UNIVERSITI SAINS MALAYSIA

First Semester Examination
2012/2013 Academic Session

January 2013

EAS 665/4 –Bridge Engineering

Duration : 3 hours

Please check that this examination paper consists of **SIX (6)** pages of printed material before you begin the examination.

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.

All questions must be answered in English.

Each question **MUST BE** answered on a new page.

1. (a) It is well known that arches are among the oldest forms of structural support for civil engineering support including bridges. With the aid of sketches, discuss the mechanism of load transfer and the importance of arch in bridge structures.

[10 marks]

(b) Briefly explain the advantage and disadvantage of following type of bridges.

i. Suspension bridge
ii. Cantilever bridge
iii. Arch bridge
iv. Girder bridge
v. Moveable bridge

[10 marks]

2. It is important to understand the principles and processes of bridge construction even though bridges vary widely in material and design, there are many components that are common to all bridges. Discuss in detail these basic components which classified as a bridge superstructure and substructure.

[20 marks]

3. (a) Find the HA loading (HA-UDL and HA-KEL) and bending moment for a bridge deck with a carriageway of 15.0m wide and the loaded length of 39m (centre to centre of bearings for a simply supported single span).

HA Lane Factor

Loaded Length,L (m)	First Lane Factor (β_1)	Second Lane Factor (β_1)	Third Lane Factor (β_1)	Fourth & Subsequent Lane Factor (β_1)
0< L ≤ 20	α_1	α_1	0.6	$0.6\alpha_1$
20< L ≤ 40	α_2	α_2	0.6	$0.6\alpha_2$
40< L ≤ 50	1.0	1.0	0.6	

$\alpha_1 = 0.274\ b_L$ and cannot exceed 1.0

$\alpha_2 = 0.0137\ [b_L\ (40\text{-}L) + 3.65\ (L\text{-}20)]$; b_L is the national lane width (m).

(b) Calculate the bending moment and reactions at the abutments when the deck is loaded by HB alone (45 units) at notional lane 1 as shown in Figure 1.

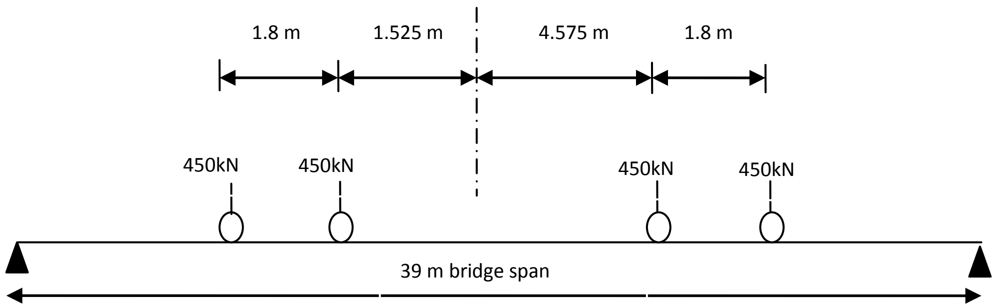

Figure 1: Elevation of HB Loading

[20 marks]

4. (a) Explain briefly **FIVE (5)** general rules for choosing a grillage mesh based on deck and load characteristics.

[5 marks]

(b) A solid slab highway bridge, with cross-section as shown in Figure 2, has a right (total width) of 12m, a slab thickness of 225mm and skew of 0°. The specified highway loading is HA and 45 units of HB. The nominal superimposed dead load is equivalent to a uniformly distributed load of 2.5 kN/m^2, and the nominal parapet loading is 3.5 kN/m along each free edge. Calculate the total ULS loads in edge girder and inner girder (assume dead load as 50kN). Calculate the moments for HA loading for edge and inner girder and determine the maximum moment of HB loading with the following data :

Load	γf_3
Dead	1.15
Surfacing	1.75
Parapet	1.15
HA (alone)	1.50
HB	1.30

γf_3 partial safety factors applied to load

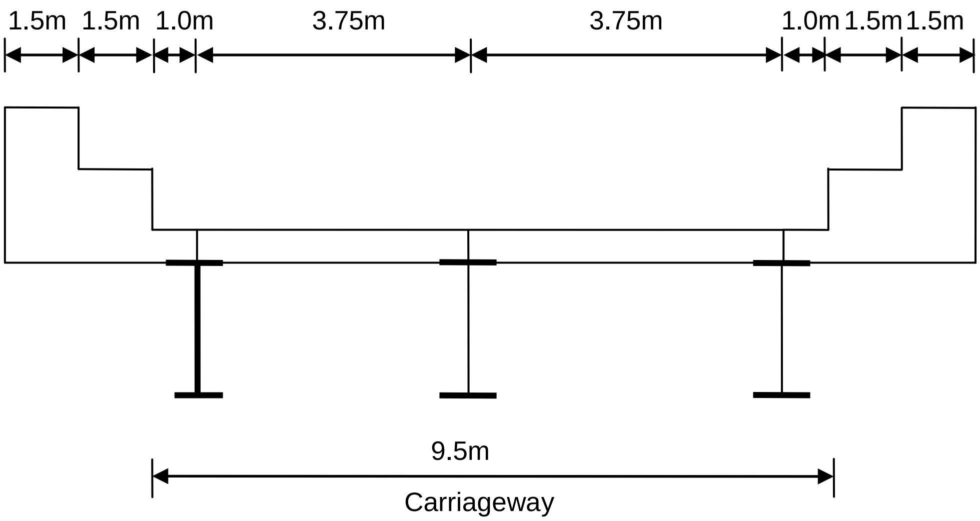

Figure 2 : Cross-Section of Carriageway

[15 marks]

5. (a) Describe **THREE (3)** types of bridge deck other than timber deck and discuss briefly the disadvantages of timber bridge deck as bridge structures

[5 marks]

(b) Explain the function of having diaphragms in bridges. Use appropriate sketches to aid your explanation

[5 marks]

(c) A bridge structure is having daily and seasonal fluctuations in shade air temperature cause by solar radiation, re-radiation and other factors. This can cause changes in overall temperature of the bridge deck. Calculate the temperature differences for concrete bridge deck on plate girder according to BS5400.

[10 marks]

i. Minimum shade air temperature = -20ºC
ii. Maximum shade air temperature = 35ºC
iii. Height above sea level = 200m
iv. Group 3 in Figure 1
v. Assume 30ºC = effective bridge temperature at the time of the structure is attached.
vi. Structural depth = 0.3m
vii. Bridge span = 20m

6. (a) Describe and explain **FIVE (5)** types of bearings. Use appropriate sketches to aid your explanation.

[10 marks]

(b) A reinforced bridge pier shown in Figure 3 is subjected to vertical and horizontal design load at ultimate limit state. Failure of bridge pier can be disastrous and may lead to total collapse. Design the reinforcement for the pier and use appropriate sketches to aid your explanation.

[10 marks]

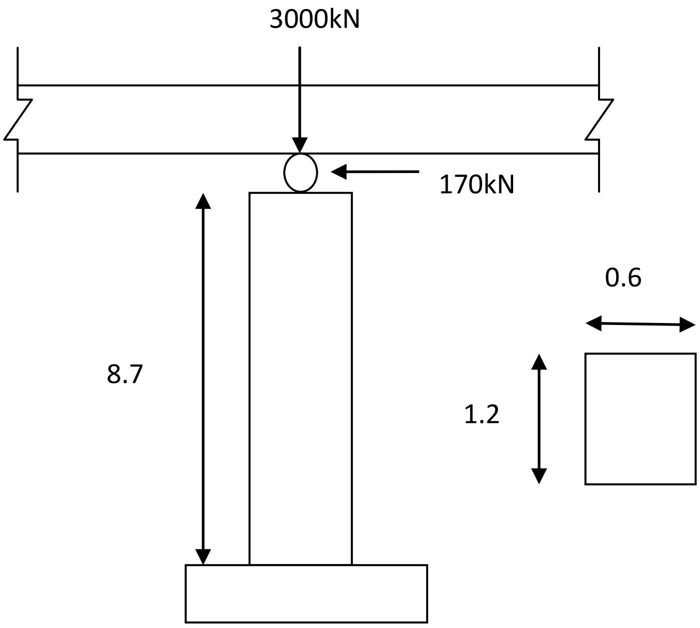

Figure 3

Assume:

concrete strength = 35 N/mm^2

concrete cover = 40 mm

steel reinforcement = 460 N/mm^2

effective height = actual height

minimum eccentricity = 0.05h for the vertical load

concrete cover = 40 mm with 40 mm bars in each face so d/h = 540/600 = 0.9

using the design chart provided

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