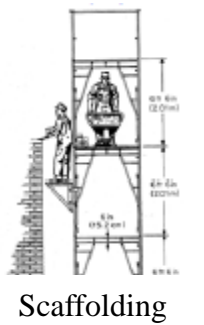


TEMPORARY STRUCTURES

****CONSTRUCTION LOADS****

- I believe Temporary Structure Design is truly the most important topic for construction engineers. I think this is the reason NCEES and the engineering community decided to make a module on the PE exam for Construction Engineering. Temporary structures are never really given much thought when designing or constructing projects. There has always been and continues to be limited standards on temporary construction. The construction is usually something just put up for erection of the structure that is being built. So quality and the cost of the temporary structures are always the very, very bare minimum to get the job done. This is the problem and the reason why more structures fail during construction than in service after completion; and many if not most of them occur as the result of the failure of “is the cause of more accidents than “temporary structures” that are used to provide support, protection or access during construction.



- Temporary structures are without foundation and after certain periods of time (usually less than 180 days) the structure is removed. Some examples of these structures can be concert stages, shoring during construction, formwork and associated falsework, etc.
- Construction Loads as defined by ASCE 37-02 are those loads imposed on a partially completed or temporary structure during and as a result of the construction process. Construction loads include, but are not limited to, materials, personnel, and equipment imposed on the temporary or permanent structure during the construction process.
- The standards that addresses this topic is ASCE 37-02 and ACI SP-4 . They are must have manuals during the exam. Go to my reference section to buy. ASCE is only a 44 page manual which provides the minimum design load requirements during construction for temporary structures. The SP-4 provides standards for formwork. The structural engineering section also covers design loads- Dead, Live, and construction loads. However, in that section it is not specific to Temporary Structures like this portion is.

****CONSTRUCTION LOADS****



- For Temporary Structures you still have to consider all the loads. The loads to consider as expressed in ASCE 37-02 are;
- 1). Final Loads
- a. D = Dead Loads, b. L = Live Loads
- **2). Construction Loads – This is the topic that you need to focus on – section 4 in ASCE 37-02
- a. Weight on Temporary structure
 - C_D = Construction Dead Load
 - b. Material Loads
 - C_{FML} = Fixed Material Load
 - C_{VML} = Variable Material Load
 - c. Construction procedure loads
 - C_P = Personnel and Equipment Loads
 - C_H = Horizontal Construction Load
 - C_F = Erection and fitting forces
 - C_R = Equipment Reactions
 - C_C = Lateral pressure of concrete
- 3). Lateral Earth Pressure
- a. C_{EH} = Lateral Earth Pressures
- 4). Environmental Loads
- a. W = Wind b. T = Thermal Loads c. S = Snow Loads d. E = Earthquake e. R = Rain f. I = Ice
- So we will further discuss in the next section only the * Construction Loads on the Temporary Structure;

****CONSTRUCTION LOADS****



→ Weight on Temporary structure

- C_D = Construction Dead Load – The dead load due to shoring, scaffolds and other construction related dead loads. These loads will be gone after the construction is completed.

→ Material Loads – Loads due to material during construction is divided into two groups, Ex. Weight of concrete placed in a form for the permanent structure is a material load. When the concrete gains sufficient strength so that the formwork is not required for its support, the concrete becomes a dead load.

- C_{FML} = Fixed Material Load – is the load from materials that is fixed in magnitude. During construction material have to be stockpiled in the structure that's been constructed. Load due to fuel and various other materials required during construction may be relatively fixed if they are replenished.

- C_{VML} = Variable Material Load – is the load from materials that varies in magnitude during the construction process. Steel, nuts and bolts may be stored, but once they are constructed it becomes part of the permanent dead load.

→ Construction procedure loads

- C_P = Personnel and Equipment Loads – is the load from personnel and Equipment. Construction workers working on the structure, concrete buggies, concrete pumping hoses, equipment for formwork and shoring, generators, gang boxes and compressors. There are some minimum loads in Table 1 C_P in ASCE 37-02.

- C_H = Horizontal Construction Load – Forces necessary for member stability are determined during analysis of the structure. Moving wheelbarrows, moving personnel generates lateral loads on the structure. Wind load is not considered in this item since wind load is considered separately. It is assumed moving person would exert 50 lbs lateral load on the structure.

- C_F = Erection and fitting forces – Forces caused by erection (alignment, fitting, bolting, bracing, guying, and so on) shall be considered.

- C_R = Equipment Reactions – The equipment reactions shall include the full weight of the equipment operating at its maximum rated load.

- C_C = Lateral pressure of concrete – Lateral Forces on formwork from placing concrete – This covers Form and Slipform Pressure, and shoring loads. I will address these formulas and problems in later sections.

****CONSTRUCTION LOADS****



- Application of Loads – Construction loads depend very much on the specific planning and processes of construction. This section includes rules for applying and combining the various loads, as well as traditional minimums for several common construction processes.
- Combined Loads – ASCE 37-02 provides some standard design construction loads.
- Working Surfaces. Table 2 provides Standard Uniformly Distributed Construction Loads for different standard construction jobs (ex. Light frame construction, Painting, caulking, Concrete finishing, etc)
- Reduction in Construction Loads – ASCE 37-02 provides some guidance on possible allowable Reduction in Construction Loads
1. Material Loads. No reduction is allowed for fixed or variable loads.
 2. Personnel and Equipment Loads. When justified by an analysis of the construction operations, members having an influence area of 400 sf or more may be designed for a reduced uniformly distributed personnel and equipment load determined by applying the following formula:
→ $C_p = L_o (.25 + 15/\sqrt{A_1})$ where C_p = reduced design uniformly distributed P&E load per sf
 L_o = is the unreduced uniformly distributed P&E per sf
 A_1 = is the influence area, sf
 3. Personnel and Equipment Loads on sloping Roofs
→ $R = 1.2 - .05F$ where: F = slope of the roof (in/ft)
 R = Reduction Factor ($.6 < R < 1.0$)
- Restriction of Loads – As per ASCE 37-02 the following working surfaces shall have their use and access restricted by posting of the permitted loads.
1. Scaffolds with working surfaces of 40 sf or less shall be rated for the number of individual personnel loads that they can support.
 2. Working surfaces designed for superimposed uniform loads of 25 psf or less shall be rated for both their superimposed uniform load capacity and the number and location of the individual personnel loads that they can support
 3. Working surfaces designed for loads less than what could reasonably be expected to be placed thereon shall be restricted to the design loads.

****CONSTRUCTION LOADS****



Question #1: While one person and a wheel of powered equipment is working on the 8in/1ft sloped roof of a house. What can you reduce the Personnel and Equipment Construction load to? (Need ASCE 37-02)

- a. 2500lbs
- b. 250 lbs
- c. 2000 lbs
- d. 1000 lbs

Answer #1: **c. 2000 lbs**

Step 1: Figure out what is the construction load.

→ Using Table 1 in ASCE 37-02

- each person = 250lb

- wheel of powered equipment = 2000lbs

construction load = 2500lbs

Step 2: Figure out the reduction factor as per ASCE 37-02.

→ Using paragraph 4.8.3.3 Personnel and equipment loads on sloping roofs. Use

$$R = 1.2 - .05F = 1.2 - .05(8\text{in}/1\text{ft}) = 1.2 - .4 = .8$$

Step 3: Calculate the allowable design construction load.

→ Allowable construction load = 2500lbs * .8 = **2000 lbs**