FINAL EXAMINATION
SEMESTER I, SESSION 2012/2013

COURSE CODE : SAB 3353/ SAM 3313/ SAA 3243
COURSE : REINFORCED CONCRETE DESIGN I
PROGRAMME : SAW
DURATION : 3 HOURS
DATE : JANUARY, 2013

INSTRUCTION TO CANDIDATES:
1. ANSWERS ALL QUESTIONS.
2. ALL SOLUTIONS MUST BE IN ACCORDANCE WITH MS EN 1992-1-1: 2004

WARNING!
Students caught copying/cheating during the examination will be liable for disciplinary actions and the faculty may recommend the student to be expelled from the study.

This examination question consists of ( 5 ) printed pages only.
Semua Pelajar
Program Pengajian Separuh Masa
Universiti Teknologi Malaysia

Saudara/i,

PERINGATAN KHAS PEPERIKSAAN


2. Tindakan tatatertib boleh dikenakan ke atas mana-mana pelajar yang ditangkap kerana kesalahan seperti di atas dan jika disabit kesalahan boleh dihukum melalui Peruntukan Kaedah 48, Bahagian V, Tatacara Tatatertib, Kaedah-Kaedah Universiti Teknologi Malaysia (Tatatertib Pelajar-Pelajar) 1999, yang membawa hukuman maksima seperti "digantung daripada pengajian" atau "dipecat" dari Universiti Teknologi Malaysia. Hukuman juga boleh berdasarkan Peraturan Akademik, UTM Bahagian XIII yang membawa hukuman maksima "membatalkan keputusan keseluruhan peperiksaan dan diberhentikan daripada pengajian".

3. Pihak Universiti tidak teragak-agak untuk mengambil tindakan dan menjatuhkan hukuman maksima jika saudara/i didapati bersalah dalam melakukan penyelewengan akademik.

Sekian.

DEKAN
Sekolah Pendidikan Profesional dan Pendidikan Berterusan (UTMSCAPE)
Universiti Teknologi Malaysia

2 Januari 2013
Q1. (a) A simply supported beam is carrying uniformly distributed load along its span. Describe briefly the mode of failure of the beam.

(4 marks)

(b) Figure Q1(a) shows the cross section of a ‘box’ reinforced concrete element. The element has the compression zone depth, \(x\). Prove that the balanced moment for the section, \(M_{bal} = 0.1086 f_{ck} b^3\).

(6 marks)

(c) Figure Q1(b) shows part of the floor plan of a reinforced concrete office building. During construction, slabs and beams are cast together. Figure Q1(c) is the cross-section of Beam D/3-4 using the previous design for office building. This office building was later changed to become a retail shops which cause all slab panels to carry a larger variable action. All slabs are at the same level except panel D-C/1-4 which drop 50 mm. Design data related to the action and construction material are as follows:

- Variable action for retail shop = 4.0 kN/m\(^2\)
- Floor finishes, ceiling and building services = 1.5 kN/m\(^2\)
- Characteristics cylinder strength of concrete, \(f_{ck}\) = 30 N/mm\(^2\)
- Nominal cover = 30 mm

Determine whether beam D/3-4 can withstand the new variable action for retail shop. Beam D/1-4 also carries a 3 m high brick-wall with a density of 2.6 kN/m\(^2\).

(30 marks)

(40 marks)
(b) Plan view

(c) Cross section A-A (Beam D/3-4)

(All dimensions are in mm unless otherwise stated)

FIGURE Q1
Q2. (a) Briefly describe 3 types of reinforced concrete slab.  

(5 marks)

(b) Using the information given in Q1(c) above, design all the slabs in Figure Q1(b). Sketch the reinforcement details of the slab in the Z-Z cross-section.  

(25 marks)  
(30 marks)

Q3. (a) Discuss and explain the advantages and disadvantages of prestressed concrete compared to reinforced concrete.  

(10 marks)

(b) The cross section of a post-tensioned prestressed bridge is shown in Figure Q3(a). The beam is simply supported over a span of 20 m and carries a service load (excluding the beam self weight) of 9 kN/m. The beam was prestressed using 4 numbers of tendons. Each tendon is initially stressed up to 250 kN with an eccentricity as shown in Figure Q3(b). The losses of prestressing force are 10% and 20% at transfer and service, respectively. The strength of concrete at service and transfer is 50 and 36 N/mm², respectively. Draw the stress distribution during transfer and service at mid-span and support by noting the important values. Then, check whether these stresses are within the allowable values in EN 1992-1-1: 2004.  

(20 marks)  
(30 marks)
(a) Beam cross section at mid-span

(a) Side view and tendon profile along beam span

(All units are in mm unless otherwise stated)

FIGURE Q3
6.4.3 Punching shear calculation

(1) The design procedure for punching shear is based on checks at the face of the column and at the basic control perimeter \( u_t \). If shear reinforcement is required (a further perimeter \( u_{out,ef} \) (see figure 6.22) should be found where shear reinforcement is no longer required. The following design shear stresses (MPa) along the control sections, are defined:

\[ V_{Rd,c} \] is the design value of the punching shear resistance of a slab without punching shear reinforcement along the control section considered.

\[ V_{Rd,cs} \] is the design value of the punching shear resistance of a slab with punching shear reinforcement along the control section considered.

\[ V_{Rd,max} \] is the design value of the maximum punching shear resistance along the control section considered.

(2) The following checks should be carried out:

(a) At the column perimeter, or the perimeter of the loaded area, the maximum punching shear stress should not be exceeded:

\[ V_{Ed} < V_{Rd,max} \]

(b) Punching shear reinforcement is not necessary if:

\[ V_{Ed} < V_{Rd,c} \]

(c) Where \( V_{Ed} \) exceeds the value \( V_{Rd,c} \) for the control section considered, punching shear reinforcement should be provided according to 6.4.5.

(3) Where the support reaction is eccentric with regard to the control perimeter, the maximum shear stress should be taken as:

\[ V_{Ed} = \beta \frac{V_{Ed}}{u_d} \quad (6.38) \]

where

\[ d \] is the mean effective depth of the slab, which may be taken as \((d_y + d_z)/2\) where:

\[ d_y, d_z \] are the effective depths in the y- and z- directions of the control section

\[ u \] is the length of the control perimeter being considered

\[ \beta \] is given by:

\[ \beta = 1 + k \frac{M_{Ed}}{V_{Ed}} \frac{u_t}{W_1} \quad (6.39) \]

where

\[ u_t \] is the length of the basic control perimeter

\[ k \] is a coefficient dependent on the ratio between the column dimensions \( c_1 \) and \( c_2 \); its value is a function of the proportions of the unbalanced moment transmitted by uneven shear and by bending and torsion (see Table 6.1).

\( W_1 \) corresponds to a distribution of shear as illustrated in Figure 6.19 and is a function of the basic control perimeter \( u_t \):

\[ W_1 = \int_0^u |e| \, dl \quad (6.40) \]
\( dl \) is a length increment of the perimeter
\( e \) is the distance of \( dl \) from the axis about which the moment \( M_{Ed} \) acts

<table>
<thead>
<tr>
<th>( c_1/c_2 )</th>
<th>( \leq 0.5 )</th>
<th>1.0</th>
<th>2.0</th>
<th>( \geq 3.0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k )</td>
<td>0.45</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Figure 6.19: Shear distribution due to an unbalanced moment at a slab-internal column connection

For a rectangular column:

\[
W = \frac{c_1^2}{2} + c_1c_2 + 4c_2d + 16d^2 + 2\pi dc_1
\]

(6.41)

where:
\( c_1 \) is the column dimension parallel to the eccentricity of the load
\( c_2 \) is the column dimension perpendicular to the eccentricity of the load

For internal circular columns \( \beta \) follows from:

\[
\beta = 1 + 0.6\pi \frac{e}{D + 4d}
\]

(6.42)

where \( D \) is the diameter of the circular column

For an internal rectangular column where the loading is eccentric to both axes, the following approximate expression for \( \beta \) may be used:

\[
\beta = 1 + 1.8 \left( \frac{e_x}{b_y} \right)^2 + \left( \frac{e_y}{b_y} \right)^2
\]

(6.43)

where:
\( e_x \) and \( e_y \) are the eccentricities \( M_{Ed}/V_{Ed} \) along y and z axes respectively
\( b_y \) and \( b_z \) is the dimensions of the control perimeter (see Figure 6.13)

Note: \( e_y \) results from a moment about the z axis and \( e_x \) from a moment about the y axis.

(4) For edge column connections, where the eccentricity perpendicular to the slab edge (resulting from a moment about an axis parallel to the slab edge) is toward the interior and there is no eccentricity parallel to the edge, the punching force may be considered to be uniformly distributed along the control perimeter \( u_{tr} \) as shown in Figure 6.20(a).
KERTAS SOALAN PEPERIKSAAN TAMAT