

UPDATES - GEOWALL COMPETITION

Competition Dates: Thursday, April 19, 2018

Saturday, April 21, 2018

Competition Location: Sacramento State Campus

Contact:

Any questions regarding the Geo-Wall Competition may be sent to:

Robby Wikoff

2018midpacgeowall@gmail.com

Updates:

Any updates or RFIs after the release of Mailer 2 will be posted on the website; it is the responsibility of the teams to check the website regularly for any updates.

The following updates are important changes to the rules detailed in Mailer 1:

The design poster submission should read: "Any changes or corrections made to the design poster after this time will incur a penalty (see Section 11)."

In Section 5 – Sandbox and Section 13 – Pre-Competition Team Captains' Meeting, the rules state that teams have the ability to correct any compliance issues after the captains' meeting on Thursday, April 19, until 9:00 AM local time on competition day. Due to the competition beginning early morning, teams will only have until 8:00 AM local time on competition day to fix any compliance issues. Sandboxes will be checked for compliance to specifications at the captain's meeting. The only changes that can be made are due to compliance issues and/or unsatisfactory specifications of backfill and/or wall materials. As the rules state, teams will incur penalties for any unauthorized changes.

In Section 11 – Design Changes, the rules state that teams can change the requested length of 60lb kraft paper between the time the design report is submitted and 9:00 AM local time on competition day. Due to reasons stated above, teams only have until 8:00 AM local time on competition day for design changes.

The following updates are important additions to the rules detailed in Mailer 1:

Design Poster Submittal - Each team is to present their analysis and design on a design poster. The 24-inch x 36-inch (maximum size) poster shall be displayed in a designated area throughout the GeoWall competition. The design poster must include:

- a) The school name and logo must be visible on the poster. The school name shall have at least 1 inch tall letters.

- b) The names and status of each team member, the identification of team captain, and name and title of the advisor of the GeoWall team.
- c) Material properties used in design including methods used to obtain the properties.
- d) Description of the engineering design and construction procedures including assumptions and equations used.
- e) A complete description of the geometry and placement of all reinforcing elements including the estimated mass of the reinforcing paper in grams.
- f) Acknowledgments to team sponsors and advisors both named in (b).
- g) References (books or papers referred to in the design or analysis).

Design posters will be judged by a panel of practicing engineers and may include professors. Posters will be briefly (approximately 5 minutes) described by the team captain and up to one other team member. Judges will follow up with questions and will consider quality, reasonableness, and completeness of the design, material properties, and assumptions. "Trial and error" designs will be heavily penalized. The judging rubric for the design poster is presented in Appendix E.

Below is the score adjustment to Section 12 – Scoring and Appendix C5: Scoring to include the design poster.

$$Score = R + P + 15(60 - M) + 5(10 - L) - 10N_{min} - 40N_{maj} - 2T - 20D$$

Poster score is out of 50, P (Weight = 1)

Appendix E: Design Poster Judging Rubric

Geo-Institute of the ASCE: GeoWall Design Poster – Scoring Form			
Reviewer Guidelines: 1) Place weight on the team ability for engineering reasoning not technical knowledge; 2) Place weight on team communication skills on procedures, findings, and observations; 3) Score in 0.5-point increments; 4) Team to be awarded higher score if design parameters were verified beyond assumptions and references			
Criterion	Max	Actual	Notes
1) Formatting, Mechanics, Grammar & Safety			
a. Poster size (24"x36" max), headings, fonts, margins and layout	1		Poster complies with specifications
b. Grammar and punctuation are correct	1		Error free paper with writing that clearly presents design
c. Figures and tables are clear, properly numbered, captioned and referenced in the text	2		Good choice of tables vs. figures, clear presentation of data
d. References are reasonably formatted and complete	1		Quantity appropriate with correct citations and references
2) Experimental Methods, Analyses and Design:			
a. Conveys the Experimental Methods, Analyses and Design steps used to plan the GeoWall construction	10		Experimental methods, analyses, and design of the project are displayed. This is not as in-depth as the report, but technical enough for another engineer to grasp the concepts and gain an understanding of the GeoWall Competition.
3) Engineering Reasoning and Communication			
a. The poster is, on the whole, clear, precise, and well-reasoned. Engineering terms and distinctions are used effectively and in keeping with established professional usage. The report demonstrates a clear and precise analysis of the wrapped face segmental MSE wall design problem, very little or no irrelevant information is presented, key assumptions are identified, and key concepts are clarified. The authors have shown, through their poster, excellent engineering reasoning and problem-solving skills.	10		Scores may range from 0 to 10. It is the opinion of the reviewer as to how the overall report measures up to the criteria listed under item 3 "engineering reasoning and communication".
b. Answering judge's questions	25		This score reflects the team's ability to professionally answer the judge's questions and clearly explain the material.
Total	50		

ASCE 2018 MID-PACIFIC 18 STUDENT CONFERENCE



MAILER I

GEO-WALL COMPETITION

Competition Dates: Thursday, April 19, 2018

Saturday, April 21, 2018

Competition Location: Sacramento State Campus

Summary:

The objective of the Geo-Wall competition is to design and build a model mechanically stabilized earth (MSE) retaining wall using paper reinforcement attached to a poster board wall facing. Students are to design a MSE wall using the least amount of reinforcement needed to support the retained soil and design loads, and effectively communicate their analysis and design processes.

Contact:

Any questions regarding the Geo-Wall Competition may be sent to:

Robby Wikoff

2018midpacgeowall@gmail.com

DESIGN REPORT SUBMISSION:

The complete Design Report must be submitted in PDF format via email to the Mid-Pac Geo-Wall Coordinator, 2018midpacgeowall@gmail.com, by 5:00 pm PST on March 17, 2018. Subject line must include "Geo-Wall 2018 Report Submittal." The sender will receive confirmation of receipt by e-mail. Any changes or corrections made to the design report after this time will incur a penalty (see Section 11).

DESIGN POSTER SUBMISSION:

The complete Design Poster must be submitted in PDF format via email to the Mid-Pac Geo-Wall Coordinator, 2018midpacgeowall@gmail.com, by 5:00 pm PST on April 15, 2018. Subject line must include "Geo-Wall 2018 Poster Submittal." The sender will receive confirmation of receipt by e-mail. Any changes or corrections made to the design report after this time will incur a penalty (see Section 11).

RULES

1. **Objective** – The objective of the Geo-Wall competition is to design and build a model wrapped faced segmental mechanically stabilized earth (MSE) retaining wall using kraft paper. The competition objectives are for students to:
 - a) Design a wrapped face segmental MSE wall using the least amount of facing and reinforcement material needed to support the retained soil plus both vertical and horizontal surcharge loads.
 - b) Effectively communicate their analysis and design processes.
 - c) Enjoy a friendly but spirited competition among schools.
 - d) Attend a world-class professional engineering conference.
2. **Background** – MSE walls have root to prehistoric builders who used sticks and branches to reinforce soil structures. The modern use of reinforced soils dates to the 1960s and French architect Henri Vidal's development of the Reinforced Earth® system. In the US, the first MSE wall was built on California SR-39 near Los Angeles in 1971. A more recent development in MSE walls is the wrapped face segmental wall as shown in Figure 1. This year's competition will model this development of MSE walls by requiring teams to design and construct a wrapped face retaining wall.



Figure 1: Typical wrapped face MSE walls

3. **Eligibility** – Only one team per school will be allowed to compete. A team consists of a maximum of four (4) students consisting of not more than two (2) graduate students. Each team shall designate a captain who shall be the point of contact for the team. All team members must be enrolled students at the date of the national competition.
4. **Design Report Submittal** – Invitation to the National Competition will be based upon submittal and ranking of the Wrapped Face Segmental (MSE) Wall Design Report. The report must include:
 - a) Cover page with name of institution; names and status (graduate, undergraduate) of each team member; identification of team captain with email address; and name, title, and email address of faculty advisor.
 - b) Material properties used in design including methods (lab tests, correlations, assumptions) used to obtain the properties.
 - c) Description of the engineering design and construction procedures including assumptions and equations used.

- d) A complete description of the geometry and placement of all wrapped face MSE wall elements. Estimated mass of the facing and reinforcing paper in grams and total length of kraft paper required to construct the wrapped face MSE wall.
- e) A safety appendix (Appendix D) which outlines the potentially hazardous tasks reasonably expected during the competition and how the team will mitigate these hazards.

Formatting requirements:

- a) Length shall be a maximum of three (3) pages long (not including references, cover page, or safety appendix). Over-length design reports will not be reviewed.
- b) One inch margins, single spaced, and 12 point Times New Roman font.
- c) All pages after the cover page shall contain a header identifying the team and a footer with the page number.
- d) Entire design report must be submitted in a single PDF format file with a filename of "<School Abbreviation>2018Geo-Wall.pdf".

Design reports will be judged by a panel of practicing engineers and professors. Judging will consider reasonableness of design equations, material properties, factors of safety, assumptions, and satisfaction of the objective of this competition. "Trial and error" designs will be heavily penalized. Teams not submitting designs for a "wrapped face segmental" MSE wall will be disqualified. The judging rubric is presented in Appendix C.

Complete design report must be submitted in PDF format via email to the Mid-Pac Geo-Wall Coordinator, 2018midpacgeowall@gmail.com by 5:00 pm PST March 17, 2018. The subject line must include "Geo-Wall 2018 Submittal." The sender will receive confirmation of receipt by e-mail. Any changes or corrections made to the design report after this time will incur a penalty.

5. **Sandbox** – The wrapped face segmental MSE wall will be constructed within an apparatus hereafter referred to as a sandbox. Each team shall bring their own sandbox to the competition. Painting and addition of school or sponsor logos and other decorations to the exterior of the sandbox is highly encouraged. The sandbox shall be made up of a bottom and four vertical sides with no top. The front panel will be removable as shown in Figure 2. The removable box panel will be in place during wall construction and removed after construction to expose the wrapped face segmental MSE wall. The sandbox will also include two PVC piles used to apply the horizontal load. Dimensions of the sandbox and the PVC piles are shown in Figures 2 through 4. The sandbox shall meet the following requirements:

- a) Have exterior walls and base constructed of any grade of plywood not to exceed $\frac{3}{4}$ -inch (19 mm) thick.
- b) Have planar inside surfaces with the natural plywood finish.
- c) Have a removable front as shown in Figure 2. Panels must be flush with the base of the box and held in place with threaded inserts, screws, hinges or other easily removable fasteners.
- d) Have a full-sized base such that it extends no more than $\frac{3}{4}$ inch (19 mm) beyond the base of the wall once the front panel has been removed.
- e) Include a steel tie rod designed to keep the two fixed sides of the box parallel after removal of the facing panel.
- f) Include circular guides to ensure bases of the PVC piles are held in the correct location. A temporary template may be used to control alignment at the top of the piles.
- g) Any templates used must be removed after wall construction and before testing.
- h) All dimensions of the sandbox shall be as shown in Figures 2 and 3.

For convenience, sandboxes may be designed so they can be transported as flat pieces and reassembled at the competition site.

Sandboxes and PVC piles will be checked for compliance at the pre-competition captains' meeting. Teams will have until 9:00 AM local time the day of the competition to correct any compliance issues. Any team with a sandbox and/or PVC piles out of compliance at the start of the competition will be penalized.

6. **Piles** – Two vertical piles will be used to apply the horizontal load to the backfill behind the wall. Each team will provide their own piles. Piles will be fabricated out of 1-½" schedule 40 PVC pipe. Please see Figure 2 for the pile locations and length requirements.
7. **Backfill Material** – The backfill material will be sand provided by competition organizers on site. The sand will be a clean, dry, rounded to sub-rounded sand with grain size as specified in Table 1 and Figure 5. The backfill material must be used as-is: no water, additives, or chemical stabilizers may be placed in the backfill material.

Competition organizers will make reasonable efforts to ensure the competition backfill materials meet the specifications in Table 1 and Figure 5. Teams will be allowed to examine a sample of the competition backfill at the captains' meeting. No backfill samples may be removed from the meeting room. Teams may modify their wall design at this time if they desire. See section 11 below.

Table 1: Representative anticipated grain-size distribution for Geo-Challenge competition sand.

Typical Distribution		Lower Bound		Upper Bound	
Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
2.00	100.0	1.30	100.0	2.50	100.0
1.70	96.8	1.20	96.9	2.30	96.9
1.18	41.8	1.15	93.7	2.10	93.7
1.00	15.8	0.80	38.7	1.60	38.7
0.85	3.3	0.60	12.7	1.30	12.7
		0.50	2.0	1.10	2.0

8. **Wall Materials** – Materials will be provided by competition organizers on site. See Appendix A for detailed specifications. Facing and reinforcement for the wrapped faced segmental MSE wall will be prepared from 60 lb kraft paper. Quantity of kraft paper will be measured by mass to the nearest 0.01g. There are no restrictions on the shape or geometry of the wall elements, except that all wall elements must be cut from kraft paper and must satisfy the constraints of a *wrapped face segmental* MSE wall. The teams must specify in their report the length of the 24-inch wide kraft paper required for their design during the competition.

Competition organizers will make reasonable efforts to ensure the wall materials meet the specifications in Appendix A. Teams will be allowed to examine small samples of the reinforcing material at the captains' meeting. No reinforcing material samples may be removed from the meeting room. Teams may modify their wall design at this time if they desire. See section 11 below.

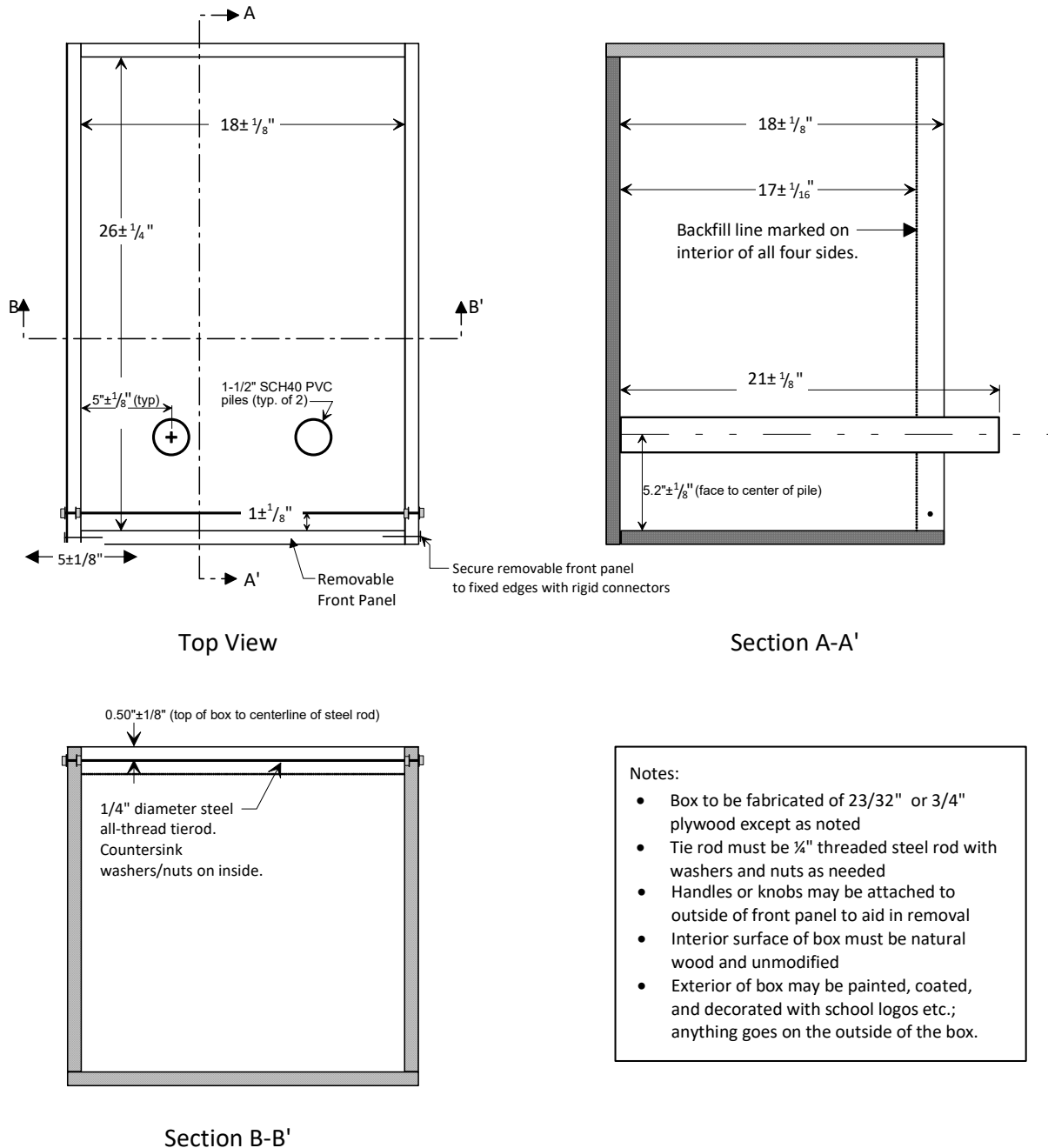
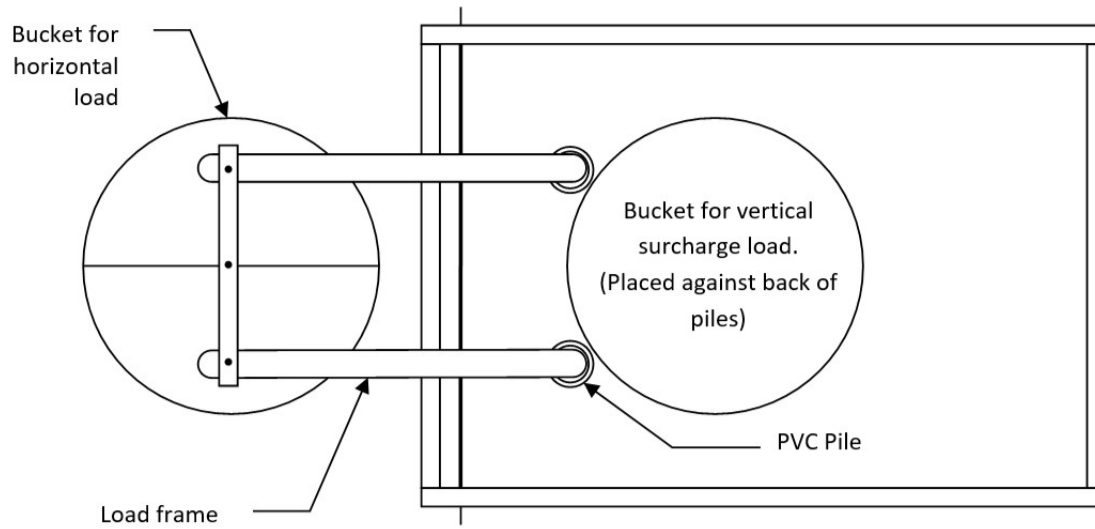
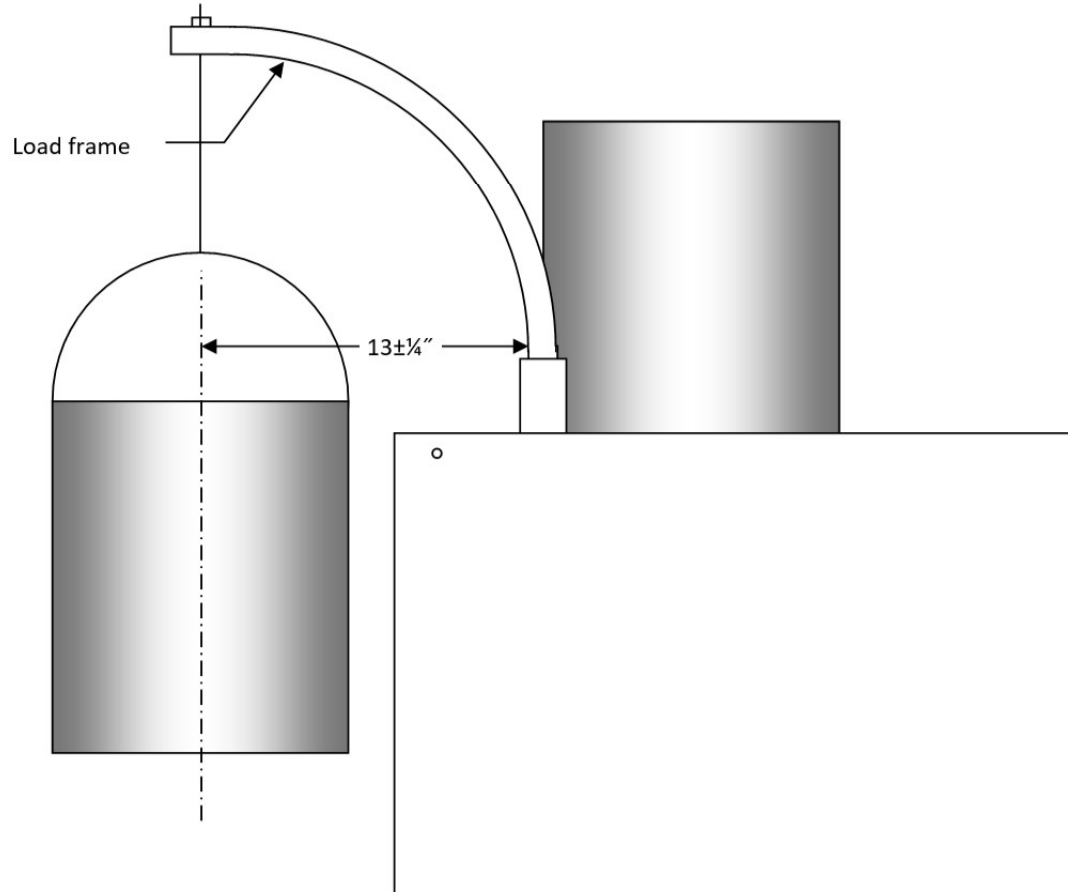


Figure 2: Sandbox dimensions (not to scale)



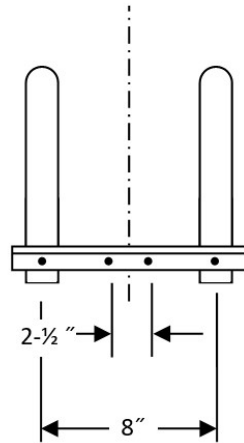
Top View



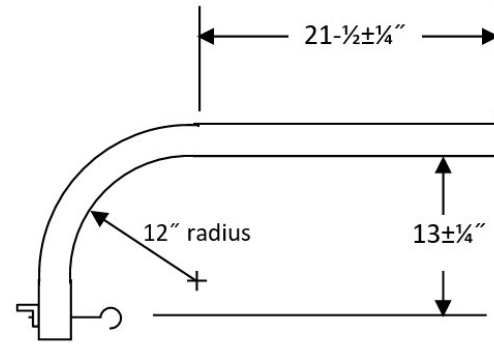
Side View

s

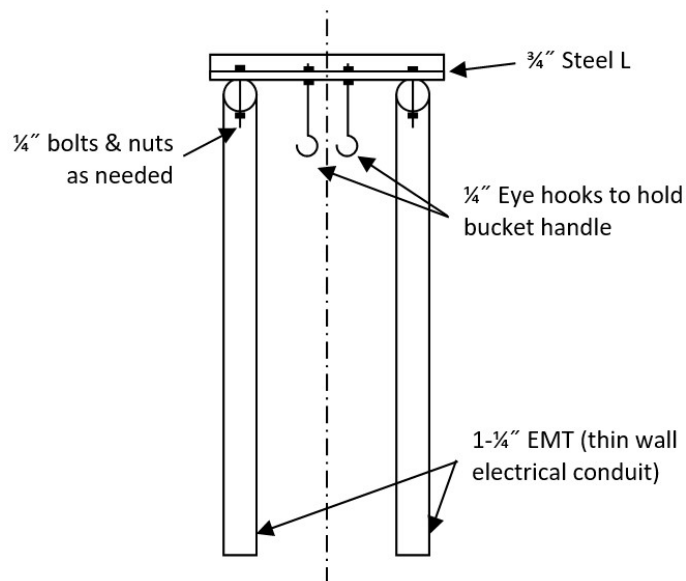
Figure 3: Load Placement (not to scale)



Top View



Side View



Front View

Figure 4: Dimensions of Horizontal Load Frame (not to scale)

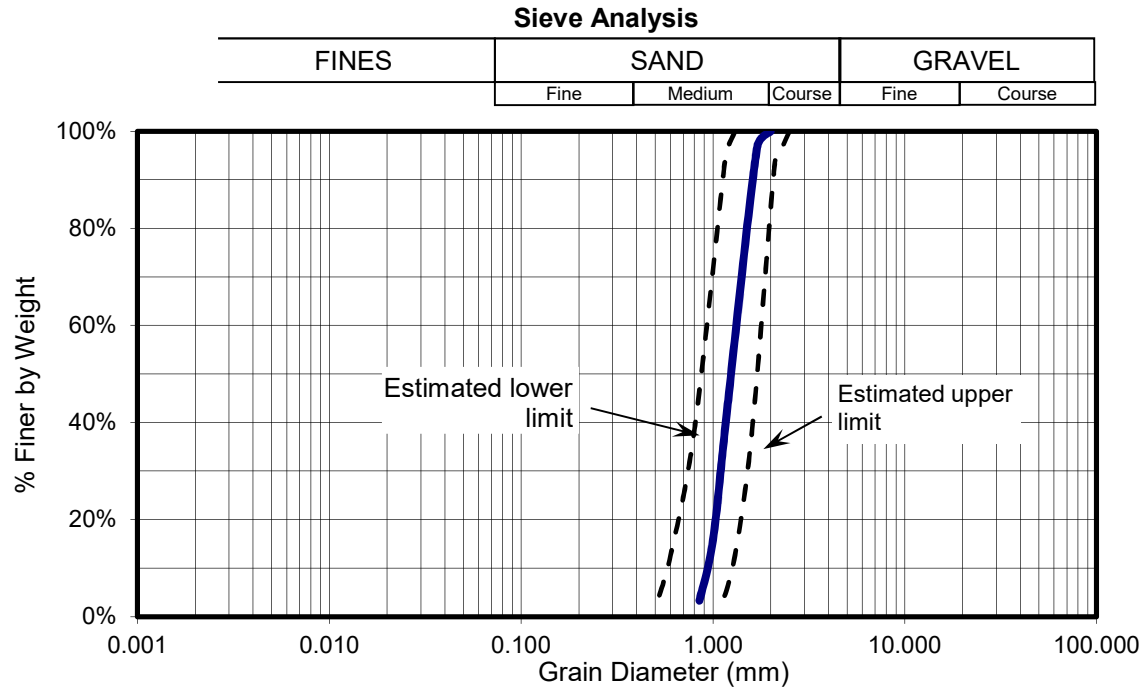


Figure 5: Estimated grain size distribution of backfill sand

9. **Construction Tools** - The following construction tools may be used and must be provided by the competing team (quantities of these items shall not be restricted):
- a) Pencils, pens, and markers
 - b) Rulers and straight edges
 - c) Levels
 - d) Manually operated cutting instruments (e.g., scissors, utility knives, safety razor blades, hole punch)
 - e) Cutting boards or mats
 - f) Design notes, calculations, and drawings
 - g) Material handling and compaction tools consisting of any hand operated devices.
 - h) Screwdrivers (battery operated drills or screwdrivers may be used, but only to remove fasteners when removing the facing panels)
 - i) Temporary templates for use in any stage of competition. These templates may be made of any material, must not have any moving parts, and must be removed at the end of any stage in which they are used.

Buckets and shovels will be provided by the competition organizers. It may be necessary for teams to haul backfill a distance up to 20 feet.

10. **Execution** – Construction and testing of the wall will be done in the following stages:

- a) **Reinforcement Fabrication Stage** – Each team will be provided with 60 lb kraft paper (as mentioned in their design report). The team must fabricate all their wrapped face segmental MSE wall elements from those sheets using authorized construction tools. Twenty (20) minutes will be allotted for this stage. Teams will be penalized for time exceeding the time limit. After all wrapped face MSE wall elements are fabricated, excess material will be disposed of and the judges will weigh the reinforcing elements to the nearest 0.01 grams.
- b) **Construction Stage** – After each team's wrapped face segmental MSE wall elements have been fabricated and weighed, the judges will instruct the team to start construction. During this stage the team constructs the wrapped face segmental MSE wall filling the box with sand so that the backfill line (see Figure 2) is covered and the backfill is level, and places the empty 5 gallon vertical surcharge bucket on top of the sand. The facing material must be in direct contact with the inside of the sandbox at all times during this stage. The tie rod may be removed from the box at the start of this stage, but it must be in place before any sand is placed in the box. Temporary templates or guides may be used during this stage so long as they are removed before the end of the stage.

The construction stage is complete when the wall is in place, the sand backfill covers the sand fill line and is level, any temporary templates or guides have been removed, and the empty vertical surcharge loading bucket is in place. Twenty-five (25) minutes will be allotted for this stage. At the end of the phase, judges will check fill placement and the placement of the empty vertical surcharge loading bucket to ensure that they meet the requirements.

- c) **Loading Stage** – Details of the load placement are shown in Figure 3. This stage occurs in three steps: 1) removal of front panel, 2) placement of vertical surcharge, and 3) placement of the static horizontal surcharge load. During each step, the wall will be checked for the following three criteria: 1) excessive deformation (any portion of the wall extending outside imaginary planes extending vertically from base of sandbox), 2) excessive soil leakage (more than 30 cm³ of sand passing out of the sandbox), and 3) catastrophic failure. The team will be penalized for excessive soil loss and excessive deformation. The team will be disqualified for a catastrophic failure.
- i. When directed by judge, the team shall remove the front panel of the sandbox. After the panels are removed, the judge will wait one (1) minute and then check the three criteria.
 - ii. If the wall does not fail catastrophically, the team will then place 50 lbs of sand in the vertical surcharge bucket. The team will have one (1) minute to place the load. After the load is placed, the judge will wait one (1) minute and then check the three criteria.
 - iii. If the wall does not fail catastrophically, the team will hang an empty 5 gallon bucket on the loading frame and place 20 lb of sand in the bucket (see Figure 4). The team will have one (1) minute to complete this loading sequence. After the sequence is complete, the judge will wait one (1) minute and then check the three criteria. The horizontal load frame will be provided by the competition organizers. Teams should not bring their own load frames to the competition.

11. **Design Changes** – Teams may change their design between the time the design report is submitted and the wall is tested. The adjusted mass of the reinforcing material used for scoring, M , will be computed as

$$M = m_A + (m_D - m_A + 0.50)^2 \quad (1)$$

Where,

M = adjusted mass (g) rounded to two decimal places

m_D = reinforcing mass (g) reported in design report

m_A = reinforcing mass (g) used during competition

Teams may also change the requested length of the 60 lb kraft paper between the time the design report is submitted until 9:00 AM local time the day of the competition. The official length of the kraft paper used for the scoring will be computed as the greater of a) the average of the length requested in the design report and the length requested at any point after the submission of the design report until 9:00 AM local time the day of the competition or b) the length requested at any point later after the submission of the design report until 9:00 AM local time the day of the competition. The official length will be rounded up to the next half foot (6 inches).

12. **Scoring** – After completion of the loading stage, the score for each team will be computed using the following formula:

$$Score = R + 15(60 - M) + 5(10 - L) - 10N_{min} - 40N_{maj} - 2T - 20D \quad (2)$$

Where,

R = report score out of 50 points

M = adjusted mass of the wrapped face MSE elements in grams from Equation 1

L = official length of 60 lb kraft paper in feet as determined in section 11

N_{min} = number of minor rules violations

N_{maj} = number of major rules violations

T = total number of minutes over time limit for all phases each rounded up to nearest minute

D = deflection rating

8 if wall fails deflection criterion during initial loading without surcharge

6 if wall fails deflection criterion during vertical surcharge loading

4 if wall fails deflection criterion during horizontal surcharge loading

0 if wall passes deflection criterion for all loading phases

If the wall fails catastrophically during any loading step, the team will be disqualified.

a) **Minor Penalties**

i) Box dimension out of spec

ii) Pile location out of spec

iii) Any addendum to the design report required by judges which simply clarifies content but does not change the design

iv) Any other rule violation that in the opinion of the judges that has the potential to provide the team with a measurable but minor advantage

b) Major Penalties

- i) Soil leakage greater than 30 cm³ (volume of standard 1 oz. plastic medicine cup)
- ii) Any addendum to the design report required by judges which results in a significant change to the design
- iii) Any other rule violation that in the opinion of the judges has the potential to provide the team with a significant advantage, but does not warrant disqualification

c) Disqualification – Teams may be disqualified for the following:

- i) Failure to design a *wrapped face segmental* MSE wall
- ii) Failure to send a representative to the pre-competition captains' meeting
- iii) Unsafe practices
- iv) Design or construction techniques which violate the spirit of the competition and provide a large and/or unfair advantage
- v) Catastrophic wall failure at any point during the loading

Scores will be recorded to the nearest tenth of a point. In the event of a tie the following criteria will be used, in order, to break the tie: 1) lowest actual reinforcement mass, 2) higher report score, 3) lowest deflection rating, 4) lowest length of reinforcement paper, and 5) judges' consensus of best decorated box.

The judges will follow the rules as published using reasonable judgment and interpretation. The head judge will be the arbiter of any disputes, which are to be brought forth solely by the Team Captain. Decisions of the head judge are final. Results posted at the competition are not subject to review after the competition.

Scoring Example: Assume a team constructs a wall with following characteristics

- Report Score: 48/50, $R = 48$
- Design report specifies 46.23 g. Reinforcement used is 47.01 g. From Equation 1,

$$M = 47.01 + (46.23 - 47.01 + 0.50)^2 = 47.53 \text{ g}$$
- Requested length in the design report was 6 feet. The requested length at the captain's meeting was 7.2 feet. Official length, $L = 7.5$ feet from section 12
- Minor deduction for two box dimensions out of spec, $N_{min} = 2$
- Execution times were
 - Reinforcement fabrication: 20:18 (18 sec over allotted time, round up to 1 min)
 - Construction: 26:05 (1:05 over allotted time, round up to 2 min)
 - Total time over: 3 min, $T = 3$

Note: Only times over limit during each stage are counted. Teams get no benefit for times under the limit of any individual stage.
- Wall passed deflection test in initial loading without surcharge and during vertical surcharge loading phase, but failed deflection test during horizontal surcharge loading phase, $D = 4$

Using Equation 2, the final score would be

$$Score = 48 + 15(60 - 47.53) + 5(10 - 7.5) - 10(2) - 40(0) - 2(3) - 20(4) = 141.2$$

See Appendix B for scoring checklists.

13. **Pre-Competition Team Captains' Meeting** – A team captains' meeting will be held prior to the competition for the purposes of: checking sandboxes and PVC piles for compliance, establishing competition order, gathering team biographical information, and disseminating any logistical or administrative information. This is a MANDATORY meeting. Each team must have the team captain (or designee) present. All team members are encouraged to attend. Specific meeting time and location will be announced on the Geo-Wall website before the conference. Teams without a representative at the captains' meeting will be disqualified.

Teams should bring their sandboxes, PVC piles, and any hardware or tools needed for assembly. Sandboxes and piles will be assembled and checked for compliance at the meeting. Teams will have until 9:00 AM local time of the day of the competition to correct any compliance issues identified during the captains' meeting. Any sandboxes or piles found out of compliance at the captains' meeting will be rechecked at this time.

GEWALL COMPETITION APPENDICES

Appendix A: Material Specifications

- **Sand:**
 - Clean sand with grain size distribution as specified in Table 1 and Figure 5
 - Grain shape will be rounded to sub-rounded
- **Sandbox Material:**
 - Walls and Base: 23/32 or ¾-inch plywood, any grade
 - Pile guide: any wood material ¼-inch thick or less
 - Tie Rod: ¼-inch threaded steel rod with washers and nuts as needed
 - Fasteners: any suitable wood fasteners
- **Pile Material:** 1- ½-inch Schedule 40 PVC pipe
- **Horizontal Load Frame Materials:** These are recommended materials. Teams may fabricate their load frames out of any materials so long as they have the correct moment arm as shown in Figures 3 and 4. The load frames provided by organizers for the competition will use the following materials and meet dimensions shown in Figure 4.
 - 1 –¼-inch steel EMT conduit (thin wall electrical conduit)
 - ¾-inch steel L
 - ¼-inch bolts
 - ¼-inch eye hooks
- **Facing and Reinforcing Material:**
 - 60 lb Kraft Paper
 - Grammage: 97.7 g/m², 0.063 g/in²
 - Office Depot® Postal Wrap Item # 444835 (2 ft x 50 ft roll)

Appendix B: Design Report Judging Rubric

Geo-Institute of the ASCE: GeoWall Design Paper – Scoring Form			
Reviewer Guidelines: 1) Place weight on the team ability for engineering reasoning not technical knowledge; 2) Place weight on team communication skills on procedures, findings, and observations; 3) Score in 0.5-point increments; 4) Team to be awarded higher score if design parameters were verified beyond assumptions and references			
Criterion	Max	Actual	Notes
1) Formatting, Mechanics, Grammar & Safety			
a. Paper length, margins & font are acceptable	2		Paper complies with specifications
b. Layout, or structure, of paper is logical	2		Paper organization is clear and supports the message
c. Grammar and punctuation are correct	2		Error free paper with writing that clearly presents design
d. Figures and tables are clear, properly numbered, captioned and referenced in the text	2		Good choice of tables vs. figures, clear presentation of data
e. References are reasonably formatted and complete	2		Quantity appropriate with correct citations and references
f. Appendix A and safety appendix (Appendix E) complete with reasonable controls	2		Clearly identifies key safety concerns and provides viable plans to keep team safe during competition
2) Experimental Methods, Analyses and Design:			
a. Methods to obtain soil properties	3		Experimental methods are reasonable and clearly described
b. Methods to determine reinforcement properties	3		Experimental methods are reasonable and clearly described
c. Methods to determine backfill-reinforcement interaction	3		Experimental methods are reasonable and clearly described
d. Engineering properties are reasonable	3		Backfill unit weight, friction angle, interface friction angle, reinforcement strength are compared to typical values

e. Earth-pressure calculations (backfill only)	3		Calculations are correct and presented in a logical, readily followed format
f. Vertical surcharge load included in the design	3		Considers both lateral loads on wall and effect on reinforcement pullout
g. Method used to compute pressure applied from laterally loaded piles addressed in report	3		Considers distribution of lateral loads on wall
h. Method used to account for segmental front face	3		Method and assumptions are reasonable
i. Determination of reinforcement length	2		Method and assumptions are reasonable
j. Determination of reinforcement spacing	2		Method and assumptions are reasonable
3) Engineering Reasoning and Communication			
The report is, on the whole, clear, precise, and well-reasoned. Engineering terms and distinctions are used effectively and in keeping with established professional usage. The report demonstrates a clear and precise analysis of the wrapped face segmental MSE wall design problem, very little or no irrelevant information is presented, key assumptions are identified, and key concepts are clarified. The authors have shown, through their report, excellent engineering reasoning and problem-solving skills.	10		Scores may range from 0 to 10. It is the opinion of the reviewer as to how the overall report measures up to the criteria listed under item 3 "engineering reasoning and communication".
Total	50		

Appendix C: Judges' Scoring Checklist for GeoWall Competition

C1: Captains' meeting—Box check

Team School:		Deductions	
Item	Instruction	Minor	Major
Plywood	<input type="checkbox"/> 23/32 or ¾-inch thickness <input type="checkbox"/> Inside surfaces planar and natural		
Box dimensions	<input type="checkbox"/> Within tolerance <input type="checkbox"/> Sand fill height marked		
Facing panels	<input type="checkbox"/> Flush to box base <input type="checkbox"/> Removable fasteners <input type="checkbox"/> Base extends to outside of vertical facing panels		
Tie rod	<input type="checkbox"/> ¼-inch diameter <input type="checkbox"/> Located within tolerances		
Piles	<input type="checkbox"/> 1-½-inch Sch. 40 PVC <input type="checkbox"/> Length in tolerance <input type="checkbox"/> Base guides ≤ ¼-inch thick <input type="checkbox"/> Locations in tolerance <input type="checkbox"/> Upper pile template easily removable		
Tools	<input type="checkbox"/> Only authorized tools used		
Other minor, explain:			
Other major, explain:			
Disqualification, explain:			
Total deductions			

Notes:

C2: Reinforcement fabrication

Item	Instruction	Time	
		Total	> 20:00 (min:sec)
Time	Give start command. Time ends when all elements cut to size and shape		
		Mass (g)	
		Design	Actual
Mass	Weigh reinforcement to nearest 0.01 g		
Compute official adjusted Mass, M , using Equation 1		$M =$	
		Length (g)	
		Design	Actual
Length	Length of 60 lb kraft paper rounded up to the nearest half foot (6 inches)		
Compute official adjusted Length, L , using section 11		$L =$	
		Deductions	
Deductions		Minor	Major
Tools	Only authorized tools used		
Safety	No mishaps		
Other, explain			
Total deductions			

Notes:

C3: Construction

Item	Instruction	Time	
		Total	> 25:00 (min:sec)
Time	Give start command. Time ends when soil filled to line and empty bucket is in place		
		Deductions	
		Minor	Major
Backfill	<input type="checkbox"/> Level <input type="checkbox"/> Filled to fill line		
Tools	<input type="checkbox"/> Only authorized tools used		
Safety	<input type="checkbox"/> No mishaps		
Total deductions			

Notes:

C4: Loading

Team School:			
Item	Instruction	Scoring Guidelines	
Stage 1: Backfill Only	<ul style="list-style-type: none">Place clean poster board on floor in front of boxAt judge’s direction students remove front panel from box. Electric drills/screwdrivers may be used to remove fasteners.Once panels are completely removed start 1 min wait period.At end of 1 min make following checks:		
	<input type="checkbox"/> Swipe front wall front and sides with straight edge to check wall deflection	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail $D = 8$
	<input type="checkbox"/> Less than 30 cm ³ sand leaked from box onto floor	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail Major Ded
	<input type="checkbox"/> Catastrophic failure	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail Disqualified
Stage 2: Vertical Surcharge	<ul style="list-style-type: none">Bucket pre-weighed with 50 lbs of sand should be ready.At judge’s direction students add 50 lbs of sand to surcharge bucket. Students have one minute to complete loading.Once load is placed start 1 min wait period.At end of 1 min make following checks:		
	<input type="checkbox"/> Loading complete within 1 minute	<input type="checkbox"/> Yes	<input type="checkbox"/> No Minor Ded
	<input type="checkbox"/> Swipe wall front with straight edge to check wall deflection	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail $D = 6$
	<input type="checkbox"/> Less than 30 cm ³ sand leaked from box onto floor	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail Major Ded
	<input type="checkbox"/> Catastrophic failure	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail Disqualified
Stage 3: Horizontal Load	<ul style="list-style-type: none">Bucket pre-weighed with 20 lbs of sand should be ready.At judge’s direction students add 20 lbs of sand to horizontal loading bucket. Students have one minute to complete loading.At end of 1 min make following checks:		
	<input type="checkbox"/> Loading complete within 1 minute	<input type="checkbox"/> Yes	<input type="checkbox"/> No Minor Ded
	<input type="checkbox"/> Swipe wall front with straight edge to check wall deflection	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail $D=4$
	<input type="checkbox"/> Less than 30 cm ³ sand leaked from box onto floor	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail Major Ded
	<input type="checkbox"/> Catastrophic failure	<input type="checkbox"/> Pass	<input type="checkbox"/> Fail Disqualified

C5: Scoring

Adjusted mass, M , computed by

$$M = m_A + (m_D - m_A + 0.50)^2$$

$$Score = R + 15(60 - M) + 5(10 - L) - 10N_{min} - 40N_{maj} - 2T - 20D$$

Team School:			
Item	Score	Weight	Extended
Report score out of 50, R		1	
Reinforcement mass score, enter as $(60 - M)$		15	
Official length of 60 lb kraft paper, enter as $(10 - L)$		5	
Total # of minor deductions, N_{min}		-10	
Total # of major deductions, N_{maj}		-40	
Total time over limit rounded up to nearest whole minute, T		-2	
Deflection rating, D 8 = Deflection exceeded at Stage 1 6 = Deflection exceeded at Stage 2 4 = Deflection exceeded at Stage 3 0 = Deflection never exceeded		-20	
Catastrophic failure any stage disqualifies the team	DQ	Stage #	
		Final Score	

Notes:

Appendix D: Safety Appendix

This section is intended for each team to consider the competition steps and manage safety risk. Use rows as necessary.

Title	Work Task	Hazards	Controls

Notes:

- 1) Safety mishaps that result in bleeding will be classified as “major.”