UNIVERSITI SAINS MALAYSIA

1st Semester Examination

Academic Session 2010/2011

November 2010

EAS 665/4 – Bridge Engineering

Duration : 3 hours

Please check that this examination paper consists of…….. printed pages before you begin the examination.

[Instructions: This paper contains ____( )____ questions. Answer _____( )_____ questions only.

You must answer the questions in English.

All questions **MUST BE** answered on a new page.

1. a) There are several aspects are required to be investigated prior to design and build the major bridges. List out and briefly explain all the possible aspects of investigation are required for major bridges.

[10 Marks]

b) In general, the selection of bearing to be used depend on vertical load, horizontal movement and rotation requirements. Briefly describe the factors to be considered when selecting a bearing for bridges.

[10 Marks]

2. A composite bridge deck of 25 m span is comprised of prestressed concrete beam (pretensioned) and concrete slab. The simply supported prestressed beam is located at 1 m centre to centre on top of abutment with a 225 mm thick of precast concrete slab with the characteristic strengths of 50 MPa and 30 MPa, respectively. The position of tendon at the quarter span and at both supports of the beam are shown in Figure 1 (a) and (b). After taking all losses, the total tendon force is 3500 kN. The shear forces and moments of beam at the quarter span and support are given in Table 1. Design the reinforcement for both vertical and interface shear at quarter span. Assume and arrange the position of tendons geometrically.

Table 1

Load	**Support**		**Quarter Span**	
	Shear force(kN)	**Moment (kNm)**	**Shear Force (kN)**	**Moment (kNm)**
Selfweight	165	0	85	770
Parapet	27	0	15	140
Surfacing	30	0	18	145
HB + Associated HA	340	0	200	1330

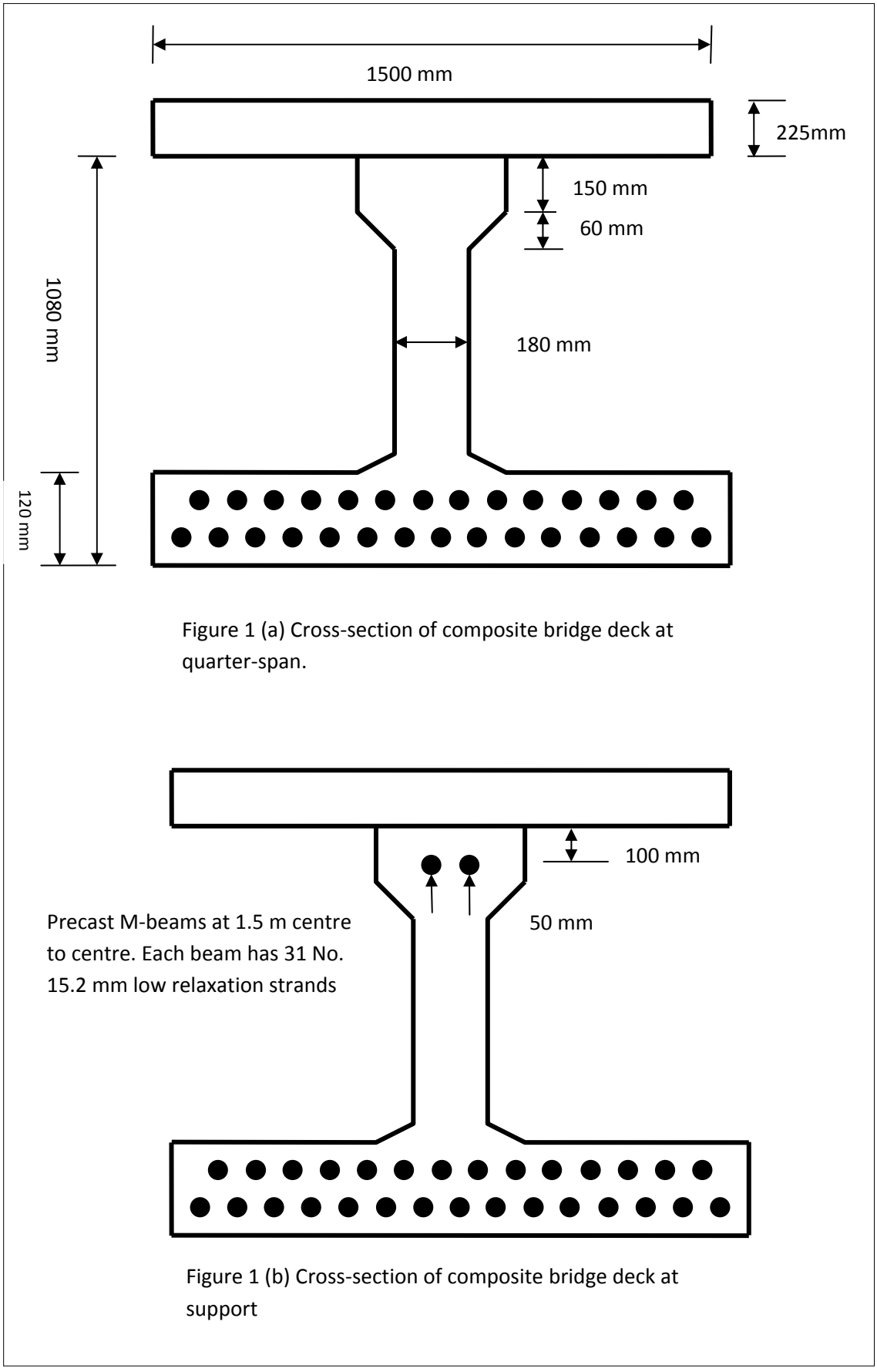

Figure 1 (a) Cross-section of composite bridge deck at quarter-span.

Figure 1 (b) Cross-section of composite bridge deck at support

Figure 1

[20 Marks]

3. Abutments of fixed and free end cantilever as shown in Figure 2 (a) and (b) are required to carry HA and 45 units of HB loading with the deck span of 20 m. Ground investigation report has shown suitable founding strata about 9.5 m below the proposed road level. The founding strata is cohesionless soil having an angle of shearing resistance (φ) = 30^0 and bearing capacity of 400 kN/m^2. The backfill material has an effective angle of internal friction (ϕ) =350 and density (γ) = 19 kN/m^3. The deck consists of 11No. I-beam prestressed concrete beams and concrete slab deck.

Table 2 : Loading From the Deck

	Critical Reaction under One Beam		**Total Reaction on Each Abutment**	
	Nominal Reaction(kN)	**Ultimate Reaction(kN)**	**Nominal Reaction(kN)**	**Ultimate Reaction(kN)**
Concrete deck	180	230	1900	2400
Surfacing	30	60	320	600
HA udl + kel	160	265	1140	1880
45 units HB	350	500	1940	2770

i. Calculate nominal loading on the abutment and ultimate thermal movement in the deck.

ii. Calculate total horizontal load on each abutment when the deck expands or contracts.

iii. Calculate the critical moments and shear in free abutment.

[20 Marks]

4. a) Define HA and HB loading with respect to highway bridge live loads.

[5 marks]

b) Define permanent and superimposed dead loads for bridge loading.

[5 marks]

c) Find the HA loading and bending moment for a bridge deck with a carriageway of 7m wide and the deck span of 39 m (centre to centre of bearings for a simply supported single span) and the number of the notional lanes are **TWO (2)**.

Table 3 : 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)**
$0< L \leq 20$	α_1	α_1	0.6	$0.6\alpha_1$
$20< L \leq 40$	α_2	α_2	0.6	$0.6\alpha_2$
$40< L \leq 50$	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).

[10 marks]

6. a) Explain briefly **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 (a) and (b)

ii. Critical Knife Edge Load (KEL)

Sketch all critical sections.

Proposed Bridge Data

Span	:	21 meter
Width	:	14 meter
Beam	:	Seven precast rectangular beams at 2 meter spacing
Beam Section	:	300 mm (width) x 1550 mm (Depth)
Slab thickness	:	200 mm
Diaphragm	:	200 mm (width) x 1500 mm (Depth) located at both abutments and at midspan.

[15 marks]

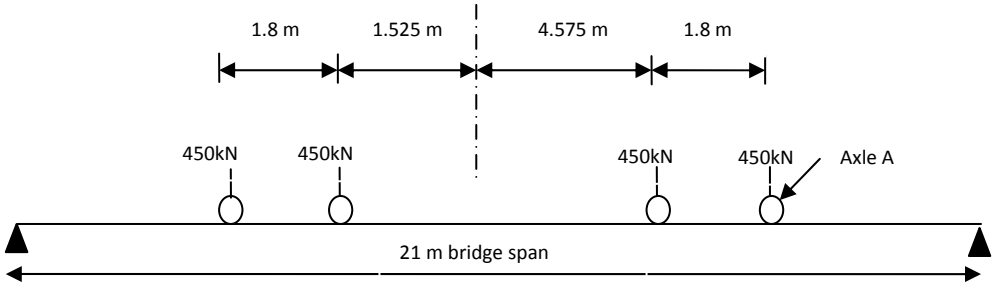

Figure 2 (a): Elevation of HB Loading

Figure 2 (b): Plan View of HB Loading

Figure 2

oooOOOooo