 1020.4. Exception #2 allows for a dead end corridor of 50 feet when the building is equipped with NFPA 13 sprinkler system compliant with Section 903.3.1.1 throughout.
24. R-2 use is not required to provide emergency escape and rescue openings if building is equipped with an automatic sprinkler system per Section 1030.1, exception #1.
25. All interior finishes shall meet the requirements of Chapter 8 and Table 803.11. Sprinkled buildings of R-2 occupancy require minimum Class C finishes.
26. All floor/ceiling and roof/ceiling assemblies and all wall assemblies shall be constructed as required to meet the requirements of the assemblies shown on Sheet A6.1, Wall & Floor Type Legend & Details. Coordinate screw and nail size and spacing requirements between these assemblies and the structural drawings. The more stringent shall be used.
27. See "Note for all Fire Resistance Rated Assemblies" on A6.1 for additional information.
28. All holes, gaps, cracks and openings are required to be sealed w/ city approved fire stopping material.
29. Maximum allowable dryer vent duct run is 35' with 2.5 feet deducted for each 45 degree bend and 5 feet deducted for each 90 degree bend. Coordinate longer runs with the building official, the dryer manufacturer and the MEP Engineer. Provide dryer vent signage as required by building official.
30. Parapets are required at all exterior walls unless they meet one of the exceptions of Section 705.11.
31. Exterior walls shall meet the requirements of Section 705.
32. Fire Barriers shall meet the requirements of Section 707. Fire Barriers shall extend to the underside of the deck of the floor or roof above.
33. Fire partitions shall meet the requirements of Section 708. Fire Partitions shall extend to the underside of the deck of the floor or roof above, OR to the underside of the fire rated floor/ceiling or roof/ceiling assembly above.
34. Shaft enclosure walls shall meet the requirements of Section 713.
35. Elevator shafts shall meet Section 713 and chapter 30. Enclosed elevator lobbies are NOT required where building is sprinkled with a NFPA 13 sprinkler system compliant w/ Section 903.3.1.1, per Section 713.14.1 Exception #4
36. Penetrations of the fire rated assemblies shall meet the requirements of Section 714 and Section 715.
37. Fireblocking is to meet the requirements of Section 718.2 and draftstopping is to meet the requirements of Section 718.3.
38. Draftstopping is not required in the concealed space between units where building is sprinkled with a NFPA 13 sprinkler system compliant w/ Section 903.3.1.1., per Section 718.3.2 Exception #1
39. Draftstopping is not required in the attic/concealed roof space where building is sprinkled with a NFPA 13 sprinkler system compliant w/ Section 903.3.1.1., per Section 718.4.2 Exeption #2.
40. Doors in fire rated walls shall meet the requirements of Section 716.5.
41. Windows/glazing in fire rated walls shall meet the requirements of Table 716.5.
    A. Door and window *glazing in 1 hour rated* corridor *fire* partitions *shall be minimum 20 minute rated.*
    B. Door and window glazing in 1 hour rated fire partitions *shall be minimum 45 minute rated.*
    C. Door and window glazing in 1 hour rated fire barriers *shall be minimum 60 minute rated.*
43. In interior 1-hour rated fire barrier and fire partition walls, openings of all types are limited to 25% of the length of the wall and are also limited to a maximum 25% of the wall. Per Section 716.6.7.2 and Section 707.6. Refer Section 707.6 for maximum window sizes. Refer to Table 716.6.
44. Glazing is not allowed in walls with a fire resistance rating greater than 1-hour per Section 716.6.7.
45. Number of Exits (in a building with NFPA 13 sprinkler systems) for each use, shall be (2), for any use exceeding the common path of egress travel as follows per Table 1006.2.1: Group R-2 = 125', Group S = 100'.
46. Structural observation shall be provided by Structural Engineer during construction in accordance with Sections 1702 and 1704.6.
47. Special Inspections shal be provided per Section 1705. See Structural for a list of Inspections required.
48. Where provided, Fire Pump rooms shall have protection per Section 913.2.1: Fire pumps shall be located in rooms that are separated from all other assemblies constructed in accordance with Section 707 & 711. Exception 1 allows 1 hour ratings with an NFPA 13 sprinkler.
49. Section 1011.12 Roof Access: Access required unless roof is a minimum 4:12slope. Minimum slope provided is 4.75:12.
50. Section 3002.4 Elevator Car to Accommodate Ambulance Stretcher: Not required in buildings less than four stories above grade.
51. Section 1203.1 Buildings shall be provided with natural ventilation in accordance with Section 1203.4 or mechanical ventilation in accordance with the International Mechanical Code.
52. Section 1204.1 Equipment and systems. Interior spaces intended for human occupancy shall be provided with an active or passive space-heating system capable of maintaining a minimum indoor temperature of 68° F at a point 3 feet above the floor on the design heating day. Exception #1 Interior spaces where the primary purpose is not associated with human comfort.
53. Section1208.2 Minimum ceiling heights: Occupiable spaces and habitable spaces shall have a ceiling height of not less than 7'-6". Bathrooms, toilet rooms, kitchen, storage rooms and laundry rooms shall have a ceiling height of not less than 7'-0". Corridors within dwelling units shall have a ceiling height of not less than 7'-0".
54. Section 1709.5 Exterior window and door assemblies: The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1709.5.1 or 1709.5.2. Refer to exception in this Section.
55. Section 1405.3 Vapor retarders: Class I and II vapor retarders shall be provided on the interior side of frame walls in Climate Zones 5. Exceptions:
    A. Below grade portions of any walls.
    B. Construction where moisture or its freezing will not damage the mateials.
56. Michigan Mechanical Code Section 501.3.1 location of exhaust outlets. The termination point of exhaust outlets and ducts discharging to the outdoors shall be located in the following distances:
    A. For garages: for other product-conveying outlets: 10 feet from property lines 3 feet from exterior walls and roofs; 10' from operable openings into buildings; 10 feet above adjoining grade.
    B. For units: for environment air exhaust other than enclosed parking and transformer vault exhaust; 3 feet from property lines, 3 feet from operable openings into buildings for all occupancies other than Group U and 10 feet from mechanical air intakes. Such exhaust shall not be considered hazardous or noxious.

General Notes

1. All work shall comply with all current and applicable Federal, State, and Local Codes, Regulations and Ordinances. This includes, but is not limited to, the list of Reference Standards in the Code Summary.
   Code section references refer to Michigan Building Code unless noted otherwise.
2. The "General Conditions of the Contract for Construction" AIA document A201, most current edition, governs this work, unless otherwise noted.
3. Items affecting all trades are placed throughout the set of documents. The contractor shall be responsible for the coordination of all work of all trades regardless of where said item is shown in the documents.
4. Any discrepancies, omissions, or ambiguities discovered in the drawing set shall be brought to the attention of the architect for resolution.
5. Submit all Shop Drawings (including, but not necessarily limited to, Trusses, Wall Panels, and Structural Steel) to the Architect for review prior to fabrication.
6. Floor Truss layout drawings MUST indicate location of all plumbing fixtures for coordination, to avoid field conflicts. General Contractor is responsible for coordiantion between floor framing and location of all floor penetrations.
7. No procedure, products, or processes shall be permitted to be used in this project which are prohibited by law or may cause a harmful effect to the natural environment or to the health of any person on or off the site during construction and/or occupancy of the project.
8. The General Contractor shall fully familiarize him/herself with all site conditions & constraints prior to submitting proposals for work. No increases to the contract sum will be awarded for items/issues with which the contractor could have familiarized him/herself prior to bid.
9. General Contractor is responsible for verification of final quantities, areas, dimensions, and coordination of discrepancies between the Drawings and Field Conditions.
10. No substitutions for specified materials or equipment shall be allowed except as provided for on the drawings.
11. All Subcontractors are to submit documentation for all rated or tested components and/ or systems to be installed; to architect, owner and building officials.
12. The General Contractor shall maintain a current and complete record set of construction documents on site during all phases of construction for the use of all trades, and shall provide all subcontractors with current construction documents as required. The contractor shall neatly and correctly document all deviations from the contract documents on the record set.
13. All work is to be done in a professional manner by professionals skilled in their respective trades. Work is to be guaranteed against defects and poor workmanship for at least one year from the date of completion of the project.
14. Each trade is responsible for their own cleanup unless otherwise indicated by general contractor. Failure to clean up may result in a back-charge.
15. General Contractor is responsible for protecting common site elements including but not necessarily limited to; existing landscaping, sidewalks, driveways, curbs, site lighting, and utilities, from damage which may occur from construction, demolition, etc., as well as to protect the public using such elements during the period of construction. Damage to new and existing materials, finishes, structures, and equipment shall be repaired or replaced to the satisfaction of the owner and building officials.
16. All Dimensions are to the Face of Framing and Exterior Face of Sheathing, or Face of Masonry, unless noted otherwise. All angles are 90 degrees unless noted otherwise.
17. Wall framing member sizes, gypsum board thickness and rating (normal, or Type 'X', or Type 'C'), and thermal or acoustical insulation per wall type legend.
18. Fire rated assemblies vary in permitted materials. Particular care should be used to ensure that each is constructed with materials exactly as listed by the testing agency.
19. Provide, install, and remove any and all bracing required to insure the stability of the structure until the permanent support/ framing is in place.
20. Window and Hinged Patio Door designations refer to nominal feet and inches (i.e. 3053 = 3'-0"x5'-3"). Tempered Glass to be used where required by Code. Andersen 400 series windows & patio doors are used as the Basis of Design. Additional manufacturers may be submitted as a voluntary bid alternate, for possible acceptance by Architect.
21. Window Supplier to verify Code compliance (i.e. current Michigan Energy Code, Accessibility, Emergency Egress, Tempered Glass, etc.) prior to purchase and shipment of windows. Provide Architect & General Contractor with a schedule of rough openings and window size, clear openings of egress and accessible windows & patio doors, and code compliance certificate.
22. Door Supplier to provide Architect & General Contractor with a schedule of rough openings and door sizes.
23. All Window and Door Headers: See Structural Drawings.
24. Any products or materials explicitly called out may NOT be substituted without express authorization of the Architect.
25. Use Protecto Wrap Triple Guard Energy Sill Sealer between Foundation and Mud Sill. Contact phone # (800) 759-9172. Note that face of sheathing is flush with face of Foundation.
26. At all sloped roofs: Grace 'Ice & Water Shield' or approved alternate at all Valleys and Eaves, extend 'Ice & Water Shield' a minimum of 2'-0" inside from the Interior Face of the Exterior Wall.
27. All details, sections, and notes shown on drawings are intended to be typical and shall apply to similar situations elsewhere unless noted otherwise.
28. Coordinate the size, location, fire rating, firestopping/sealant, weather & moisture sealants and construction of all wall, floor, and roof openings; stair details; penetrations for ducts, dampers, vents, conduits, wiring, pipes; and any other required openings on Architectural, Mechanical, Electrical, Plumbing, and Fire Suppression Drawings.
29. All lumber in contact with masonry or concrete shall be pressure treated 'yellow pine' rated for ground contact.
30. Stud spaces used as Return Air Ducts to be spay-painted black behind all Register Covers.
31. All signage required at elevator, stair access, stair floor level landings, and elsewhere required by Code or the Building Official, shall comply with Section 1023.9.1, and ICC A117.1 Section 504.9. General sign criteria is given in ICC A17.1 Section 703.3 Raised Characters & 7.3.4 Braille
32. All design, engineering, coordination and documentation for Mechanical, Electrical, and Plumbing is the responsibility of the respective design-build contractor(s). Each contractor shall be responsible for coordinating Architectural design issues and items with the Architect. the Architect is not responsible for coordination between Mechanical, Electrical, and Plumbing Contractors.
33. Final Mechanical, Electrical, Plumbing, and Fire Suppression Drawings may be included in a deferred submittal as stipulated Section 107.3.4.1 of the 2015 Michigan Building Code.

Project Address:
Auburn Anagra Oaks Development - Charlevoix Model Multi-Family Building.
3046 Anagra Drive
Rochester Hills, Michigan 48309

Description of Work:
Proposed new 8 unit, residential apartment (condominium) building, Building A
Proposed new 9 unit, residential apartment (condominium) building, Buildings B, C, D
Proposed new 7 unit, residential apartment (condominium) building, Building E

Building Planning:

Reference Standards:

Michigan Building Code	(2021)	ICC/ANSI A117.1 and Michigan Barrier Free Design Law	(2017)
Mich. Commercial Energy Code	(2021)	International Fire Code	(2021)
ASHRAE 90.1	(2019)	NFPA 13 - Fire Sprinkler Systems	(2019)
Michigan Mechnical Code	(2021)	NFPA 72 - Fire Alarm Code	(2013)
Michigan Plumbing Code	(2021)	Michigan Electrical Code (IEC + Part 8 State amendments)	(2023)

CHAPTER 3 Occupancy Description

Residential (Primary use - dwelling units/ accessory spaces) Use Group R-2
Storage (Low-hazard storage / parking garage) Use Group S-2

CHAPTER 5

Type of Construction: 5B - (2) stories above grade w/ (1) story below grade garage

Automatic Sprinkler System: NFPA 13 compliant with Section 903.3.1.1 (note **NOT** NFPA13R 903.3.1.2)

Separated Mixed Use: Per Sect. 508.4, requires min. 1 hour fire separation between S and R uses (in building w/ 903.3.1.1 [full NFPA-13] compliant sprinkler system)

ALLOWABLE HEIGHT AND BUILDING AREAS (per TABLES 504.3, 504.4 & 506.2):

ALLOWABLE HEIGHT:

	Sprinkler system equipped*	
Use Group:	Height (Feet)	Height (Stories)
S-2 (Parking garage) @ Type 5B constr'n	60 feet	3 stories
R-2 (Permanent dwelling) @ Type 5B constr'n	60 feet	3 stories
ACTUAL building height in Feet/Stories	29'-11"	2 Stories

*NFPA 13 complying with Section 903.3.1.1(and **NOT** NFPA13R 903.3.1.2)

ALLOWABLE BUILDING AREA (per story):

Use Group:	Allowable Area per Story (SF)	Actual per Story
S-2 (Parking garage) - Type 5B constr'n*	40,500	5,588
R-2 (Permanent dwelling) - Type 5B constr'n*	21,000	5,708 max see below

*NFPA 13 complying with Section 903.3.1.1(and **NOT** NFPA13R 903.3.1.2)

Floor (Use Groups):	Max. Allowed (sf)	Provided (sf)
Basement (Garage) Level: (S-2)	40,500	5,588
First Floor: (R-2)	21,000	5,700
Second Floor: (R-2)	21,000	5,708
TOTAL ACTUAL BLDG. AREA		16,996

CHAPTER 7 Fire Resistive Construction (Tables 601 & 508.4, & Chapter 4, 5, 7, 10)

	Type 5-B	Req'd	Provided	UL Listings & Notes
Structural Protection per Table 601	Structural Frame	0 hr.	0 hr.	n/a
	Bearing Walls - Exterior	0 hr.	0 hr.	n/a
	Bearing Walls - Interior	0 hr.	0 hr.	n/a
	Non-Bearing - Exterior	0 hr.	0 hr.	n/a
	Non-Bearing - Interior	0 hr.	0 hr.	n/a
	Floor Construction	0 hr.	0 hr.	n/a
	Roof Construction	0 hr.	0 hr.	n/a
Use & Exit Separation per Sect. 420, 508.4, 708, 713, 1019.3, 1020, 1023	Elevator Shaft Construction	1 hr.	2 hr.	UL U905
	Stair Enclosure Construction	1 hr.	1 hr.	UL U305
	Floor-Ceiling Assembly	1* hr.	1 hr.	UL U305
	Corridor Wall Construction	0.5 hr.	1 hr.	UL U340
	Dwelling Unit Separation (see A6.1 for wall & floor assemblies)	1 hr.	1 hr.	UL U305 dbl stud

*Per 711.2.4.3 If equipped with NFPA 13, horizontal separation between dwelling units requires 1/2 hour min. rating. Provided - 1 hour rating.

Separation of multiple buildings on site per Sect. 503.1.2, 602 — Exterior Rating based on Fire Separation Distance per Table 602

	Fire Sep'n Dist. (ft)	Req'd Rating	UL Listing and Notes
North	10' or more	0 hr.	n/a
East	10' or more	0 hr.	n/a
South	10' or more	0 hr.	n/a
West	10' or more	0 hr.	n/a

CHAPTER 9 Fire Protection Systems

(903)	Automatic Sprinkler System Fully Sprinkled	Yes X	No
	NFPA 13 or 13R	13 X	13R
(905)	Standpipe System *	Yes	No X
(907)	Alarm System	Yes X	No
	Smoke Control System	Yes	No X
	Fire Control Room	Yes	No X

* highest floor is 21'-4" = less than 30' above lowest fire vehicle access

CHAPTER 10 Means of Egress

Occupant Load	Floor Area	Allowable Occ/ sf	Occ. Load	Use Group	Tot.occ. + area/Use
Lower Level:					
Parking, incl bike stor & Trash		1/200 s.f.	27	S-2	27 occ.
Elec./Utility Room	44 s.f.	1/300 s.f.	1	Acces'y	1 occ.
Water Meter/Fire Sprinkler	115 s.f.	1/300 s.f.	1	Acces'y	1 occ.
Stair	104 s.f.	1/200 s.f.	1	Acces'y	1 occ.
	5,588 s.f.				Accessory = 3 occ.
				Lower Level Occupant Load:	30

Occupant Load	Floor Area	Allowable Occ/ sf	Occ. Load	Use Group	
First Floor:					
Dwelling Units, Common Rm, Corr,	5,700 s.f.	1/200 s.f.	29	R-2	= 29 occ.
Second Floor:					
Dwelling Units, Corridor	5,708 s.f	1/200 s.f.	29	R-2	= 29 occ.
					Residential = 58 occ.
				Total Residential Floors Occupant Load:	58
				TOTAL BUILDING OCCUPANT LOAD:	88

Min. required egress width per Sect. 1005.1

Total egress/door width req'd:
- At EXTERIOR STAIRWAY doors, convergence of basement traffic + traffic from floors above = 88 total
  88 * 0.2" = 17.6" / 2 = 18" each (minimum)
- *PROVIDED: 32" min. clear per door (per icc a117.1) at all stairs & building entries (using nominal 36" doors).*

Total stair with req'd:
- 1ST FLOOR, 2ND FLOOR stair width: 29 x .3 = 8.7 / 2 exits = 4.4" each (minimum)
- *PROVIDED: 36" clear per stair* (per section 1011.2 exception 1: 36" min. for occ. load less than 50)

Required number of exits per Sect. 1006.2 & 1006.3

Per Dwelling Unit: One exit required per Table 1006.2.1

Per Story: 2nd Floor - One exit per Table 1006.3.2(1)
1st Floor - Two exits per Table 1006.3.1
Basement - Two exits per Table 1006.3.1

Required exit separation per Set. 1007.1.1 Exception 1:
Sprinkled building = 1/3 of overall diagonal of area = 108'-4" / 3 = 36'-2"
PROVIDED: Bldgs A,B,C: 51'-1"
Bldgs D,E: 57-11"

Exit access travel distance MAX. per Table 1017.2, w/sprinkler system:
R-2 2nd Floor -- Required - 250 ft. Provided - 116'-6"
R-2 1st Floor -- Required - 200 ft. Provided - 112'-6"
S-2 Garage -- Required - 400 ft. Provided - 99'-6"

J BRADLEY MOORE & ASSOCIATES, INC.
4844 Jackson Road #150 • Ann Arbor, MI 48103 • (734) 930-1500

Three Oaks Communities
Charlevoix at Auburn
Auburn Angara Oaks
Code Information, Project & General Notes - All Buildings

City Review	07.21.23
Revised	01.22.24
Revised	08.15.25

Code Info
Proj, Gen'l Notes
All Buildings

JBMA Project No.
222051

T1.2