Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	PRECAST CONCRETE DESIGN
COURSE CODE	:	BFS41103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) Sketch the following situations and propose its solution:

(i) Excessive of bearing length.
(ii) Loss of bearing due to accidental actions on the precast column.
(iii) Loss of bearing due to settlement of precast column.

in precast concrete beam and column construction.

(9 marks)

(b) **Figure Q1(a)** shows the typical upper floor plan of a double storey building. The floor of the building is constructed using precast solid slab and precast concrete beam. The floor beams are non-composite precast beam. The detail of the precast beam (FB) is shown in **Figure Q1(b)**. Given the following data:

Characteristic strength of main reinforcement	=	460 N/mm^2
Characteristic strength of shear reinforcement	=	250 N/mm^2
Characteristic strength of concrete	=	30 N/mm^2
Concrete topping	=	50 mm
Unit weight of concrete	=	25 kN/m^3
Finishes and services	=	2.5 kN/m^2
Variable action	=	4 kN/m^2

(i) Evaluate the ultimate moment capacity of the precast beam. Assume strength of the T10 bars is limited to 80% of the characteristic strength.

(13 marks)

(ii) Check the adequacy of precast beam (FB) in resisting the design moment.

(8 marks)

(iv) Check the adequacy of the shear reinforcement. Ignore the upstand section (200 mm x 150 mm) of the beam.

(10 marks)

Q2 A 500 mm x 600 mm precast column located at the corner is braced with a floor-to-floor height of 4 m is shown in **Figure Q2** is used to support two precast beams. The total ultimate loads from the precast beam 1 and precast beam 2 are 300 kN and 1000 kN, respectively. Besides, the column is subjected to the biaxial bending. The ultimate moment at the major and minor axis is 300 kNm and 100 kNm, respectively. Given the following data:

Strength of concrete	=	35 N/mm^2
Strength of steel reinforcement	=	460 N/mm^2
Nominal concrete cover	=	40 mm
Diameter of main reinforcement	=	32 mm
Diameter of link	=	8 mm

(a) Classify the column based on the slenderness effect.

(4 marks)

(b) Evaluate the design moment for the column.

(10 marks)

(c) Based on the column design charts given in the appendix, design the main reinforcement for the column.

(10 marks)

(d) Design the shear reinforcement for the column.

(6 marks)

Q3 **Figure Q3(a)** shows an overhead crane used to haul the precast structures in a factory. The crane has a maximum capacity of 500 kN is attached to the universal beam with a maximum hauling distance of 16 m. The universal beam is supported on the concrete corbels at both ends. The details of the concrete corbel are shown in **Figure Q3(b)**. Given the strength of concrete and strength of strength reinforcement are 35 N/mm^2 and 500 N/mm^2, respectively.

(a) Determine the axial force (F) acting on the corbel. Ignore the weight of the universal beam and corbel.

(3 marks)

(b) Check the bearing stress of the bearing pad. Given the safe bearing stress,

$$\sigma_{b,safe} = 0.48[1-(f_{ck}/250)]\ f_{ck}$$

(6 marks)

(c) Design the reinforcement for the corbel. Assume the bearing is flexible and at a distance (a_H) = 65 mm above the tension tie. The design stress for the concrete,

$$f_{cd} = 0.34f_{ck}[1-(\ f_{ck}/250)]$$

(16 marks)

(d) Draw the detailing for the corbel.

(5 marks)

- END OF QUESTIONS-

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I 2022/2023
COURSE NAME : PRECAST CONCRETE DESIGN

PROGRAMME CODE : BFF
COURSE CODE : BFS41103

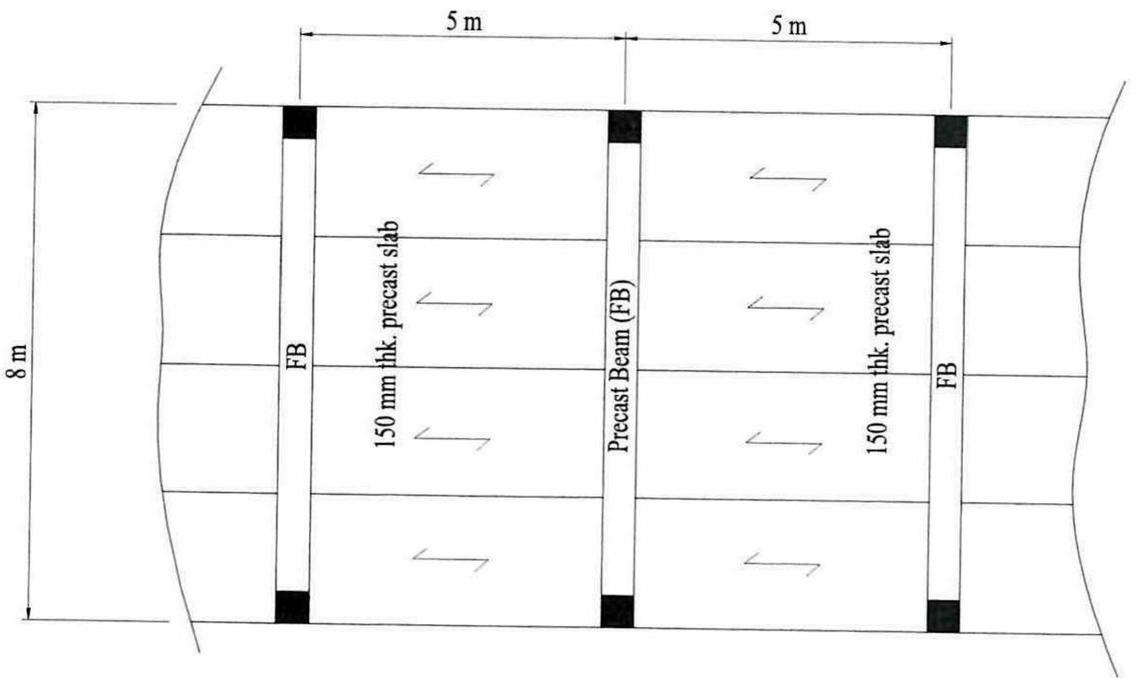
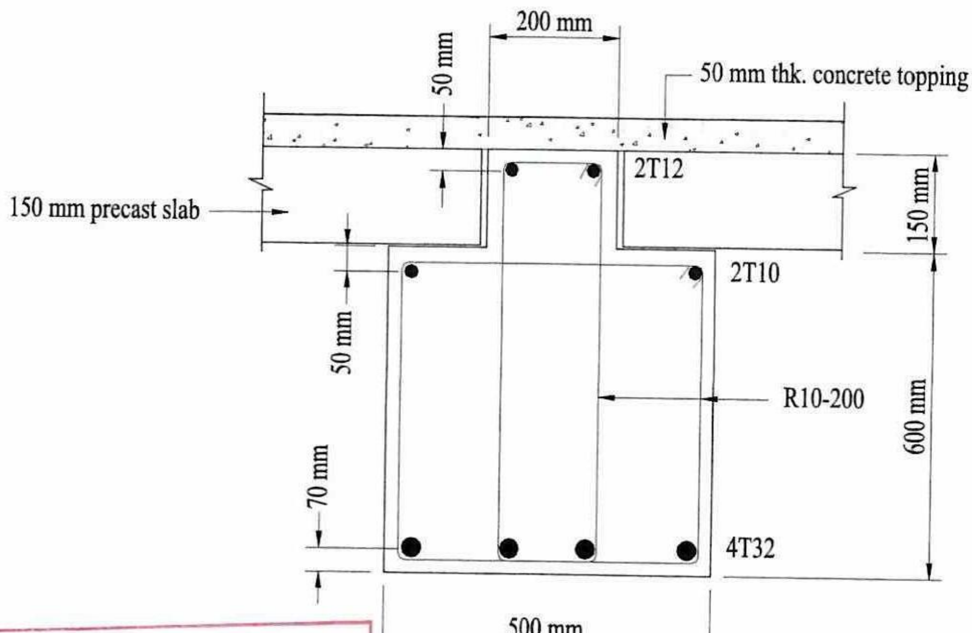


FIGURE Q1(a)



Detailing of FB

FIGURE Q1(b)

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I 2022/2023
COURSE NAME : PRECAST CONCRETE DESIGN
PROGRAMME CODE : BFF
COURSE CODE : BFS41103

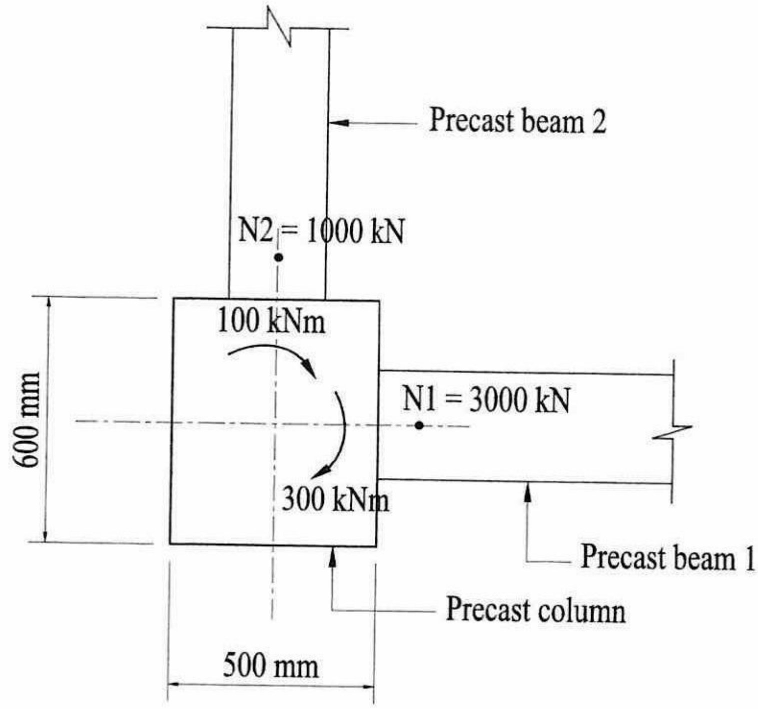


FIGURE Q2

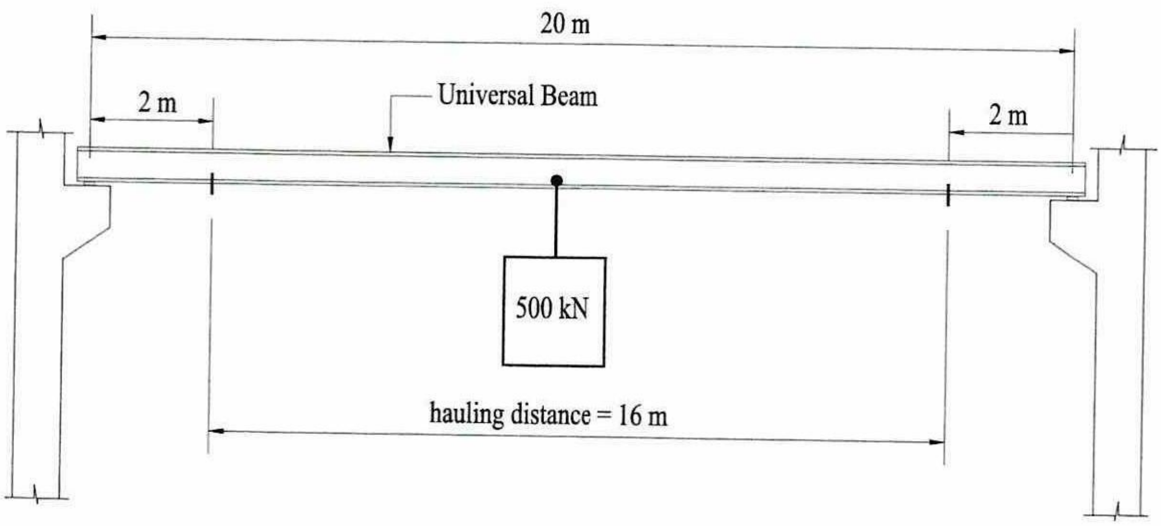


FIGURE Q3(a)

FINAL EXAMINATION

SEMESTER/SESSION	: SEMESTER I 2022/2023	PROGRAMME CODE :	BFF
COURSE NAME	: PRECAST CONCRETE DESIGN	COURSE CODE :	BFS41103

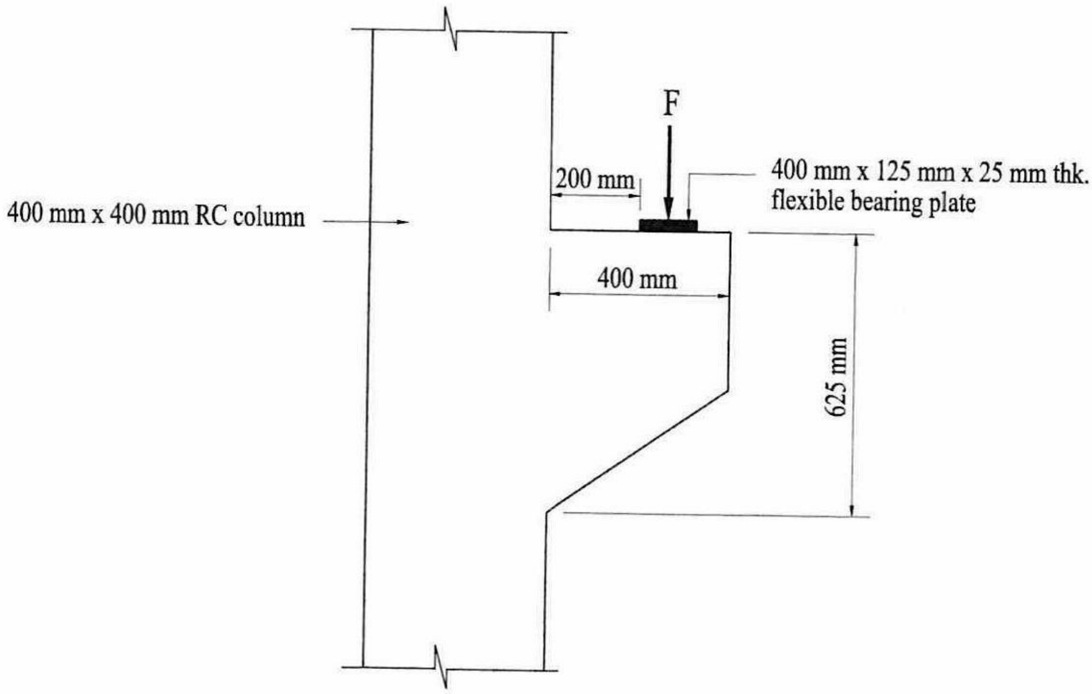


FIGURE Q3(b)

FINAL EXAMINATION

SEMESTER/SESSION	: SEMESTER I 2022/2023	PROGRAMME CODE	: BFF
COURSE NAME	: PRECAST CONCRETE DESIGN	COURSE CODE	: BFS41103

APPENDIX

(A) Precast Column Design Chart

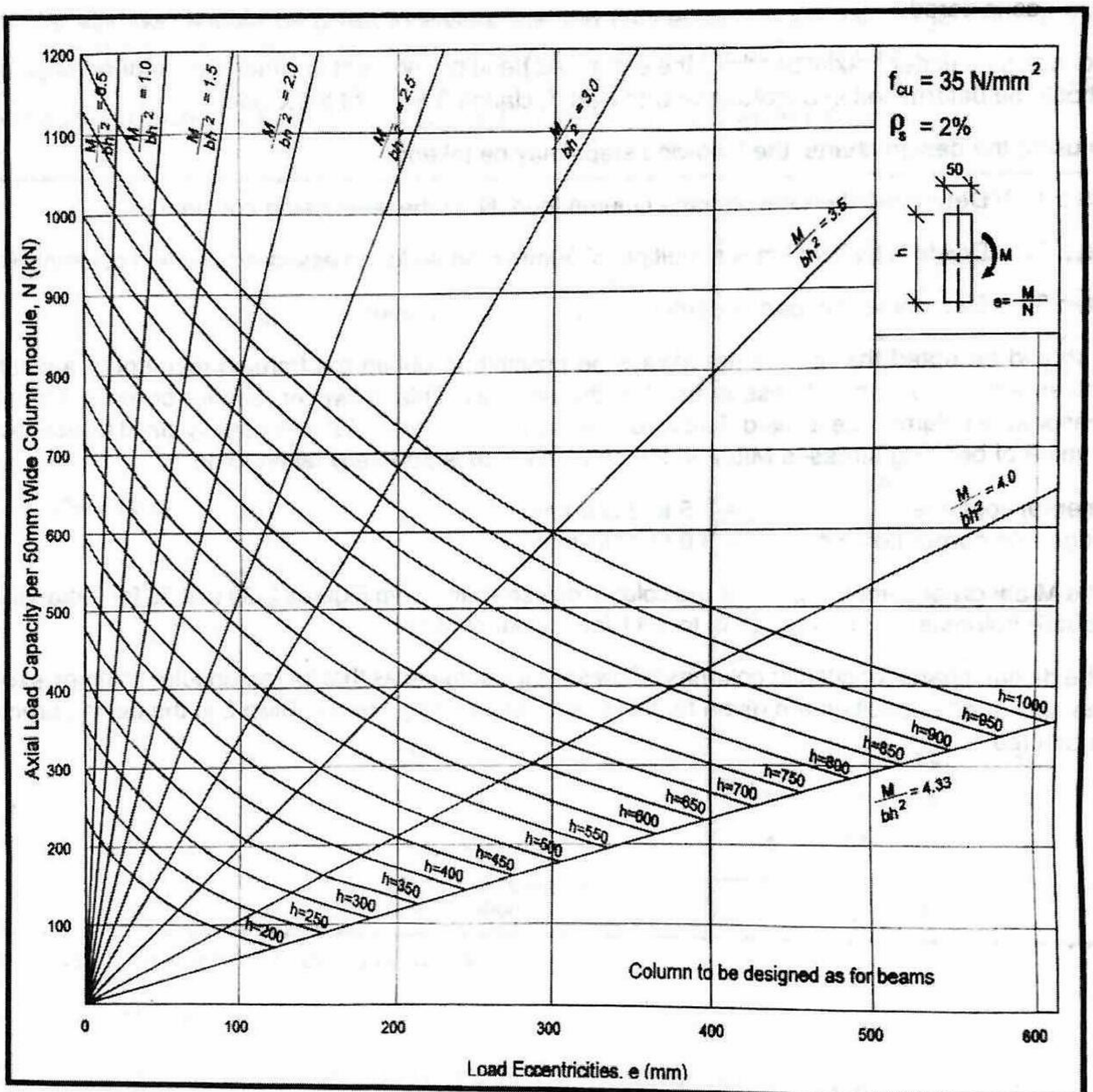


Figure 2.30 Reinforced Concrete Precast Rectangular/Square Column Design Chart For f_{cu}=35N/mm², And ρ_s=2%

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I 2022/2023 PROGRAMME CODE : BFF
COURSE NAME : PRECAST CONCRETE DESIGN COURSE CODE : BFS41103

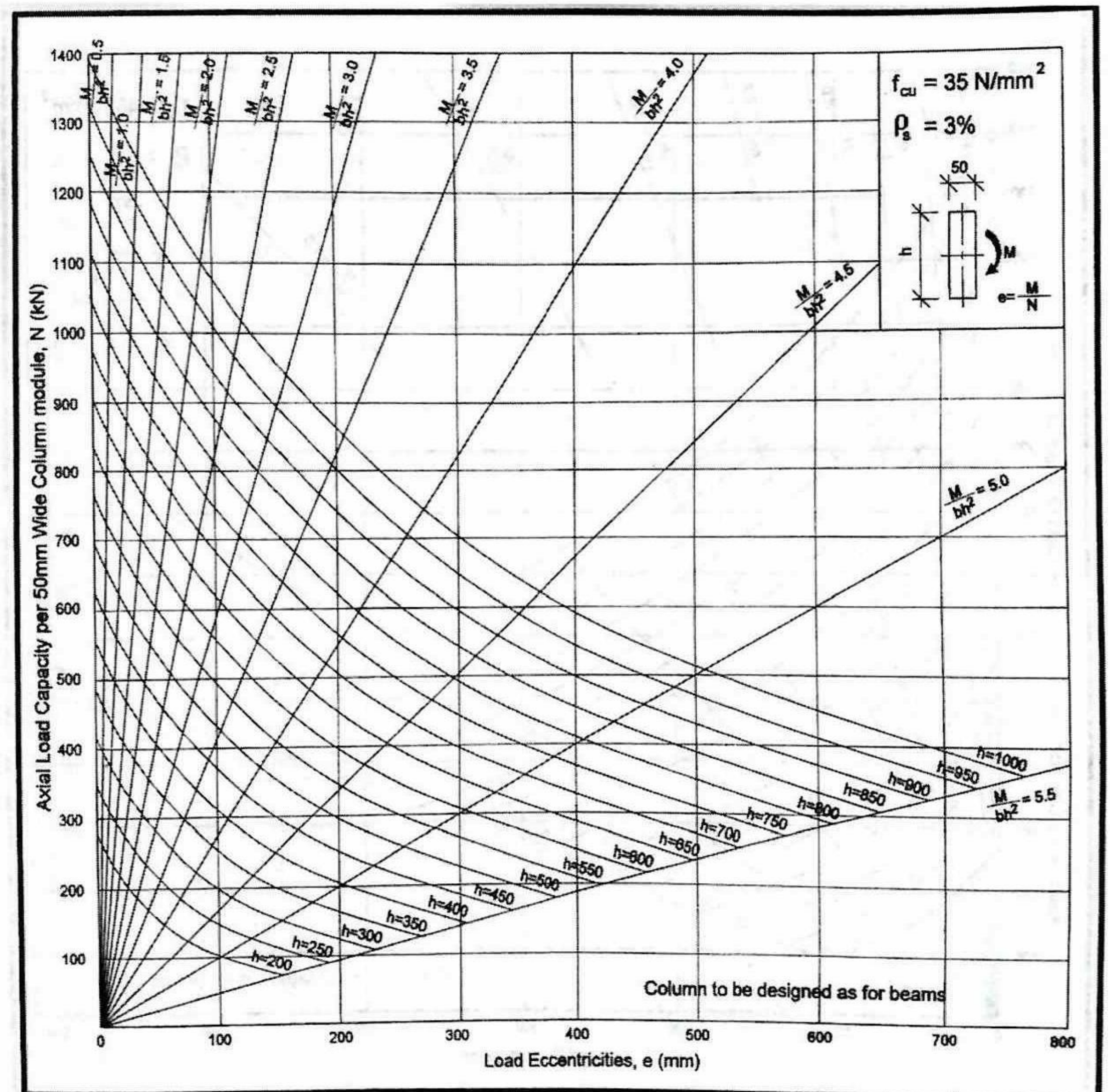


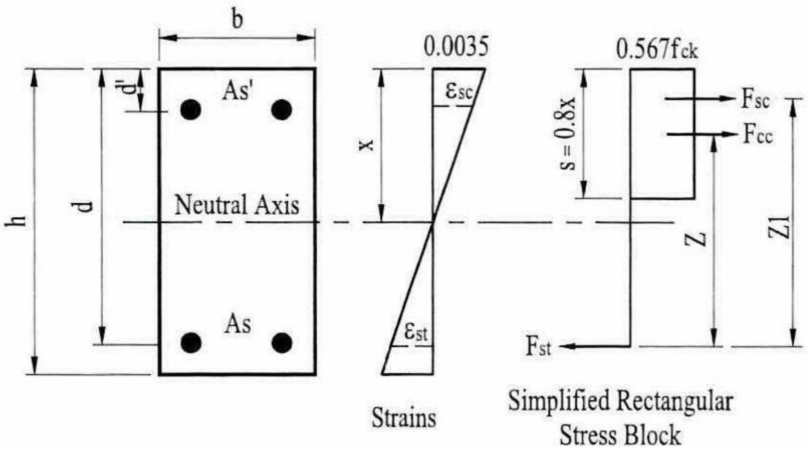
Figure 2.31 Reinforced Concrete Precast Rectangular/Square Column Design Chart For f_{cu}=35N/mm² And ρ_s=3%

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I 2022/2023 PROGRAMME CODE : BFF
COURSE NAME : PRECAST CONCRETE DESIGN COURSE CODE : BFS41103

(B) Stress Strain Relationship of Doubly Reinforced Rectangular Section ($f_{ck} \leq 50$ MPa)



(C) Design of Flexural Reinforcement (Rectangular Section)

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

If $K \leq K_{bal}$ (= 0.167), compression reinforcement is not required, and

(a) $z = d\{0.5 + \sqrt{0.25 - k/1.134}\}$

(b) $A_s = M / 0.87 f_{yk} z$

(D) Design of Shear

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

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

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

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

If $V_{Rd,max}\ \theta = 22° < V_{Ed} < V_{Rd,max}\ \theta = 45°$

(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,

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

FINAL EXAMINATION

SEMESTER/SESSION	: SEMESTER I 2022/2023	PROGRAMME CODE :	BFF
COURSE NAME	: PRECAST CONCRETE DESIGN	COURSE CODE :	BFS41103

(E) Biaxial Bending for Column Design

if $\frac{M_z}{h'} \geq \frac{M_y}{b'}$

then the increased single axis design moment is

$$M'_z = M_z + \beta \frac{h'}{b'} \times M_y$$

if $\frac{M_z}{h'} < \frac{M_y}{b'}$

then the increased single axis design moment is

$$M'_y = M_y + \beta \frac{b'}{h'} \times M_z$$

$$\beta = 1 - \frac{N_{Ed}}{bhf_{ck}}$$

(F) Design for Shallow Corbel

θ (degs)	$F_{Ed}/f_{cd}db_w$						
	$a'/d=0.9$	$a'/d=0.8$	$a'/d=0.7$	$a'/d=0.6$	$a'/d=0.5$	$a'/d=0.4$	$a'/d=0.3$
45	0.100	0.200	0.300	0.400	0.500	0.600	0.700
46	0.068	0.171	0.275	0.378	0.482	0.585	0.689
47	0.035	0.142	0.249	0.356	0.463	0.570	0.677
48	0.000	0.111	0.221	0.332	0.442	0.553	0.663
49	–	0.079	0.193	0.307	0.421	0.535	0.649
50	–	0.046	0.163	0.281	0.398	0.515	0.633
51	–	0.012	0.133	0.253	0.374	0.495	0.616
52	–	–	0.101	0.225	0.349	0.474	0.598
53	–	–	0.068	0.196	0.323	0.451	0.579
54	–	–	0.035	0.166	0.297	0.427	0.558
55	–	–	0.000	0.134	0.269	0.403	0.537
56	–	–	–	0.102	0.240	0.377	0.515
57	–	–	–	0.070	0.210	0.351	0.492
58	–	–	–	0.036	0.180	0.323	0.467
59	–	–	–	0.001	0.148	0.295	0.442
60	–	–	–	–	0.116	0.266	0.416
61	–	–	–	–	0.083	0.236	0.389
62	–	–	–	–	0.049	0.205	0.361
63	–	–	–	–	0.015	0.174	0.333
64	–	–	–	–	–	0.142	0.303
65	–	–	–	–	–	0.109	0.273
66	–	–	–	–	–	0.075	0.242
67	–	–	–	–	–	0.041	0.211
68	–	–	–	–	–	0.007	0.179