

Group #07

Bridge-00

18g, 1700N



Alex Miles

u5568175

16.7%

Arlene Mendoza

u5589650

16.7%

Itsuki Nishida

u5578430

16.7%

Paul Apelt

u5568225

16.7%

Stephen Lonergan

u5349877

16.7%

Thomas Hale

u5568225

16.7%

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1 Design

1.1 Assumptions

During the design process, the following assumptions have been made (Hibbeler and Yap, p. 264):

1. All loadings are applied at the joint,
2. Weight of the members neglected,
3. Joints are smooth (friction-less) pins,
4. Each member has no more than two joints.

Final bridge design can be seen in Figures 1 and 2.

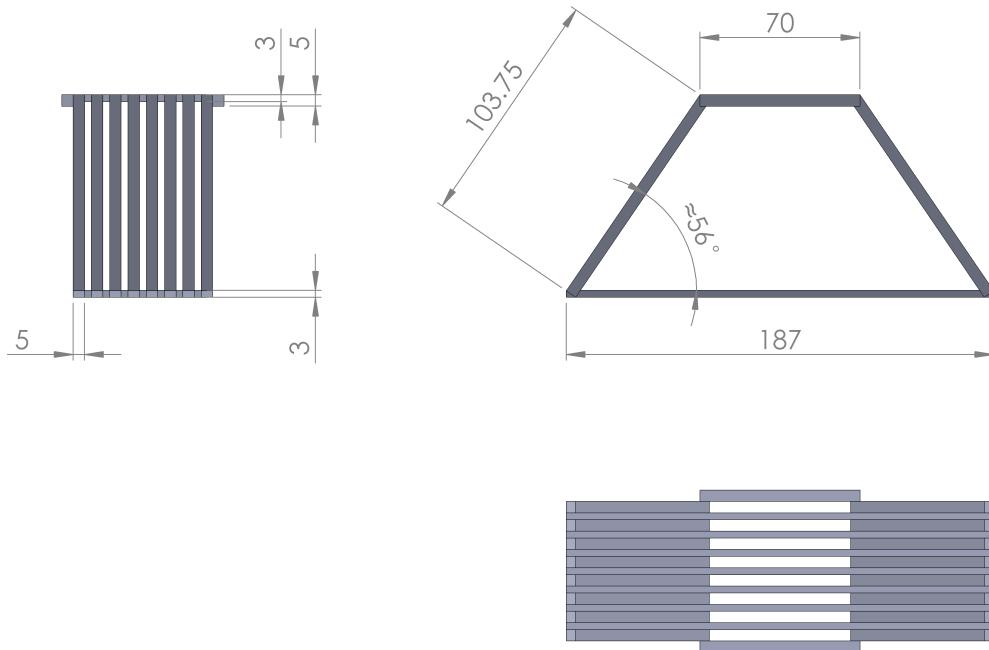


Figure 1: Dimensioned drawing.



Figure 2: 3D-Projection.

1.2 Methods

2 Analysis

Due to the unconventional design, to ease the calculations during the analysis, it was assumed that the load is equally distributed between eight trapezium-shaped trusses. Thus, a single trapezium truss was analyzed, and then extended to approximate the entire bridge. Internal forces, nodes and members are labelled as per Figure 3. As the truss is symmetrical, only two nodes needed to be analyzed. For a load of 100N divided equally between nodes A

Figure 3: Trapezium truss.

and B, force equilibrium for nodes A and C are described in equation blocks 1 and 2 respectively.

$$F_s \sin 56 = 50N, \quad (1a)$$

$$F_s \cos 56 = F_t. \quad (1b)$$

$$F_s \sin 56 = F_r, \quad (2a)$$

$$F_s \cos 56 = F_b. \quad (2b)$$

The results of solving the above equations are presented in Table 1. Maximum

Table 1: Member loads.

70 3x3 mm (top)	33.7 N (c)
103.75 5x5 mm (side)	60.3 N (c)
187 3x3 mm (bottom)	33.7 N (t)

loads for each member were calculated using the values given in the Assignment sheet. Modulus of elasticity $E = 3\text{GN/m}^2$, standard deviation $\sigma = +2.4/-2.1\text{MN/m}^2$. Tensile strength $\sigma_t = 20\text{GN/m}^2$, standard deviation $\sigma = +3.6/-3.4\text{MN/m}^2$. Compressive strength $\sigma_t = 12\text{GN/m}^2$, standard deviation $\sigma = +2.1/-2.8\text{MN/m}^2$. To calculate maximum load from strength values, equation 3 was used. The results are presented in Table 2.

$$\sigma = \frac{P}{A} \quad (3)$$

Table 2: Maximum member loads.

	average	-1σ
3x3 mm (c)	108 N	82.8 N
3x3 mm (t)	180 N	149.4 N
5x5 mm (c)	300 N	230 N

3 Results

References

R. C. Hibbeler and Kai Benh Yap. *Mechanics for Engineers: Statics*. Pearson.