Homework # 6

Arch151 – STATICS

Spring 2014-15

Topics: Loads and load paths

Textbook: Class notes

Problems: You are required to the below problems:

(Problem-1) (20 %)
The term ***live load*** is used to describe non-permanent load within a building – that is, those loads due to people and furniture. If a university classroom is 12 metres long and 10 metres wide and is designed to accommodate up to 60 students, calculate the live load in the classroom when full. (Note that you will have to make an assessment of the weight of an individual student, desk and chair.) Compare your answer with the British Standard value of live load (3.0 kN/m2) for classrooms.

(Problem-2) (20 %)
An international hotel chain plans to upgrade its hotel in a particular glamorous and exotic location by installing a rooftop swimming pool on top of its existing high-rise bedroom block. The swimming pool will be 25 metres long and 10 metres wide and will vary uniformly in depth from 1 metre to 2 metres. Calculate the volume of water in the pool. If the unit weight of water is 10 kN/m3, calculate the weight of water in the pool, in tonnes. If a small modern car weighs 1 tonne, calculate the number of cars that would be equivalent, in weight, to the water in the proposed swimming pool.

(Problem-3) (60 %)
For the structure shown in figure 1, the floor deck is a 25cms solid concrete slab spanning one way on the three steel beams shown. If the superimposed dead loads on the deck is 2.5kPa and the live load is 2.0kPa; it is required to:

a) Calculate the uniform load acting on each of the steel beam and find the reactions from these steel beams on the steel girder. Assume the self weight of the steel beam as 1 kN/m.

b) From the reactions of the steel beams in Part (a) above, find the reaction from this the steel girder on the steel column on either edge. Assume the self weight of the steel girder as 2 kN/m.

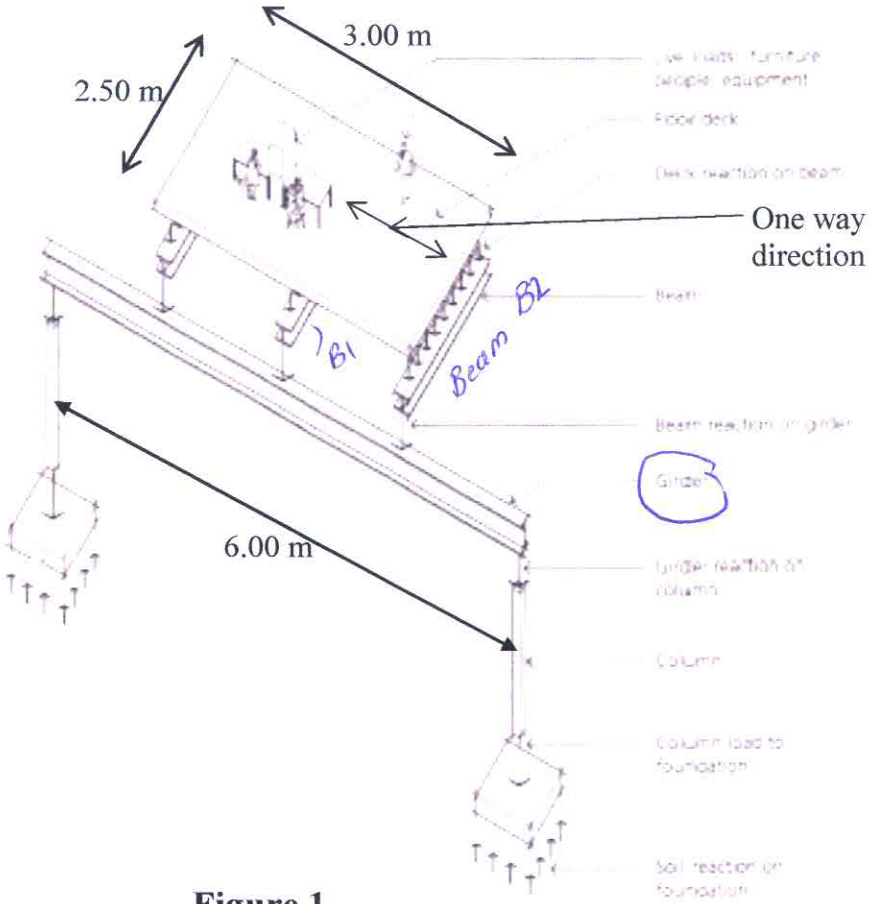

Figure 1

Given: Monday April 27, 2015

Due: Wednesday, May 06, 2015

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Problem ①

Classroom for → 60 Students

12m × 10m

Student wt: assume 70 kg/student.

Chair + desk: assume ≈ 15 kg/student.

Σ = 85 kg/student

L.L

Total ↑ mass in Class = 85 × 60 = 5100 kg.

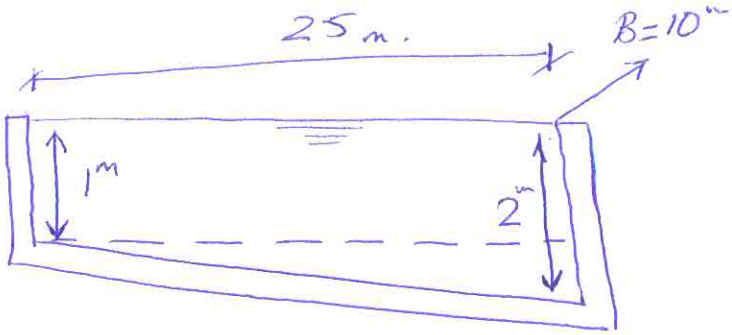
Total L.L weight in class = 5100 × 9.81 = 50,031 N

Average Smeared L.L/m² = $\frac{50031}{12 \times 10_m}$ = 417 N/m²

= 0.417 kPa.

Compared to 3.0 kN/m² from British Standard we can see how conservative L.L is usually assumed.

Problem (2)



swimming pool

Volume of water in the pool

$= 1 \times 25 \times 10 + \frac{1 \times 25 \times 10}{2}$

$= 375\ m^3$ of water

Weight of $375\ m^3$ of water = Volume x unit wt of water

$= 375 \times 10\ kN/m^3$

Weight = 3750 kN

Assume $\boxed{1\ Ton = 10_{kN}}$ Weight $= \frac{3750}{10} = 375$ tonnes

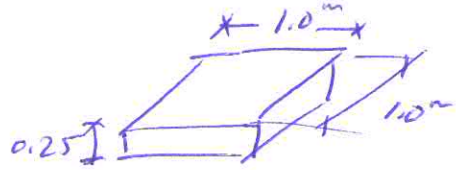
no of cars equivalent to water in pool

$= \frac{375}{1\ (weight/car)} = 375$ cars.

Could assume
1 ton = 9.81 kN
to reach ~~that~~
no of cars can be
up to 382 cars

Problem (3)

(i) Load on Slab /m^2 = self wt of Slab
+
Superimposed DL (Finishes...)
+
Live load.



Slwt of Slab = $(1 \times 1 \times 0.25) \times 24.5$

$V \times \gamma_{R.C}$

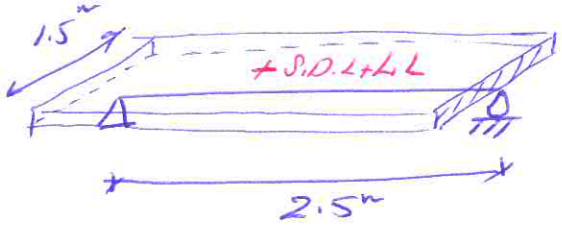
$= 6.125$ kPa.

Superimposed D.L = 2.5 kPa

Total D.L = 8.625 kPa.

L.L = 2.0 kPa (Given).

(ii) Steel beam B1



Load width = $\frac{3}{2} = 1.5$m

Uniform Load /m' on B1

load width

D.L = Slab D.L = $8.625 \times 1.5 = 12.94$ kN/m'

Slwt of Steel beam = 1.0 kN/m' given.

13.94 kN/m'

L.L = 2.0×1.5 = 3 kN/m'

Uniform Load/m' on B2

Load width of Slab on B2 = 0.75m

∴ DL = Slab D.L = $8.625 \times 0.75 = 6.46$

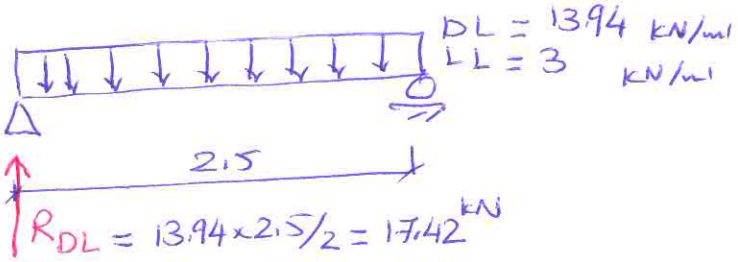
Beam Slwt = 1.0

$\Sigma = 7.46$ kN/m'

$L.L = 2 \times 0.75 = 1.5$ KN/m

(iii) Reactions of Beam B1 & B2 on Main Girder.

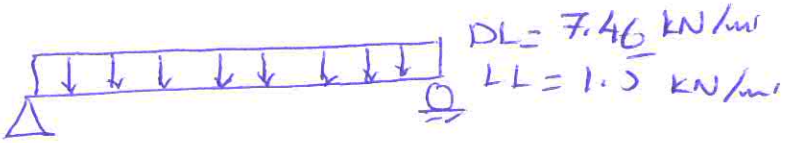
Beam B1



$R_{DL} = 13.94 \times 2.5/2 = 17.42$ KN

$R_{LL} = 3 \times 2.5/2 = 3.75$ KN

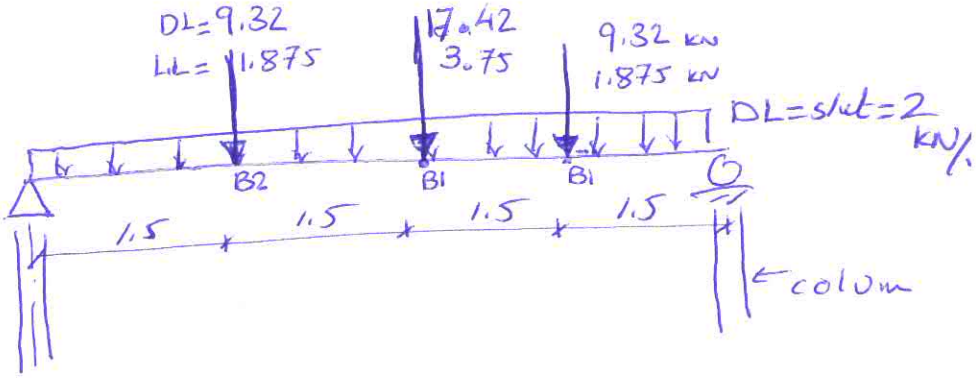
Beam B2



$R_{DL} = 7.46 \times 2.5/2 = 9.32$ KN

$R_{LL} = 1.5 \times 2.5/2 = 1.875$ KN

Main Girder Loads Diagram



Reaction on Column at either end

$$R_{column-DL} = \frac{(9.32 \times 2 + 17.42)}{2} + 2 \times \frac{6}{2} = 24.03 \text{ KN}$$

$$R_{column-LL} = \frac{(1.875 \times 2 + 3.75)}{2} = 3.75 \text{ KN}$$