First Semester Examination
2017/2018 Academic Session

January 2018

EAS665 – Bridge Engineering

Duration : 2 hours

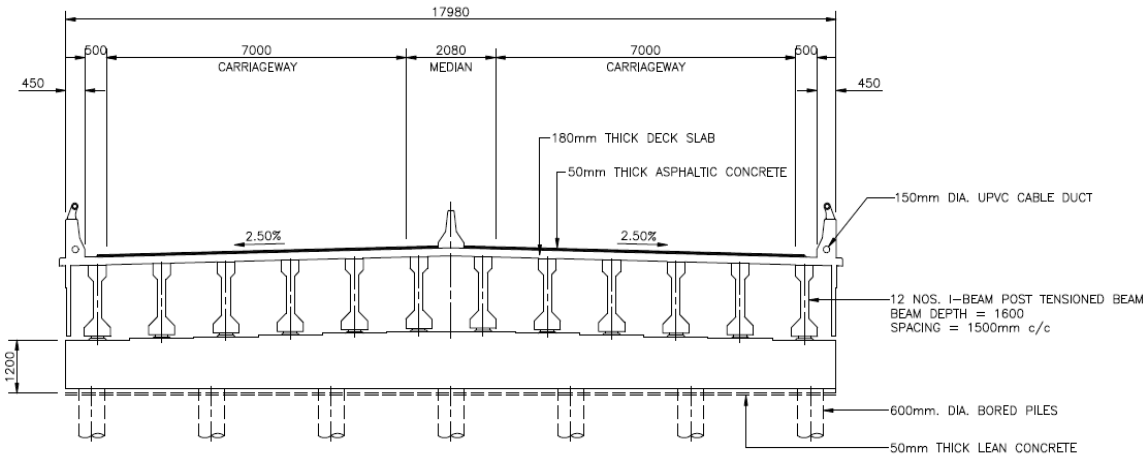
Please check that this examination paper consists of SEVEN (7) pages of printed material before you begin the examination.

Instructions: Answer **FIVE (5)** questions.

All questions must be answered in English.

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

1. A dual-carriageway of a bridge deck as shown in **Figure 1** is to be analysed for design purpose. The design data is given in Table 1 (a), (b) and (c). Evaluate the maximum shear force acting on each abutment due to the combination of HA and HB load type. The position of leading axle of the HB vehicle is at 18.30 m from the left end abutment. Use the HB vehicle with the 6.0 m inner axle spacing.



A bridge deck with the post-tensioned I-beam type

Figure 1

Table 1(a)

Span	34.0 m
Skew	0^0
Width	17.98 m
Live loads	HA loading (UDL = $336\left(\frac{1}{L}\right)^{0.67}$) HB loading (30 units) (use inner axle spacing of 6.0 m)

Table 1(b)

Carriageway width, b_L (m)	No. of notional lane
$5.00 \leq b_L \leq 7.50$	2
$7.50 \leq b_L \leq 10.95$	3
$10.95 \leq b_L \leq 14.60$	4
$14.60 \leq b_L \leq 18.25$	5
$18.25 \leq b_L \leq 21.90$	6
Lane no.	**Lane factor**
1	$\beta_1 = \alpha_2 = 0.0137[b_L(40 - L) + 3.65(L - 20)]$
2	$\beta_1 = \alpha_2 = 0.0137[b_L(40 - L) + 3.65(L - 20)]$
3	0.6
4 and above	$0.6\alpha_2$

Table 1(c)

1) HB vehicle within one notional lane

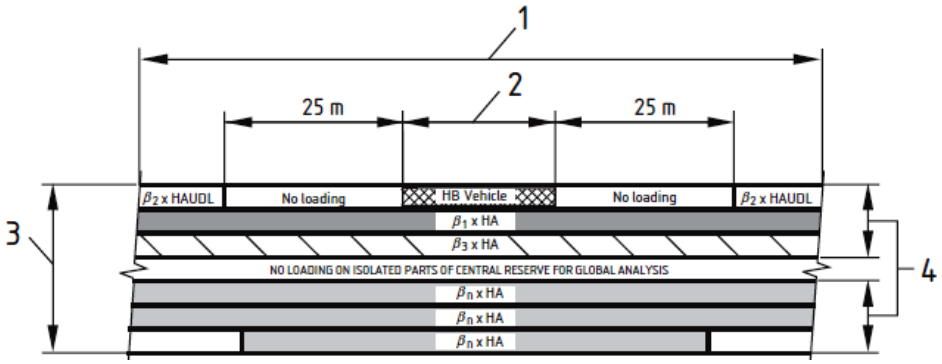


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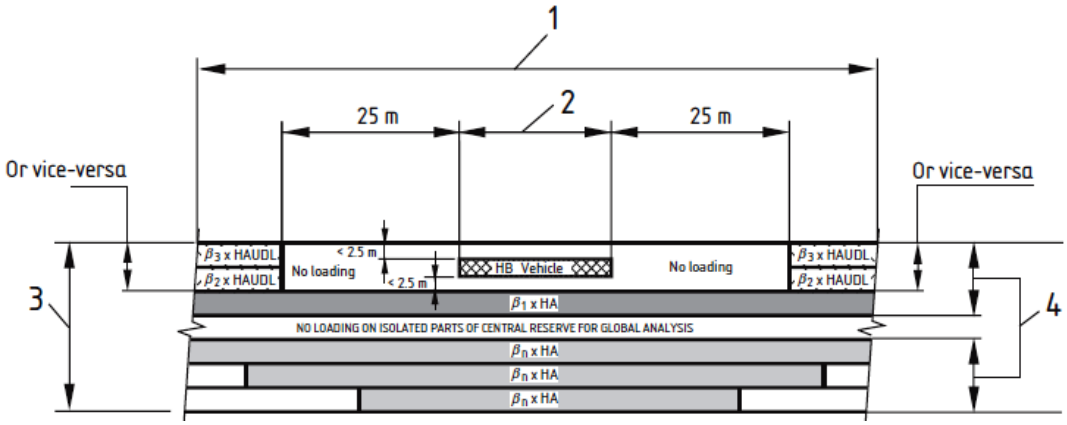
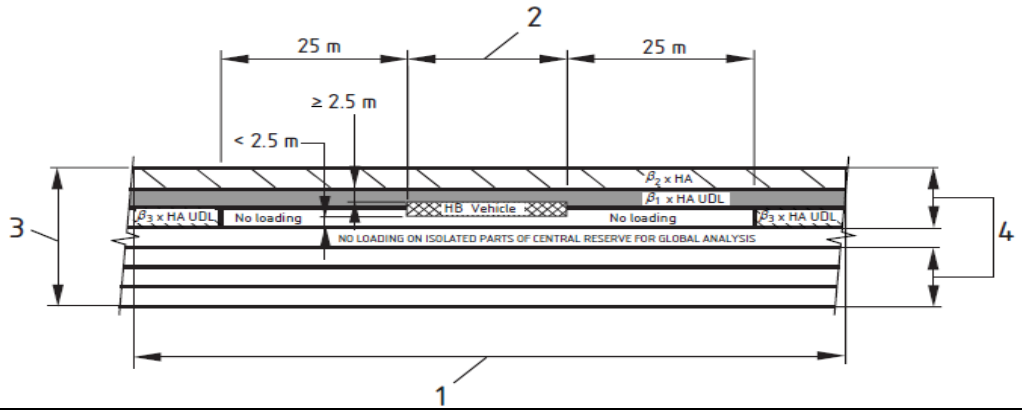
Table 1(c) (continued)

2) HB vehicle straddling two notional lanes

(a)



(b)



Key

1 Loaded length for intensity of HA UDl in lane containing HB vehicle
2 Overall vehicle length for axle spacing having most severe effect
3 Lane loadings are interchangeable for most severe effect
4 Notional lanes in each carriageway

NOTE 1 See **6.4.1.1** for the value of the HA lane factor (β) to be taken for each lane.
NOTE 2 The overall length and width of the HB vehicle shall be as specified in **6.3.1**.
NOTE 3 Unless otherwise stated, type HA loading includes both uniformly distributed loading (UDL) and knife edge loading (KEL).
NOTE 4 See **6.4.1** for loaded length to be taken in each lane.

[20 marks]

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2. (a) Choosing the best site for a bridge is as important as the characteristics of the bridge itself. Poor site or location and the structure of the bridge that is the wrong size can cause a bridge to fail and lead to increase maintenance costs. Discuss the necessary protocol of preliminary engineering involving preparation for site investigation, site work, site survey and geotechnical investigation for selecting the best site of a bridge.

[10 marks]

(b) Basically, the purpose of bridge deck joints is to protect the interior edges of concrete decks from vehicle loads, seal the joint openings, and accommodate movements resulting from temperature changes, creep and shrinkage of concrete structures. With the aid of sketch, describe several types of joints available for use on concrete bridge decks.

[10 marks]

3. Bearing is designed as one of critical element within overall bridge system. The bearing types have been developed primarily to provide efficient and economical ways to accommodate various levels of load and movement. In the event of dimensional changes and deformation of superstructure or substructure i.e. concrete material due to short-term and long-term deformation, the bearing should be able to accommodate these movements. With the aid of illustration, discuss **FIVE (5)** types of bearing which are normally used for concrete bridges including the advantages and disadvantages of each one.

[20 marks]

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

[5 marks]

(b) Construct using grillage analogy, the layout and load distribution of a simply supported non-skew reinforced concrete bridge experiencing:

(i) Axle A of HB Load as per **Figure 2** and **Figure 3**
Proposed Bridge Data
Span:20 meter
Width:14 meter
Beam:Seven precast rectangular beams
Beam Section:300 mm (width) x 1550 mm (Depth)
Slab thickness:200 mm

[15 marks]

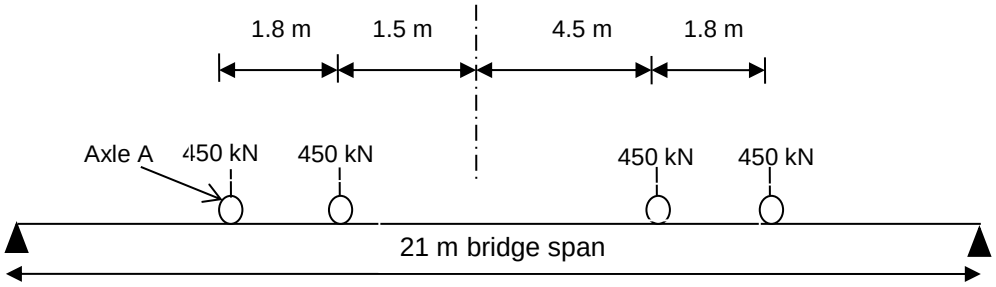

Figure 2 : Elevation of HB Loading

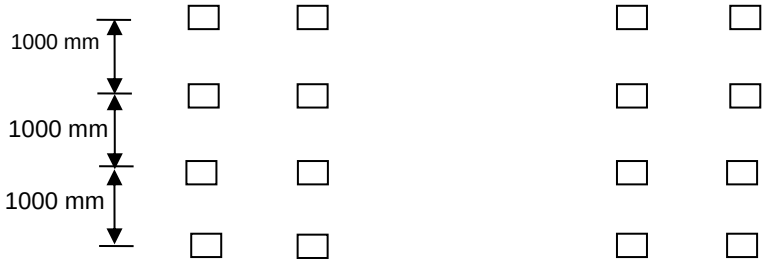

Figure 3 : Plan View of HB Loading

5. (a) With the aid of sketches, discuss the mechanics of a fixed and free abutment.

[5 marks]

(b) A seat-type reinforced concrete abutment has been selected for a single span bridge project. The proposed abutment is supported by five vertical piles and four raked piles as shown in **Figure 4**. The forces acting on the abutment are shown in **Table 2**. If the pile working capacity is set to be 700 kN, evaluate the proposed pile arrangement. Take positive moment as acting in clockwise direction.

[15 marks]

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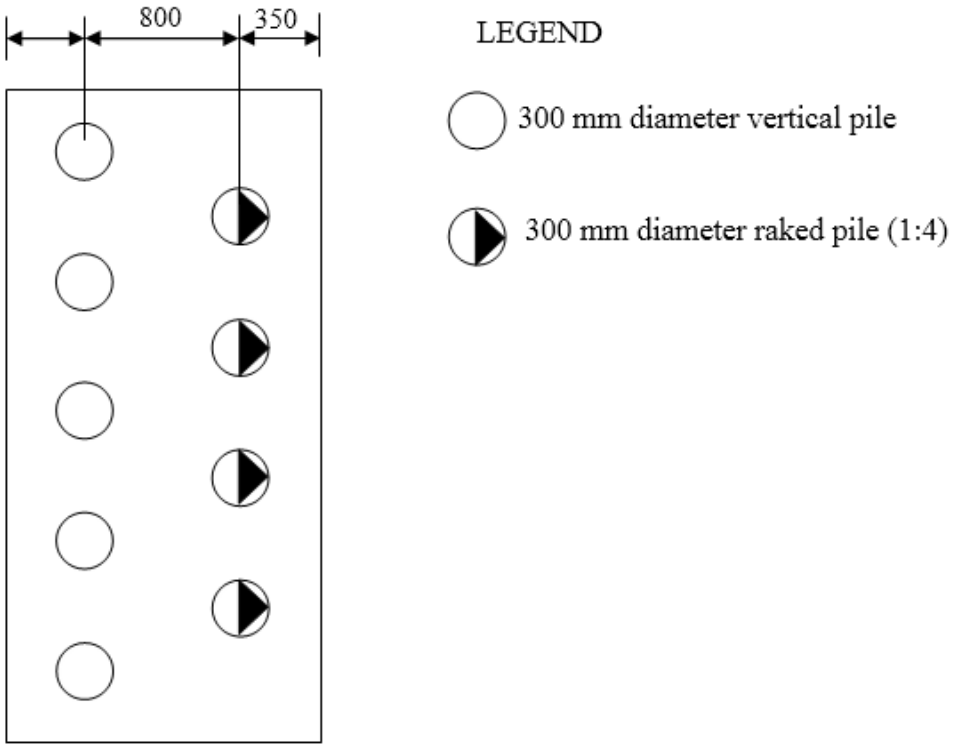

Figure 4: Pile arrangement for abutment (all dimensions in mm)

Table 2: Forces acting on abutment

Item	Force (kN)	Lever Arm (m)
Surcharge (active)	70	0.9
Surcharge (approach slab)	40	0.9
Soil (active)	100	0.6
Wind	20	1.1
Traction	300	1.1
Temperature	50	1.1
Shrinkage and Creep	80	1.1
Dead Load	1200	-0.15
Abnormal Load	1300	-0.15
Curtain Wall	10	0.3
Abutment (seating)	300	0.03
Ballast Wall	60	-0.5
Approach Slab	70	-0.6
Wing Wall	20	-1.3

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