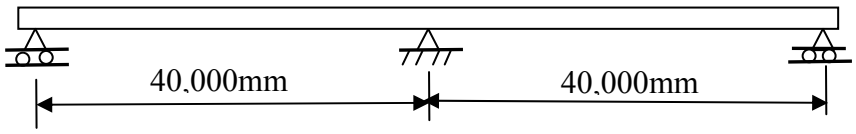
Introduction to Bridge Engineering CE-5145
Final Exam – Take Home Exam

Due Date July 13, 2009 – No Exceptions
No Collective Effort Allowed

Max Marks (100)

Problem 1: (30 marks)
Design a Laminated Elastomeric Bearing Pad for a Bridge with the following data:
Design the Bearing showing Detailed Calculations and make a neat sketch of your final design.

Data:



Bridge Elevation

l = Expandable Span Length = 40,000 mm
R_{DL} = Dead Load Reaction on Girder = 690 KN
R_{LL} = Live Load Reaction on Girder (without Impact) = 220 KN
ΔT = Max Temperature Change = 21 C^o
Δ_{PT} = Girder Shortening Due to Postensioning = 21 mm
Δ_{SH} = Girder Shortening Due to Concrete Shrinkage = 2 mm
γ = Load Factor for Uniform Temperature Loading = 1.2
θ_{smax} = Bearing Max Rotation Capacity Limit = 0.025 radians
Use 60 Durometer Rating Elastomeric Material with the Following Data:

G = Shear Modulus Range for Low and High = 0.9 Mpa → 1.38 Mpa
The Steel Laminations are made material with the following Data:
Fy = Yield Stress of Steel = 350 Mpa
Notes: *Steps for determining rotations imposed on the bearing due to dead loads and live loads may be omitted.*
The Design Constraints are such that the Bearing Width is fixed as:
W = Bearing Width = 460 mm

Problem 2: (30 marks)
Perform the necessary stability checks on the abutment Shown in the Figure using LRFD criteria for stability in sliding, restrictions on eccentricity and bearing pressures. Use Equivalent soil loading for the effect of live load induced lateral pressure on the wall. Clearly list all the assumptions you make and draw neat sketches to explain your calculations.
Data:

Unit weight of soil = γ_s = 1922 kg/m^3
Unit weight of concrete = γ_c = 2400 Kg/ m^3
Superstructure Dead Load = DL = 270 KNs/m
Live Load From Superstructure = LL = 65 KNs/m
Coefficient of Lateral Earth Pressure = Ka = 0.30
Angle of Friction between Wall and Foundation = δ = 33^0 Degrees
Max Ultimate Bearing Pressure = q_{ult} = 1050 Kpa
Braking Force at Bearing Location = BR = 5 KN/m
Longitudinal Load at Bearing Location = PL = 10% of Live Load = 6.5 KNs/m
(Includes Creep + Shrinkage + Temperature)

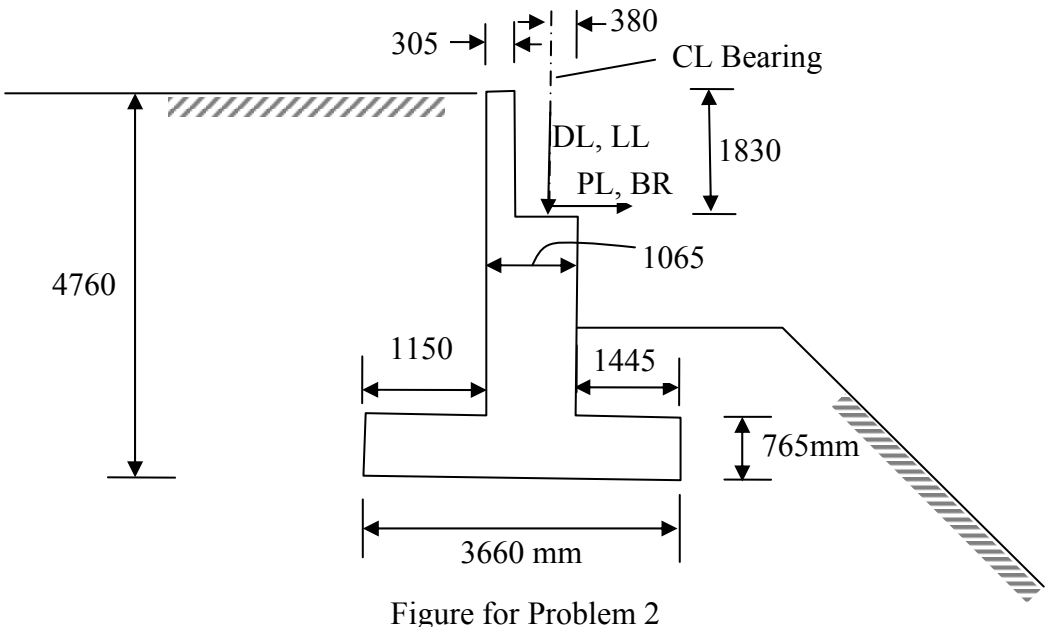


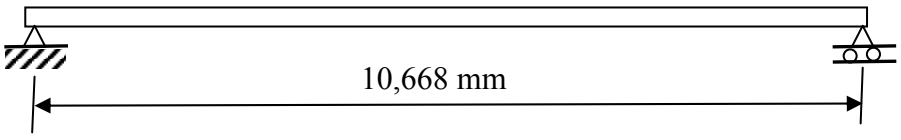
Figure for Problem 2

Problem 3: (40 Marks)

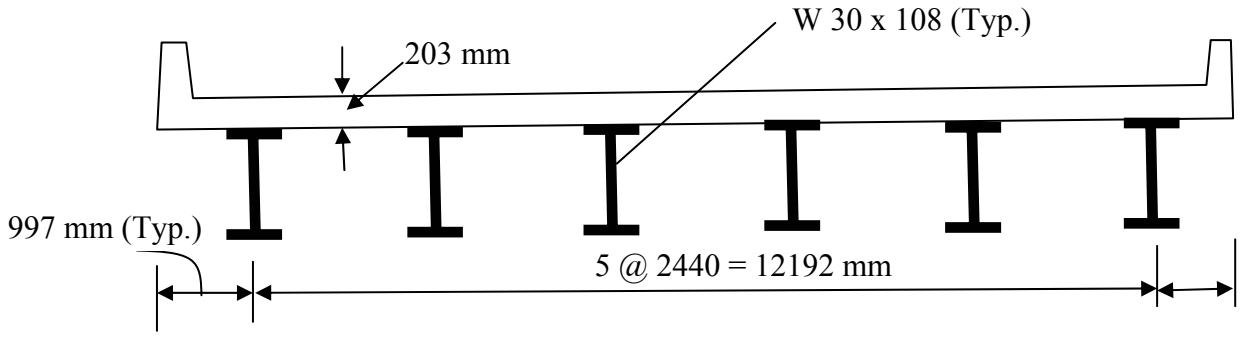
For the Bridge shown below carry out analysis using the SAP2000 Bridge Information Modeler:

i.) Carry out a moving load analysis for truck loading of HL-93 for the case of one lane loaded and two lanes loaded.
ii.) Plot the envelopes for bending moment and shear force for both cases for the entire bridge
iii.) Plot the envelopes for bending moment and shear force for both cases for the interior eab and exterior beam
iv.) From the above information, determine the moment and shear distribution factors for the interior beam and the exterior beam.

This essentially is Example 6.2 from the textbook by Barker and Puckett, but is to be solved using the SAP2000 Bridge Information Modeler. Assume that the traffic barrier plays no structural role.



ELEVATION



X-SECTION