UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	PRECAST CONCRETE DESIGN
COURSE CODE	:	BFS41103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY 2021 / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **ELEVENT (11)** PAGES

Q1 (a) Discuss **THREE (3)** circumstances precast concrete will have priority over cast in-situ reinforced concrete.

(6 marks)

(b) The precast composite beam shown in **Figure Q1** is simply supported over a span of 7 m. It carries 200 mm deep hollow core slabs that have a span of 6.0 m and a self weight (including in situ infill) of 3.5 kN/m^2. The imposed floor loading is 4.5 kN/m^2 live and 1.0 kN/m^2 dead. Given the following data:

Nominal concrete cover	=	30 mm
Diameter of main reinforcement	=	32 mm
Diameter of shear reinforcement	=	10 mm
Characteristic strength of concrete	=	35 N/mm^2
Characteristic strength of steel reinforcement	=	500 N/mm^2

(i) Calculate the design load for the composite beam at both stages.

(5 marks)

(ii) Design the flexural reinforcement for the composite beam

(12 marks)

(iii) Design the shear reinforcement for the composite beam.

(10 marks)

(iv) Determine the torsional moment for the composite beam.

(7 marks)

Q2 **Figure Q2(a)** shows the typical floor plan of a double storey braced building using precast concrete system. The floor is made by 150 mm thick precast prestressed concrete solid slabs supported by the precast concrete beams. The beams are connected to the precast column. The elevation of the precast column C1 is shown in **Figure Q2(b)**. Given the following data:

Precast beam	=	250 mm x 600 mm
Column C1	=	250 mm x 250 mm
Unit weight of concrete	=	25 kN/m^3
Brickwall	=	2.6 kN/m^2
Concrete topping and finishes	=	1.5 kN/m^2
Variable action	=	5 kN/m^2
Nominal concrete cover	=	30 mm
Diameter of main reinforcement	=	20 mm
Diameter of shear reinforcement	=	6 mm
Characteristic strength of concrete	=	35 N/mm^2
Characteristic strength of steel reinforcement	=	500 N/mm^2

(a) Evaluate the maximum axial force for column C1 between ground floor and first floor level. Ignore size of corbel.

(9 marks)

(b) Design the main reinforcement for column C1. Assume moment of the column is due to an eccentricity of 100 mm. All the joints between beam and column are pinned.

(9 marks)

(c) The precast column is lifted from the casting yard using only two points as shown in **Figure Q2(c)** Check the structural adequacy of the column during lifting process.

(12 marks)

Q3 Based on the information given in **Q2** and consider the joints between precast concrete beams (PCB 1) and column C1. The detail of the corbel is shown in **Figure Q3**. Given as follows are design data to be used In the corbel design

Width of corbel	=	250 mm
Nominal concrete cover	=	30 mm
Diameter of main reinforcement	=	16 mm
Concrete cube strength	=	40 N/mm^2
Strength of steel reinforcement	=	460 N/mm^2

(a) Determine the minimum width of the bearing plate.

(7 marks)

(b) Design all the reinforcements for the corbel.

(18 marks)

(c) Draw the detailing of the corbel.

(5 marks)

- END OF QUESTIONS-

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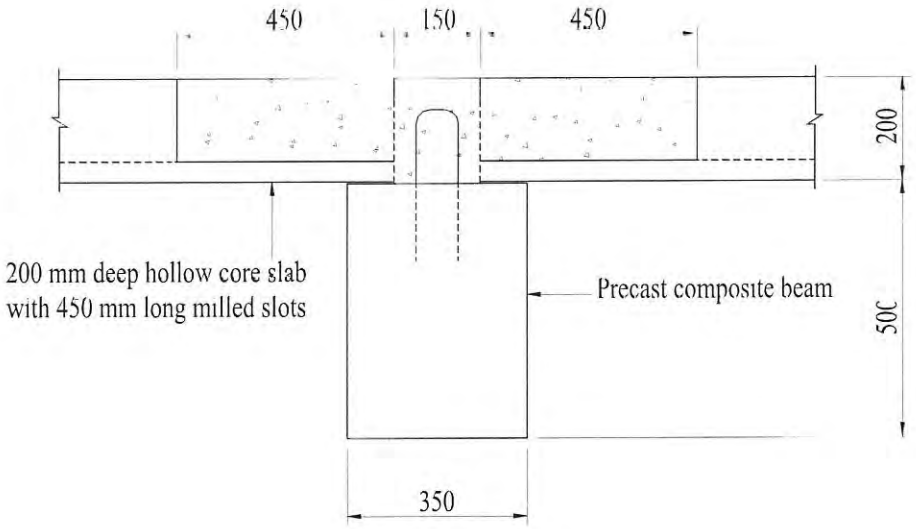

FIGURE Q1

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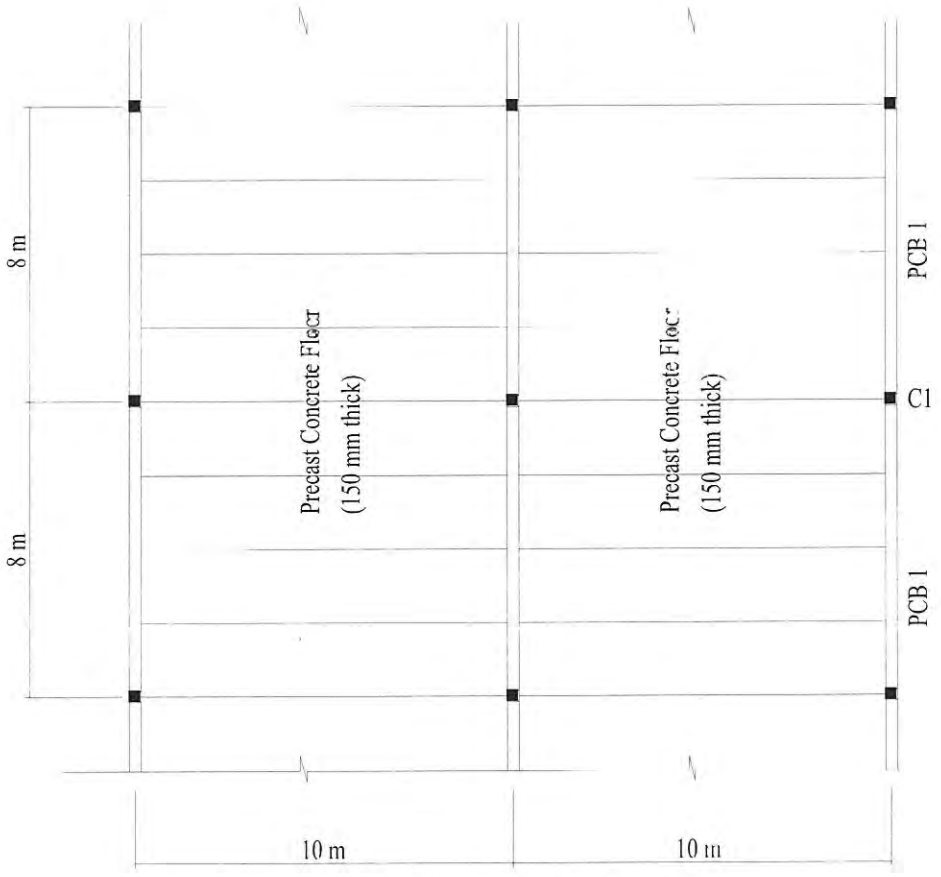

Floor Plan (Roof and First Floor)

FIGURE Q2(a)

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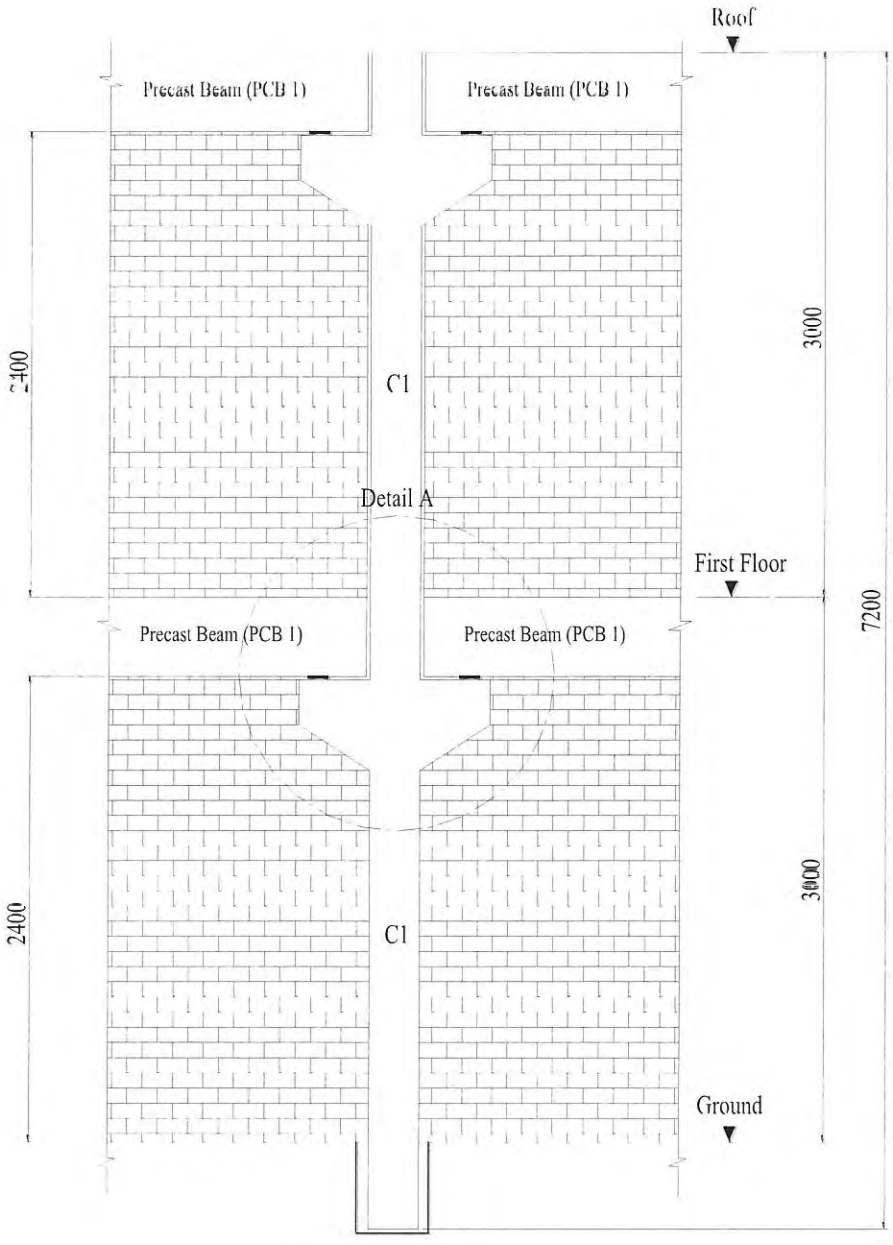

Elevation of Column C1

FIGURE Q2(b)

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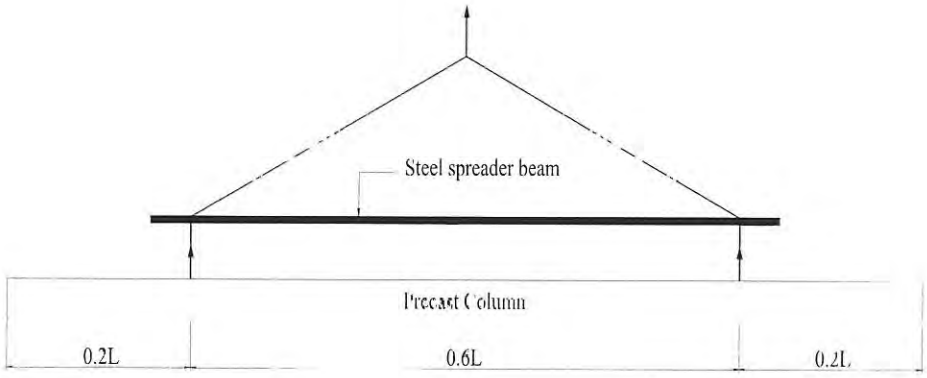
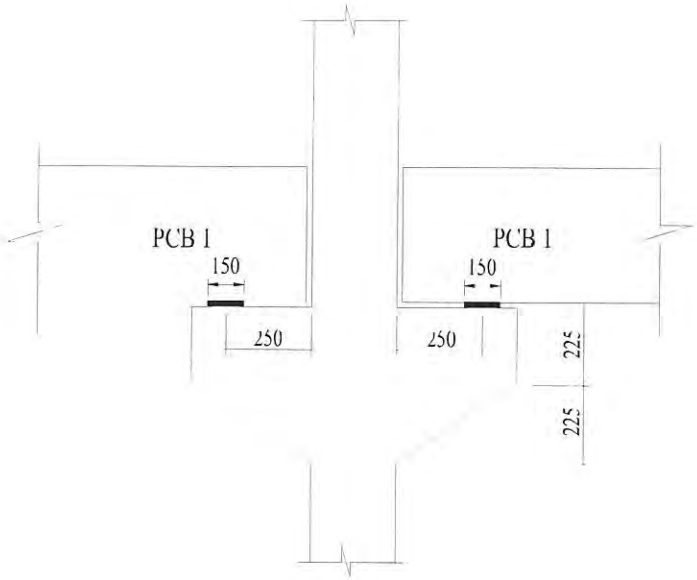


FIGURE Q2(c)



Detail A

FIGURE Q3

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APPENDIX

(A) PRECAST BEAM

(i) Design of Flexural Reinforcement (Rectangular Section)

1. Calculate $K = M / bd^2 f_{ck}$

2. Calculate $K_{bal} = 0.363(\delta - 0.44) - 0.116(\delta - 0.44)^2$

   where $\delta = M_{\text{after redistribution}} / M_{\text{before redistribution}} \leq 1.0$

3. If $K \leq K_{bal}$, compression reinforcement is not required, and

   i. $z = d\{0.5 + \sqrt{(0.25 - K / 1.134)}\} \leq 0.95d$

   ii. $A_s = M / 0.87 f_{yk} z$

4. If $K > K_{bal}$, compression reinforcement is required, and

   i. $z = d\{0.5 + \sqrt{(0.25 - K_{bal} / 1.134)}\} \leq 0.95d$

   ii. $x = (d - z)/0.4$, Check d'/x

   iii. $A_s' = (K - K_{bal}) f_{ck} bd^2 / 0.87 f_{yk}(d-d')$ if $d'/x \leq 0.38$

   $A_s' = (K - K_{bal}) f_{ck} bd^2 / 700(1 - d'/x)(d-d')$ if $d'/x > 0.38$

   iv. $A_s = K_{bal} f_{ck} bd^2 / 0.87 f_{yk} z + A_s'$

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(ii) Design of Shear

$$V_{Rd,max} = \frac{0.36 b_w d f_{ck}(1 - f_{ck}/250)}{(\cot\theta + \tan\theta)}$$

If $V_{Ed} < V_{Rd,max}$ $\theta = 22^o$, use $\theta = 22^o$,

$$\frac{A_{sw}}{s} = \frac{V_{Ed}}{0.78 f_{yk} d \cot\theta}$$

$$\frac{0.513 V_{Ed}}{f_{yk} d}$$

If $V_{Rd,max}\,\theta - 22^o < V_{Ed} < V_{Rd,max}\,\theta = 45^o$

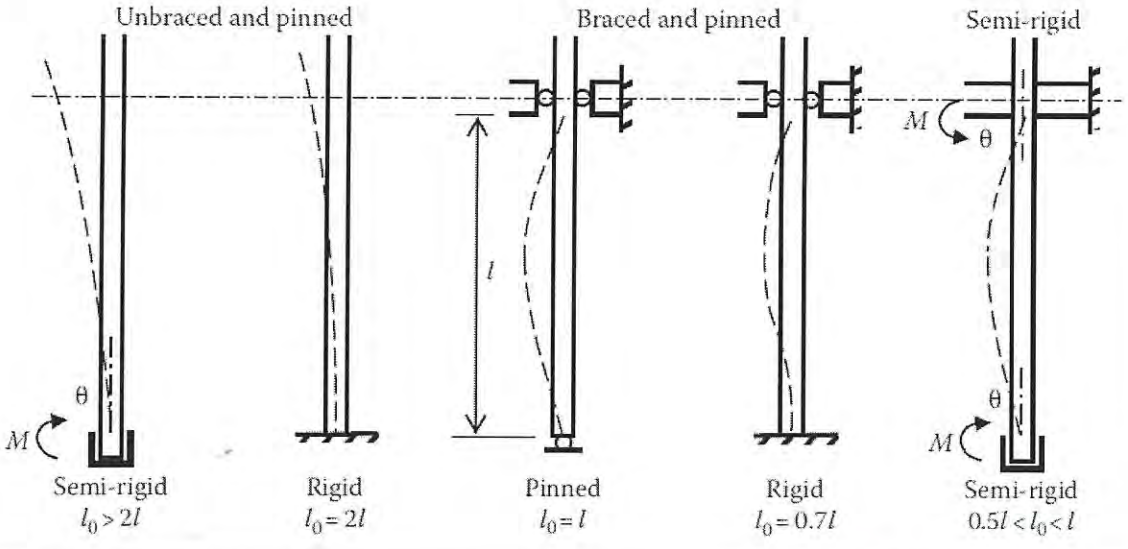
(a) Calculate $\theta = 0.5 \sin^{-1}\left[\frac{V_{Ed}}{0.18 b_w d f_{ck}(1 - f_{ck}/250)}\right]$

(b) Calculate shear link,

$$\frac{A_{sw}}{s} = \frac{V_{Ed}}{0.78 f_{yk} d \cot\theta}$$

(B) PRECAST COLUMN

(i) Column Effective Heights



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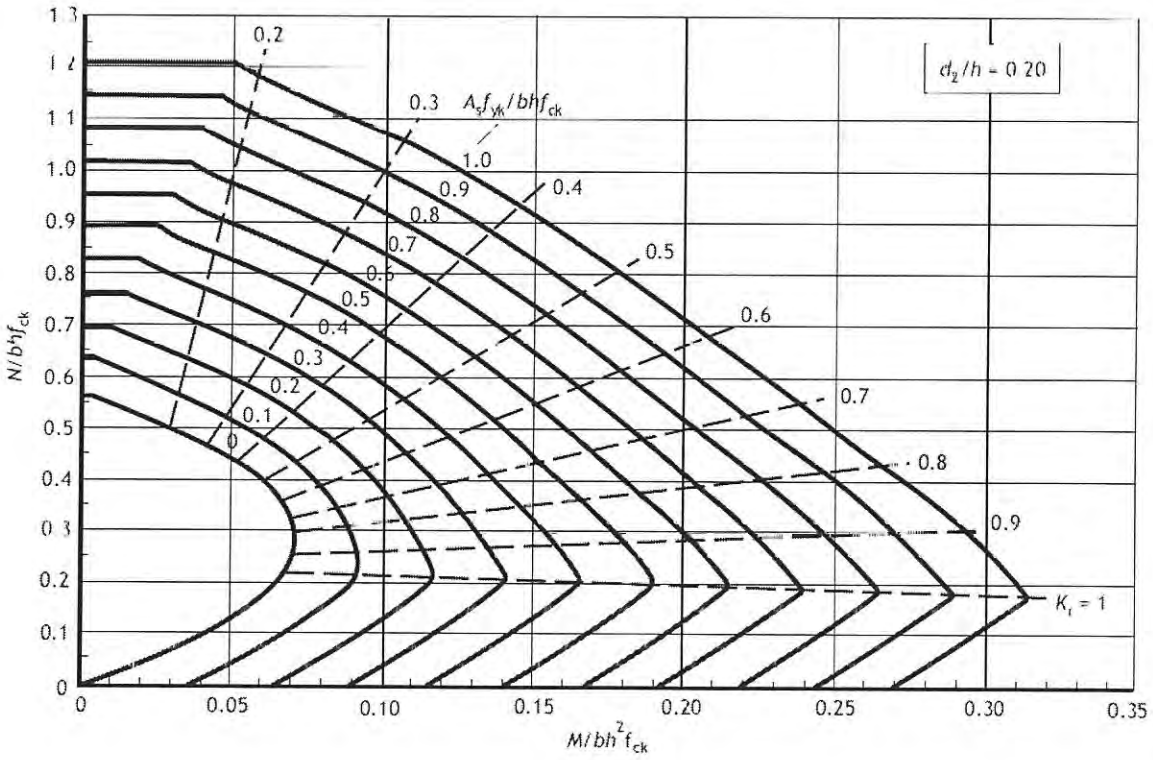
e_{min} 0.05h

f'_{cd} = $0.567f_{ck}$

λ = l_e/i

λ_{min} = $26.2 / (N_{Ed}/(A_c f_{cd}))^{1/2}$

(ii) Column Design Chart



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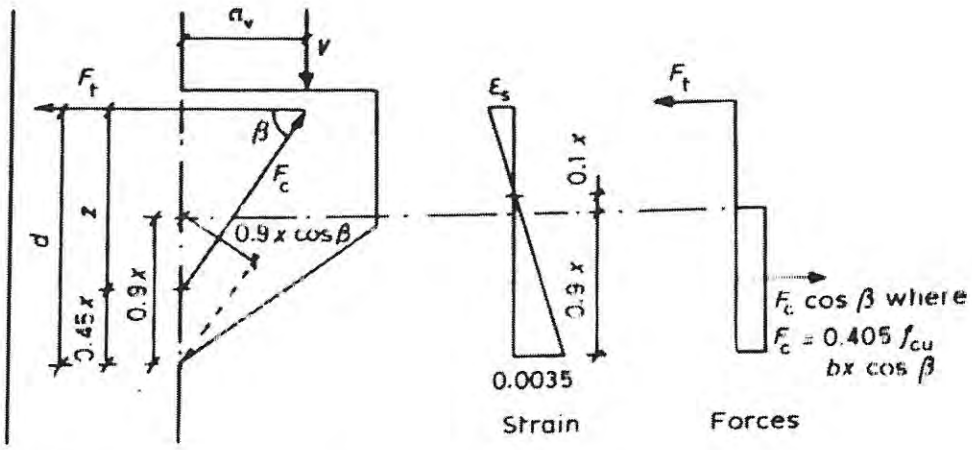
(C) DESIGN OF CORBEL

(i) System Forces of Corbel



(ii) Chart For Determining z/d