KSRM College of Engineering (Autonomous)

(Approved by AICTE, Affiliated to JNTUA, Ananthapuramu, Accredited by NAAC)

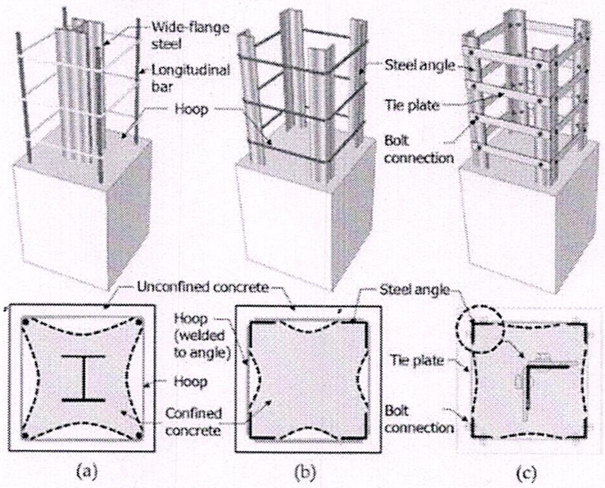
(An ISO 9001-2008 Certified Institution)

Department of Civil Engineering

Certification Course

on

Design of Compression members Using Microsoft Excel



Course Instructor: Sri K. Hemanth Kumar Reddy, Assistant Professor, CED, KSRMCE

Course Coordinators: Miss. V. Sai Neeraja, Assistant Professor, CED, KSRMCE

Dates: 12/04/2022 to 30/04/2022

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)
Kadapa, Andhra Pradesh, India– 516 003

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KSNR lives on..

Lr./KSRMCE/CE/2021-22/ Date: 07-04-2022

From
Miss. V. Sai Neeraja,
Asst. Professor,
Dept. of Civil Engineering,
KSRMCE,
Kadapa.

To
The Principal
KSRMCE
Kadapa.

Sub: Permission to Conduct Certificate Course – Reg.

Respected Sir,

The Department of Civil Engineering is planning to offer a certification course on "Design of Compression members using Microsoft Excel" to B.Tech. students of KSRMCE. The course will start on 12th April 2022 and scheduled to end on 30th April 2022. In this regard, I request you to accept the proposal to conduct the above mentioned certificate course.

Thanking you

Forwarded to principal sir

Yours faithfully

(Miss. V. Sai Neeraja)

Permitted

V. S. S. Murthy

K.S.R.M. COLLEGE OF ENGINEERING

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Kadapa, Andhra Pradesh, India– 516 003

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Cr./KSRMCE/CE/2021-22/

Date: 08/04/2022

Circular

The Department of Civil Engineering is offering a certification course on "Design of Compression members using Microsoft Excel". The course will start on 12th April 2022 and the course will run for three weeks. In this regard, all interested students of KSRMCE are required to register for the Certificate Course. The students can consult the course coordinator for registration.

For any information regarding the course contact,

The Course Coordinator
Miss. V. Sai Neeraja,
Assistant Professor,
Dept. of Civil Engineering,
KSRMCE.

HoD-CE

Cc to:

IQAC-KSRMCE

Registration form for "Certification course on Design of Compression members Using Microsoft Excel"

Course Instructor: Sri K. Hemanth Kumar Reddy, Assistant Professor, CED, KSRMCE

Course Coordinator: Miss. V. Sai Neeraja, Assistant Professor, CED, KSRMCE

Dates: 12/04/2022 to 30/04/2022

reddysrinu@ksrmce.ac.in Switch account

Your email will be recorded when you submit this form

* Required

Roll No. *

Your answer

Name *

Your answer

Sec. *

Your answer

Mail. ID *

Your answer

Submit

Clear form

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Department of Civil Engineering

Registration list of Certification course on Design of Compression members Using Microsoft Excel

Sl. No.	Reg. No.	Name	Sec.	Mail. ID
1	189Y1A0109	Rama Chandrareddy Bommireddy	A	189Y1A0109@ksrmce.ac.in
2	189Y1A0115	Satish Kumar Yadav Chennuboyina	A	189Y1A0115@ksrmce.ac.in
3	189Y1A0119	Suneetha Chirasani	A	189Y1A0119@ksrmce.ac.in
4	189Y1A0120	Anilkumar Chittiboyina	A	189Y1A0120@ksrmce.ac.in
5	189Y1A0123	Rama Mohan Derangula	A	189Y1A0123@ksrmce.ac.in
6	189Y1A0128	Venkata Sainath Reddy G Y	A	189Y1A0128@ksrmce.ac.in
7	189Y1A0132	Lakshmi Prasad Reddy Guddila	A	189Y1A0132@ksrmce.ac.in
8	189Y1A0134	Nitheesh Gunigari	A	189Y1A0134@ksrmce.ac.in
9	189Y1A0135	Sreeveni Hasti	A	189Y1A0135@ksrmce.ac.in
10	189Y1A0144	Bhanumanikanta Reddy Kannapu	A	189Y1A0144@ksrmce.ac.in
11	189Y1A0145	Sai Mallikarjuna Reddy Karnati	A	189Y1A0145@ksrmce.ac.in
12	189Y1A0146	Govardhan Kaveti	A	189Y1A0146@ksrmce.ac.in
13	189Y1A0150	Lokeswar Reddy Kudamala	A	189Y1A0150@ksrmce.ac.in
14	189Y1A0156	Sudheer Kumar Maadam	A	189Y1A0156@ksrmce.ac.in
15	189Y1A0158	Lokeshwar Reddy Mallireddy	A	189Y1A0158@ksrmce.ac.in
16	189Y1A0159	Ganesh Mandla	A	189Y1A0159@ksrmce.ac.in
17	189Y1A0165	Purushotham Reddy Mitta	B	189Y1A0165@ksrmce.ac.in
18	189Y1A0166	Siva Prasad Reddy Mitta	B	189Y1A0166@ksrmce.ac.in
19	189Y1A0172	Venkatesh Nagirikanti	B	189Y1A0172@ksrmce.ac.in
20	189Y1A0175	Abhish Nanubala	B	189Y1A0175@ksrmce.ac.in
21	189Y1A0179	Jayachandra Sai Pandugolu	B	189Y1A0179@ksrmce.ac.in
22	189Y1A0187	Rakesh Prasanna Penubala	B	189Y1A0187@ksrmce.ac.in

23	189Y1A01A3	Mohammad Arshad Shaik	B	189Y1A01A3@ksrmce.ac.in
24	189Y1A01B0	Sateesh Kumar Reddy Thallapalle	B	189Y1A01B0@ksrmce.ac.in
25	189Y1A01B4	Gayathri Thopudurthy	B	189Y1A01B4@ksrmce.ac.in
26	189Y1A01B8	Venkata Hemanth Usugari	B	189Y1A01B8@ksrmce.ac.in
27	189Y1A01C3	Ganga Swetha Vennapusa	B	189Y1A01C3@ksrmce.ac.in
28	189Y1A01C8	Sivanatha Reddy Yeturu	B	189Y1A01C8@ksrmce.ac.in
29	199Y5A0112	Mahesh Babu Chinthakunta	C	199Y5A0112@ksrmce.ac.in
30	199Y5A0113	Hari Krishna Chittiboina	C	199Y5A0113@ksrmce.ac.in
31	199Y5A0115	Sreenivasulu Dasari	C	199Y5A0115@ksrmce.ac.in
32	199Y5A0127	Venkateswarlu Kashetty	C	199Y5A0127@ksrmce.ac.in
33	199Y5A0150	Sambasivareddy Sanikommu	C	199Y5A0150@ksrmce.ac.in
34	199Y5A0155	Sravani Sirigiri	C	199Y5A0155@ksrmce.ac.in

Coordinator **HoD-Civil Engg.**

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
(Autonomous)
KADAPA 516 003. (A.P.)

Syllabus of Certification Course

Course Name: Design of Compression members using Microsoft Excel.

Module I:

Review of Limit State Method- Limit state of Collapse and Limit State of Serviceability

Module II:

Design of Axially loaded short columns

Module III:

Analysis and Design of short columns with Uniaxial Bending

Module IV:

Analysis and Design of short columns with Biaxial Bending

Text Books:

1. N. Subramanian, Design of Reinforced Concrete Structures; Oxford University Press, 2014
2. S Unnikrishna Pillai & Devdas Menon, Reinforced Concrete Design, McGraw Hill, 2021

K.S.R.M. COLLEGE OF ENGINEERING

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Department of Civil Engineering

Certification course

on

Design of Compression members using Microsoft Excel

Date	Timing	Course Instructor	Topic to be covered
12/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Types of Limit states and its applications
13/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design Curves for grades of steels
16/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Stress block parameters
17/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Usage of IS456 in the design of Compression member
19/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design of axially loaded compression member
20/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Analysis steps for a given strain profile
21/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Interaction curve and its usage
22/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design of Section using SP16
23/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Simplified Code Procedure for design of columns
24/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design of uniaxial compression members
26/04/22	4 PM to 6 PM	Sri K Hemanth Kumar Reddy	Analysis of uniaxial compression members
27/04/22	3 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design of biaxial compression members
28/04/22	3 PM to 6 PM	Sri K Hemanth Kumar Reddy	Analysis of biaxial compression members
29/04/22	3 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design of short columns
30/04/22	3 PM to 6 PM	Sri K Hemanth Kumar Reddy	Design of long columns

Instructor:

Coordinator:

Department of Civil Engineering

Attendance sheet of Certification course on “Design of Compression members using Microsoft Excel”

Sl. No.	Student Roll No.	Student Name	12/ 04	13/ 04	16/ 04	17/ 04	19/ 04	20/ 04	21/ 04	22/ 04	23/ 04	24/ 04	26/ 04	27/ 04	28/ 04	29/ 04	30/ 04
1	189Y1A0109	Rama Chandrareddy Bommireddy	[signature]	A	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	A	[signature]	[signature]	A	[signature]	[signature]
2	189Y1A0115	Satish Kumar Yadav Chennuboyina	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
3	189Y1A0119	Suneetha Chirasani	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	A	[signature]
4	189Y1A0120	Anilkumar Chittiboyina	[signature]	[signature]	A	[signature]	[signature]	[signature]	A	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
5	189Y1A0123	Rama Mohan Derangula	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
6	189Y1A0128	Venkata Sainath Reddy G Y	[signature]	A	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]
7	189Y1A0132	Lakshmi Prasad Reddy Guddila	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
8	189Y1A0134	Nitheesh Gunigari	[signature]	[signature]	A	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
9	189Y1A0135	Sreeveni Hasti	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	A	[signature]	[signature]	A	[signature]	[signature]
10	189Y1A0144	Bhanumanikanta Reddy Kannapu	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]
11	189Y1A0145	Sai Mallikarjuna Reddy Karnati	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]
12	189Y1A0146	Govardhan Kaveti	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
13	189Y1A0150	Lokeswar Reddy Kudamala	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A
14	189Y1A0156	Sudheer Kumar Maadam	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
15	189Y1A0158	Lokeshwar Reddy Mallireddy	A	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
16	189Y1A0159	Ganesh Mandla	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	A	[signature]
17	189Y1A0165	Purushotham Reddy Mitta	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
18	189Y1A0166	Siva Prasad Reddy Mitta	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]

19	189Y1A0172	Venkatesh Nagirikanti	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]
20	189Y1A0175	Abhish Nanubala	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
21	189Y1A0179	Jayachandra Sai Pandugolu	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]
22	189Y1A0187	Rakesh Prasanna Penubala	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]
23	189Y1A01A3	Mohammad Arshad Shaik	[signature]	[signature]	A	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]
24	189Y1A01B0	Sateesh Kumar Reddy Thallapalle	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
25	189Y1A01B4	Gayathri Thopudurthy	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	A
26	189Y1A01B8	Venkata Hemanth Usugari	A	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]
27	189Y1A01C3	Ganga Swetha Vennapusa	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]
28	189Y1A01C8	Sivanatha Reddy Yeturu	[signature]	A	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
29	199Y5A0112	Mahesh Babu Chinthakunta	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	A	[signature]
30	199Y5A0113	Hari Krishna Chittiboina	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]
31	199Y5A0115	Sreenivasulu Dasari	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]
32	199Y5A0127	Venkateswarlu Kashetty	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	A
33	199Y5A0150	Sambasivareddy Sanikommu	[signature]	A	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A
34	199Y5A0155	Sravani Sirigiri	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	A	[signature]

[signature]
Coordinator

[signature]
HoD-Civil Engg.

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
(Autonomous)
KADAPA 516 003. (A.P.)

K.S.R.M. COLLEGE OF ENGINEERING

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KSNR
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DEPARTMENT OF CIVIL ENGINEERING

Certification Course

on

"Design of compression members Using Microsoft Excel"

Resource Person

Sri K. Hemanth Kumar Reddy,
Assistant Professor,
Dept. of Civil Engineering,
KSRM College of Engineering-Kadapa

From 12/04/2022 to 30/04/2022

4.00 PM - 6.00 PM

Coordinator: Miss. V. Sai Neeraja, Asst. Professor, CE Dept.

Dr. N Amaranatha Reddy	Dr. V S S Murthy	Prof. A Mohan	Dr. K Chandra Obul Reddy	Smt. K Rajeswari	Sri K Madan Mohan Reddy	Sri K Raja Mohan Reddy
HOD	Principal	Director	Managing Director	Correspondent Secretary, Treasurer	Vice Chairman	Chairman

ksrmceofficial www.ksrmce.ac.in 8143731980, 857697569

Report

of

Certification Course on Design of Compression members using Microsoft Excel

From 12/04/2022 to 30/04/2022

Target Group	:	**Students**
Details of Participants	:	**34 Students**
Co-coordinator(s)	:	**Miss. V. Sai Neeraja**
Organizing Department	:	**Civil Engineering**
Venue	:	**Computer Lab, Dept. of Civil Engg.**

Description:

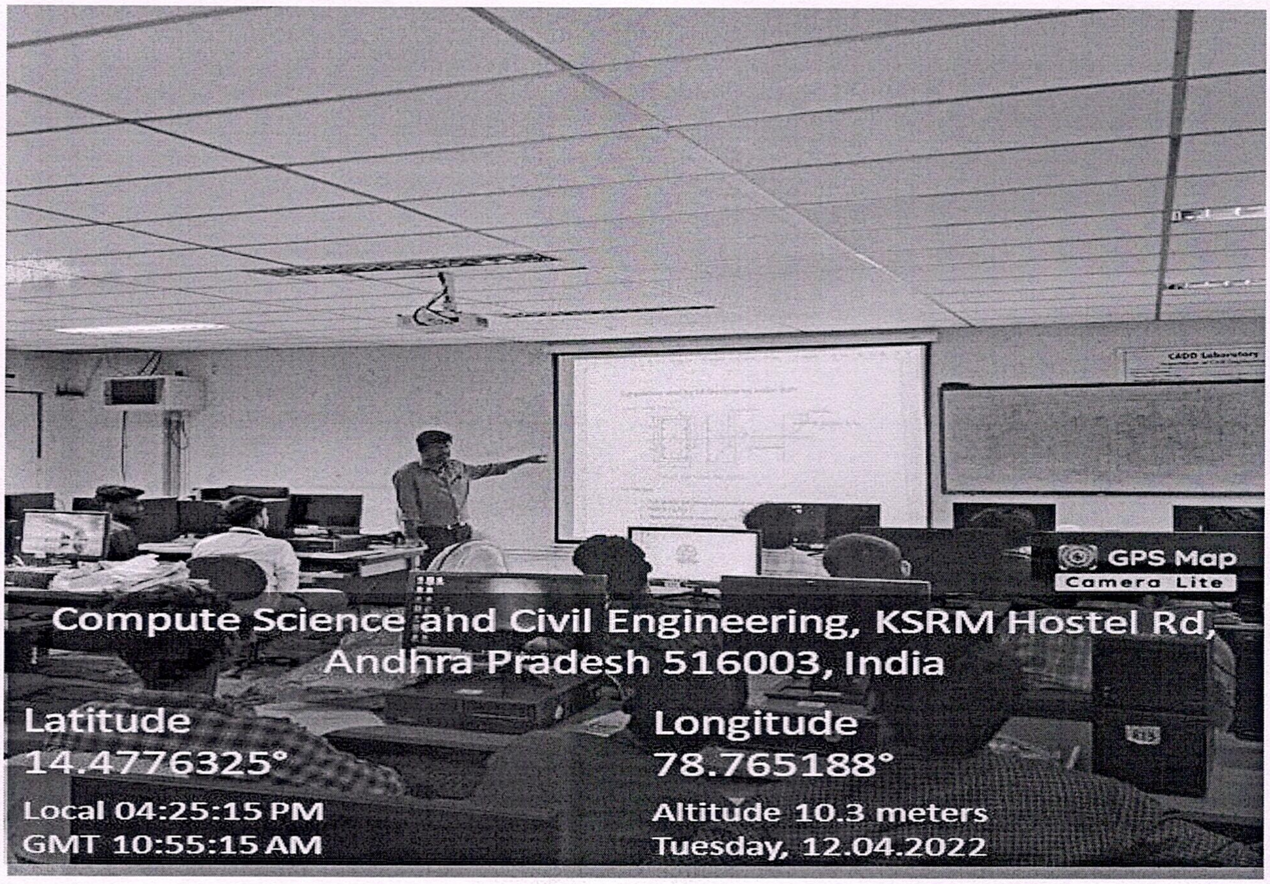
The Department of Civil Engineering conducted a certification course on "Design of Compression members using Microsoft Excel" from 12th April 2022 to 30th April 2022. The course duration was 34 hours and the session on every day was planned from 4 PM – 6 PM. The course instructor is Sri K. Hemanth Kumar Reddy, Assistant Professor, Department Civil Engineering and Coordinator is Miss. V. Sai Neeraja, Assistant Professor, Department of Civil Engineering.

The main design criteria for the compression members are effective cross sectional area and slenderness ratio of the members. Failure criteria such as buckling or crushing was also depending on the above two parameters. Instead of relying on the design software output for both steel and concrete quantities, it is better to design own economical sections using Microsoft excel by taking required data from design software.

The course was designed by considering the students have basic knowledge in Microsoft Excel. The course covered all types of compression member i.e. axially loaded members, members subjected to uniaxial bending and biaxial bending. Design was performed using both SP16 Code and interaction curve in IS 456.

Photo:

The picture taken during the course is given below:



(Course Coordinator)

(HoD, Civil Engg.)

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
(Autonomous)
KADAPA 516 003. (A.P.)

K.S.R.M College of Engineering

(AUTONOMOUS)

KADAPA, ANDHRA PRADESH, INDIA-516003

DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE OF COURSE COMPLETION

This certificate is presented to

Suneetha C. (Reg. No. 189Y1A0119), Student of KSRM College of Engineering (Autonomous) for successful completion of certification course on "**Design of compression members Using Microsoft Excel**" offered by Department of Civil Engineering, KSRMCE-Kadapa.

Course Duration:
From 12/04/2022 to 30/04/2022

Course Instructor:
Sri K Hemanth Kumar Reddy,
Assistant Professor, CE, KSRMCE-Kadapa

Coordinator

Head of the Department

V. S. S. Murthy

Principal

K.S.R.M College of Engineering

(AUTONOMOUS)

KADAPA, ANDHRA PRADESH, INDIA-516003

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DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE OF COURSE COMPLETION

This certificate is presented to

Govardhan K. (Reg. No. 189Y1A0146), Student of KSRM College of Engineering (Autonomous) for successful completion of certification course on "**Design of compression members Using Microsoft Excel**" offered by Department of Civil Engineering, KSRMCE-Kadapa.

Course Duration:
From 12/04/2022 to 30/04/2022

Course Instructor:
Sri K Hemanth Kumar Reddy,
Assistant Professor, CE, KSRMCE-Kadapa

Coordinator

Head of the Department

V. S. S. Murthy

Principal

K.S.R.M College of Engineering

(AUTONOMOUS)

KADAPA, ANDHRA PRADESH, INDIA-516003

KANDULA SREENIVASA REDDY MEMORIAL COLLEGE OF ENGINEERING KADAPA LIGHTED TO LIGHTEN

DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE OF COURSE COMPLETION

This certificate is presented to

Sreenivasulu D. (Reg. No. 199Y5A0115), Student of KSRM College of Engineering (Autonomous) for successful completion of certification course on "**Design of compression members Using Microsoft Excel**" offered by Department of Civil Engineering, KSRMCE-Kadapa.

Course Duration:
From 12/04/2022 to 30/04/2022

Course Instructor:
Sri K Hemanth Kumar Reddy,
Assistant Professor, CE, KSRMCE-Kadapa

Coordinator | Head of the Department | V. S. S. Murthy Principal

K.S.R.M College of Engineering

(AUTONOMOUS)

KADAPA, ANDHRA PRADESH, INDIA-516003

DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE OF COURSE COMPLETION

This certificate is presented to

Sravani S. (Reg. No. 199Y5A0155), Student of KSRM College of Engineering (Autonomous) for successful completion of certification course on "**Design of compression members Using Microsoft Excel**" offered by Department of Civil Engineering, KSRMCE-Kadapa.

Course Duration:
From 12/04/2022 to 30/04/2022

Course Instructor:
Sri K Hemanth Kumar Reddy,
Assistant Professor, CE, KSRMCE-Kadapa

Coordinator

Head of the Department

V. S. S. Murthy
Principal

Feedback form for "Certification course on Design of Compression members Using Microsoft Excel"

reddysrinu@ksrmce.ac.in Switch account

Your email will be recorded when you submit this form

* Required

Name of The Student *

Your answer

Reg. No. *

Your answer

Do you understand use of Excel for Civil Engg.? *

- ◯ Yes
- ◯ No

Are the lecture hours sufficient to cover the topics? *

- ◯ Yes
- ◯ No

Rate the course instructor *

1-Low, 5-High

1 ○

2 ○

3 ○

4 ○

5 ○

Is this course useful for your Carrier? *

○ Yes

○ No

Rate the entire course? *

1-Low, 5-High

1 ○

2 ○

3 ○

4 ○

5 ○

Submit

Clear form

Department of Civil Engineering

Feedback of students on Certification Course on "Design of Compression members using Microsoft Excel"

Sl. No.	Reg. No.	Name of The Student	Do you understand use of Excel for Civil Engg.?	Are the lecture hours sufficient to cover the topics?	Rate the course instructor	Is this course useful for your Carrier?	Rate the entire course?
1	189Y1A0109	Rama Chandrareddy Bommireddy	Yes	Yes	5	Yes	5
2	189Y1A0115	Satish Kumar Yadav Chennuboyina	Yes	Yes	5	Yes	5
3	189Y1A0119	Suneetha Chirasani	Yes	Yes	5	Yes	5
4	189Y1A0120	Anilkumar Chittiboyina	Yes	Yes	5	Yes	5
5	189Y1A0123	Rama Mohan Derangula	Yes	Yes	5	Yes	5
6	189Y1A0128	Venkata Sainath Reddy G Y	Yes	No	5	Yes	4
7	189Y1A0132	Lakshmi Prasad Reddy Guddila	Yes	Yes	5	Yes	5
8	189Y1A0134	Nitheesh Gunigari	Yes	Yes	4	Yes	5
9	189Y1A0135	Sreeveni Hasti	Yes	Yes	4	Yes	5
10	189Y1A0144	Bhanumanikanta Reddy Kannapu	Yes	Yes	5	Yes	5
11	189Y1A0145	Sai Mallikarjuna Reddy Karnati	Yes	Yes	5	Yes	5
12	189Y1A0146	Govardhan Kaveti	Yes	Yes	5	Yes	5
13	189Y1A0150	Lokeswar Reddy Kudamala	Yes	Yes	5	Yes	5
14	189Y1A0156	Sudheer Kumar Maadam	Yes	Yes	5	Yes	5
15	189Y1A0158	Lokeshwar Reddy Mallireddy	Yes	Yes	5	Yes	5
16	189Y1A0159	Ganesh Mandla	Yes	Yes	5	Yes	5
17	189Y1A0165	Purushotham Reddy Mitta	Yes	Yes	5	Yes	5

18	189Y1A0166	Siva Prasad Reddy Mitta	Yes	Yes	5	Yes	5
19	189Y1A0172	Venkatesh Nagirikanti	Yes	Yes	5	Yes	4
20	189Y1A0175	Abhish Nanubala	Yes	Yes	5	Yes	5
21	189Y1A0179	Jayachandra Sai Pandugolu	Yes	Yes	5	Yes	5
22	189Y1A0187	Rakesh Prasanna Penubala	Yes	Yes	5	Yes	5
23	189Y1A01A3	Mohammad Arshad Shaik	Yes	Yes	4	Yes	5
24	189Y1A01B0	Sateesh Kumar Reddy Thallapalle	Yes	Yes	5	Yes	5
25	189Y1A01B4	Gayathri Thopudurthy	Yes	Yes	5	Yes	5
26	189Y1A01B8	Venkata Hemanth Usugari	Yes	Yes	5	Yes	5
27	189Y1A01C3	Ganga Swetha Vennapusa	Yes	Yes	5	Yes	5
28	189Y1A01C8	Sivanatha Reddy Yeturu	Yes	Yes	5	Yes	5
29	199Y5A0112	Mahesh Babu Chinthakunta	Yes	Yes	5	Yes	5
30	199Y5A0113	Hari Krishna Chittiboina	Yes	Yes	5	Yes	5
31	199Y5A0115	Sreenivasulu Dasari	Yes	Yes	5	Yes	5
32	199Y5A0127	Venkateswarlu Kashetty	Yes	Yes	5	Yes	5
33	199Y5A0150	Sambasivareddy Sanikommu	Yes	Yes	5	Yes	5
34	199Y5A0155	Sravani Sirigiri	Yes	Yes	5	Yes	5

Coordinator

HoD-Civil Engg.

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
(Autonomous)
KADAPA 516 003. (A.P.)

K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516003
DEPARTMENT OF CIVIL ENGINEERING
CERTIFICATE COURSE ON
DESIGN OF COMPRESSION MEMBERS USING MICROSOFT EXCEL
MARKS AWARD LIST

S.No	Roll Number	Name of the Student	Marks Obtained
1	189Y1A0109	Rama Chandrareddy Bommireddy	7
2	189Y1A0115	Satish Kumar Yadav Chennuboyina	11
3	189Y1A0119	Suneetha Chirasani	13
4	189Y1A0120	Anilkumar Chittiboyina	16
5	189Y1A0123	Rama Mohan Derangula	16
6	189Y1A0128	Venkata Sainath Reddy G Y	12
7	189Y1A0132	Lakshmi Prasad Reddy Guddila	13
8	189Y1A0134	Nitheesh Gunigari	13
9	189Y1A0135	Sreeveni Hasti	18
10	189Y1A0144	Bhanumanikanta Reddy Kannapu	19
11	189Y1A0145	Sai Mallikarjuna Reddy Karnati	19
12	189Y1A0146	Govardhan Kaveti	13
13	189Y1A0150	Lokeswar Reddy Kudamala	8
14	189Y1A0156	Sudheer Kumar Maadam	16
15	189Y1A0158	Lokeshwar Reddy Mallireddy	10
16	189Y1A0159	Ganesh Mandla	13
17	189Y1A0165	Purushotham Reddy Mitta	16
18	189Y1A0166	Siva Prasad Reddy Mitta	19
19	189Y1A0172	Venkatesh Nagirikanti	14
20	189Y1A0175	Abhish Nanubala	14
21	189Y1A0179	Jayachandra Sai Pandugolu	18
22	189Y1A0187	Rakesh Prasanna Penubala	17
23	189Y1A01A3	Mohammad Arshad Shaik	14
24	189Y1A01B0	Sateesh Kumar Reddy Thallapalle	12
25	189Y1A01B4	Gayathri Thopudurthy	18
26	189Y1A01B8	Venkata Hemanth Usugari	17
27	189Y1A01C3	Ganga Swetha Vennapusa	5

28	189Y1A01C8	Sivanatha Reddy Yeturu	16
29	199Y5A0112	Mahesh Babu Chinthakunta	15
30	199Y5A0113	Hari Krishna Chittiboina	11
31	199Y5A0115	Sreenivasulu Dasari	17
32	199Y5A0127	Venkateswarlu Kashetty	14
33	199Y5A0150	Sambasivareddy Sanikommu	14
34	199Y5A0155	Sravani Sirigiri	12

Coordinator **HoD**

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
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K.S.R.M. COLLEGE OF ENGINEERING (AUTONOMOUS), KADAPA-516003
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CERTIFICATE COURSE ON
DESIGN OF COMPRESSION MEMBERS USING MICROSOFT EXCEL
ASSESSMENT TEST

Name of the Student: R. Mohan Devansh **Reg. Number:** 189Y1A0123

Time: 20 Min **(Objective Questions)** **Max. Marks: 20**

Note: Answer the following Questions and each question carries **one** mark.

1	What is the primary purpose of designing compression members in structural engineering?				[C] ✓
	A) To resist bending forces	B) To withstand tensile stresses	C) To resist axial loads that result in compression	D) To provide aesthetic appeal	
2	Which structural element is commonly designed as a compression member in building construction?				[B] ✓
	A) Beams	B) Columns	C) Roof trusses	D) Foundations	
3	In structural engineering, what is the term for a member that is subject to both axial compression and bending?				[B] ✓
	A) Tension member	B) Combined member	C) Cantilever member	D) Shear member	
4	What is Euler's critical load in compression member design?				[B] ✓
	A) The load at which the member fails	B) The load at which buckling occurs with no resistance	C) The load at which the member experiences maximum stress	D) The load at which the member reaches its yield point	
5	In the context of structural engineering, what does "L/r" represent when designing compression members?				[B] ✓
	A) The length of the member divided by its radius	B) The slenderness ratio of the member	C) The load acting on the member	D) The lateral support provided to the member	
6	Which equation is commonly used to calculate the critical buckling load for a compression member?				[C] ✓
	A) Hooke's Law	B) Pythagorean Theorem	C) Euler's Formula	D) Archimedes' Principle	
7	What is the term for a compression member that is braced against lateral movement?				[C] ✗
	A) Pinned column	B) Fixed column	C) Unbraced column	D) Braced column	
8	Which factor affects the slenderness ratio (L/r) of a compression member?				[C] ✓
	A) The material strength	B) The cross-sectional area	C) The length and radius of gyration	D) The axial load	
9	What does the "radius of gyration" (r) represent in the context of compression member design?				[B] ✓
	A) The member's actual radius	B) A measure of the member's	C) The distance between lateral	D) The load applied to the member	

		resistance to bending	supports		
10	What is the primary reason for designing compression members with adequate lateral bracing or support?				
	A) To increase the member's axial load-carrying capacity	B) To decrease the member's critical buckling load	C) To reduce the member's material strength	D) To prevent lateral buckling or instability	[D]
11	Which Microsoft Excel function is commonly used to calculate the critical buckling load in compression member design?				
	A) SUM	B) AVERAGE	C) IF	D) Solver	[D]
12	What is the primary purpose of applying safety factors in compression member design?				
	A) To increase the risk of failure	B) To decrease the applied axial load	C) To account for uncertainties and variations in design parameters	D) To ignore the effects of lateral bracing	[B] X
13	Which of the following is NOT a common material used for compression members in building construction?				
	A) Steel	B) Concrete	C) Wood	D) Glass	[D]
14	What is the term for a compression member that is free to rotate at one end and fixed at the other end?				
	A) Pinned column	B) Fixed column	C) Cantilever column	D) Slenderness column	[C]
15	In Microsoft Excel, what function can be used to calculate the slenderness ratio (L/r) of a compression member?				
	A) VLOOKUP	B) INDEX	C) MATCH	D) DIVIDE	[C] X
16	Which Excel tool is commonly used for creating charts and visual representations of compression member design results?				
	A) Excel Solver	B) Excel PivotTable	C) Excel Chart	D) Excel Filter	[C]
17	What is the primary objective of compression member design?				
	A) To maximize the member's axial load-carrying capacity	B) To minimize the member's slenderness ratio	C) To achieve an aesthetically pleasing design	D) To ignore lateral bracing requirements	[C] X
18	What does the term "buckling" refer to in compression member design?				
	A) The load-carrying capacity of the member	B) The bending of the member due to lateral forces	C) The lateral instability or failure of the member	D) The compressive strength of the member	[C]
19	What is the primary objective of lateral-torsional buckling analysis in compression member design?				
	A) To calculate the member's axial load	B) To determine the member's yield point	C) To assess the member's resistance to bending and torsion	D) To ignore lateral stability	[C]
20	Which Excel function can be used to calculate the safety factor for a compression member design?				
	A) IF	B) MAX	C) SUM	D) AVERAGE	[A]

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CERTIFICATE COURSE ON
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ASSESSMENT TEST

Name of the Student: C. Anilkumar **Reg. Number:** 18941A0120

Time: 20 Min **(Objective Questions)** **Max. Marks: 20**

Note: Answer the following Questions and each question carries **one** mark.

1	What is the primary purpose of designing compression members in structural engineering?				[C] ✓
	A) To resist bending forces	B) To withstand tensile stresses	C) To resist axial loads that result in compression	D) To provide aesthetic appeal	
2	Which structural element is commonly designed as a compression member in building construction?				[B] ✓
	A) Beams	B) Columns	C) Roof trusses	D) Foundations	
3	In structural engineering, what is the term for a member that is subject to both axial compression and bending?				[B ✓
	A) Tension member	B) Combined member	C) Cantilever member	D) Shear member	
4	What is Euler's critical load in compression member design?				[B ✓
	A) The load at which the member fails	B) The load at which buckling occurs with no resistance	C) The load at which the member experiences maximum stress	D) The load at which the member reaches its yield point	
5	In the context of structural engineering, what does "L/r" represent when designing compression members?				[B ✓
	A) The length of the member divided by its radius	B) The slenderness ratio of the member	C) The load acting on the member	D) The lateral support provided to the member	
6	Which equation is commonly used to calculate the critical buckling load for a compression member?				[C ✓
	A) Hooke's Law	B) Pythagorean Theorem	C) Euler's Formula	D) Archimedes' Principle	
7	What is the term for a compression member that is braced against lateral movement?				[B ✗
	A) Pinned column	B) Fixed column	C) Unbraced column	D) Braced column	
8	Which factor affects the slenderness ratio (L/r) of a compression member?				[C] ✓
	A) The material strength	B) The cross-sectional area	C) The length and radius of gyration	D) The axial load	
9	What does the "radius of gyration" (r) represent in the context of compression member design?				[A ✗
	A) The member's actual radius	B) A measure of the member's	C) The distance between lateral	D) The load applied to the member	

		resistance to bending	supports		
10	What is the primary reason for designing compression members with adequate lateral bracing or support?				
	A) To increase the member's axial load-carrying capacity	B) To decrease the member's critical buckling load	C) To reduce the member's material strength	D) To prevent lateral buckling or instability	[D
11	Which Microsoft Excel function is commonly used to calculate the critical buckling load in compression member design?				[A
	A) SUM	B) AVERAGE	C) IF	D) Solver	
12	What is the primary purpose of applying safety factors in compression member design?				
	A) To increase the risk of failure	B) To decrease the applied axial load	C) To account for uncertainties and variations in design parameters	D) To ignore the effects of lateral bracing	[C
13	Which of the following is NOT a common material used for compression members in building construction?				[D
	A) Steel	B) Concrete	C) Wood	D) Glass	
14	What is the term for a compression member that is free to rotate at one end and fixed at the other end?				
	A) Pinned column	B) Fixed column	C) Cantilever column	D) Slenderness column	[C
15	In Microsoft Excel, what function can be used to calculate the slenderness ratio (L/r) of a compression member?				[D
	A) VLOOKUP	B) INDEX	C) MATCH	D) DIVIDE	
16	Which Excel tool is commonly used for creating charts and visual representations of compression member design results?				
	A) Excel Solver	B) Excel PivotTable	C) Excel Chart	D) Excel Filter	[C
17	What is the primary objective of compression member design?				
	A) To maximize the member's axial load-carrying capacity	B) To minimize the member's slenderness ratio	C) To achieve an aesthetically pleasing design	D) To ignore lateral bracing requirements	[A
18	What does the term "buckling" refer to in compression member design?				
	A) The load-carrying capacity of the member	B) The bending of the member due to lateral forces	C) The lateral instability or failure of the member	D) The compressive strength of the member	[B
19	What is the primary objective of lateral-torsional buckling analysis in compression member design?				
	A) To calculate the member's axial load	B) To determine the member's yield point	C) To assess the member's resistance to bending and torsion	D) To ignore lateral stability	[C
20	Which Excel function can be used to calculate the safety factor for a compression member design?				
	A) IF	B) MAX	C) SUM	D) AVERAGE	[A

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CERTIFICATE COURSE ON
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ASSESSMENT TEST

Name of the Student: B. Ramachandra Reddy **Reg. Number:** 189Y1A0109

Time: 20 Min **(Objective Questions)** **Max. Marks: 20**

Note: Answer the following Questions and each question carries **one** mark.

1	What is the primary purpose of designing compression members in structural engineering?				[A]
	A) To resist bending forces	B) To withstand tensile stresses	C) To resist axial loads that result in compression	D) To provide aesthetic appeal	
2	Which structural element is commonly designed as a compression member in building construction?				[A]
	A) Beams	B) Columns	C) Roof trusses	D) Foundations	
3	In structural engineering, what is the term for a member that is subject to both axial compression and bending?				[A]
	A) Tension member	B) Combined member	C) Cantilever member	D) Shear member	
4	What is Euler's critical load in compression member design?				[A]
	A) The load at which the member fails	B) The load at which buckling occurs with no resistance	C) The load at which the member experiences maximum stress	D) The load at which the member reaches its yield point	
5	In the context of structural engineering, what does "L/r" represent when designing compression members?				[A]
	A) The length of the member divided by its radius	B) The slenderness ratio of the member	C) The load acting on the member	D) The lateral support provided to the member	
6	Which equation is commonly used to calculate the critical buckling load for a compression member?				[A]
	A) Hooke's Law	B) Pythagorean Theorem	C) Euler's Formula	D) Archimedes' Principle	
7	What is the term for a compression member that is braced against lateral movement?				[A]
	A) Pinned column	B) Fixed column	C) Unbraced column	D) Braced column	
8	Which factor affects the slenderness ratio (L/r) of a compression member?				[A]
	A) The material strength	B) The cross-sectional area	C) The length and radius of gyration	D) The axial load	
9	What does the "radius of gyration" (r) represent in the context of compression member design?				[A]
	A) The member's actual radius	B) A measure of the member's	C) The distance between lateral	D) The load applied to the member	

		resistance to bending	supports		
10	What is the primary reason for designing compression members with adequate lateral bracing or support?				
	A) To increase the member's axial load-carrying capacity	B) To decrease the member's critical buckling load	C) To reduce the member's material strength	D) To prevent lateral buckling or instability	[A]
11	Which Microsoft Excel function is commonly used to calculate the critical buckling load in compression member design?				[A]
	A) SUM	B) AVERAGE	C) IF	D) Solver	
12	What is the primary purpose of applying safety factors in compression member design?				
	A) To increase the risk of failure	B) To decrease the applied axial load	C) To account for uncertainties and variations in design parameters	D) To ignore the effects of lateral bracing	[C]
13	Which of the following is NOT a common material used for compression members in building construction?				[D]
	A) Steel	B) Concrete	C) Wood	D) Glass	
14	What is the term for a compression member that is free to rotate at one end and fixed at the other end?				[C]
	A) Pinned column	B) Fixed column	C) Cantilever column	D) Slenderness column	
15	In Microsoft Excel, what function can be used to calculate the slenderness ratio (L/r) of a compression member?				[D]
	A) VLOOKUP	B) INDEX	C) MATCH	D) DIVIDE	
16	Which Excel tool is commonly used for creating charts and visual representations of compression member design results?				[C]
	A) Excel Solver	B) Excel PivotTable	C) Excel Chart	D) Excel Filter	
17	What is the primary objective of compression member design?				
	A) To maximize the member's axial load-carrying capacity	B) To minimize the member's slenderness ratio	C) To achieve an aesthetically pleasing design	D) To ignore lateral bracing requirements	[A]
18	What does the term "buckling" refer to in compression member design?				
	A) The load-carrying capacity of the member	B) The bending of the member due to lateral forces	C) The lateral instability or failure of the member	D) The compressive strength of the member	[C]
19	What is the primary objective of lateral-torsional buckling analysis in compression member design?				
	A) To calculate the member's axial load	B) To determine the member's yield point	C) To assess the member's resistance to bending and torsion	D) To ignore lateral stability	[A]
20	Which Excel function can be used to calculate the safety factor for a compression member design?				[C]
	A) IF	B) MAX	C) SUM	D) AVERAGE	

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<u>ASSESSMENT TEST</u>

Name of the Student: C. Satish. **Reg. Number:** 189Y1A0115

Time: 20 Min **(Objective Questions)** **Max. Marks: 20**

Note: Answer the following Questions and each question carries **one** mark.

1	What is the primary purpose of designing compression members in structural engineering?				[C] ✓
	A) To resist bending forces	B) To withstand tensile stresses	C) To resist axial loads that result in compression	D) To provide aesthetic appeal	
2	Which structural element is commonly designed as a compression member in building construction?				[B] ✓
	A) Beams	B) Columns	C) Roof trusses	D) Foundations	
3	In structural engineering, what is the term for a member that is subject to both axial compression and bending?				[B] ✓
	A) Tension member	B) Combined member	C) Cantilever member	D) Shear member	
4	What is Euler's critical load in compression member design?				[B] ✓
	A) The load at which the member fails	B) The load at which buckling occurs with no resistance	C) The load at which the member experiences maximum stress	D) The load at which the member reaches its yield point	
5	In the context of structural engineering, what does "L/r" represent when designing compression members?				[A] ✗
	A) The length of the member divided by its radius	B) The slenderness ratio of the member	C) The load acting on the member	D) The lateral support provided to the member	
6	Which equation is commonly used to calculate the critical buckling load for a compression member?				[D] ✗
	A) Hooke's Law	B) Pythagorean Theorem	C) Euler's Formula	D) Archimedes' Principle	
7	What is the term for a compression member that is braced against lateral movement?				[C] ✗
	A) Pinned column	B) Fixed column	C) Unbraced column	D) Braced column	
8	Which factor affects the slenderness ratio (L/r) of a compression member?				[A] ✗
	A) The material strength	B) The cross-sectional area	C) The length and radius of gyration	D) The axial load	
9	What does the "radius of gyration" (r) represent in the context of compression member design?				[D] ✗
	A) The member's actual radius	B) A measure of the member's	C) The distance between lateral	D) The load applied to the member	

		resistance to bending	supports		
10	What is the primary reason for designing compression members with adequate lateral bracing or support?				
	A) To increase the member's axial load-carrying capacity	B) To decrease the member's critical buckling load	C) To reduce the member's material strength	D) To prevent lateral buckling or instability	[D]
11	Which Microsoft Excel function is commonly used to calculate the critical buckling load in compression member design?				
	A) SUM	B) AVERAGE	C) IF	D) Solver	[D]
12	What is the primary purpose of applying safety factors in compression member design?				
	A) To increase the risk of failure	B) To decrease the applied axial load	C) To account for uncertainties and variations in design parameters	D) To ignore the effects of lateral bracing	[C]
13	Which of the following is NOT a common material used for compression members in building construction?				
	A) Steel	B) Concrete	C) Wood	D) Glass	[A]
14	What is the term for a compression member that is free to rotate at one end and fixed at the other end?				
	A) Pinned column	B) Fixed column	C) Cantilever column	D) Slenderness column	[D]
15	In Microsoft Excel, what function can be used to calculate the slenderness ratio (L/r) of a compression member?				
	A) VLOOKUP	B) INDEX	C) MATCH	D) DIVIDE	[B]
16	Which Excel tool is commonly used for creating charts and visual representations of compression member design results?				
	A) Excel Solver	B) Excel PivotTable	C) Excel Chart	D) Excel Filter	[D]
17	What is the primary objective of compression member design?				
	A) To maximize the member's axial load-carrying capacity	B) To minimize the member's slenderness ratio	C) To achieve an aesthetically pleasing design	D) To ignore lateral bracing requirements	[A]
18	What does the term "buckling" refer to in compression member design?				
	A) The load-carrying capacity of the member	B) The bending of the member due to lateral forces	C) The lateral instability or failure of the member	D) The compressive strength of the member	[C]
19	What is the primary objective of lateral-torsional buckling analysis in compression member design?				
	A) To calculate the member's axial load	B) To determine the member's yield point	C) To assess the member's resistance to bending and torsion	D) To ignore lateral stability	[C]
20	Which Excel function can be used to calculate the safety factor for a compression member design?				
	A) IF	B) MAX	C) SUM	D) AVERAGE	[A]

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CERTIFICATE COURSE ON
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ASSESSMENT TEST

Name of the Student: C. Suneetha **Reg. Number:** 18991A0119

Time: 20 Min **(Objective Questions)** **Max. Marks: 20**

Note: Answer the following Questions and each question carries **one** mark.

1	What is the primary purpose of designing compression members in structural engineering?				[C]
	A) To resist bending forces	B) To withstand tensile stresses	C) To resist axial loads that result in compression	D) To provide aesthetic appeal	
2	Which structural element is commonly designed as a compression member in building construction?				[C] ✗
	A) Beams	B) Columns	C) Roof trusses	D) Foundations	
3	In structural engineering, what is the term for a member that is subject to both axial compression and bending?				[C] ✗
	A) Tension member	B) Combined member	C) Cantilever member	D) Shear member	
4	What is Euler's critical load in compression member design?				[B]
	A) The load at which the member fails	B) The load at which buckling occurs with no resistance	C) The load at which the member experiences maximum stress	D) The load at which the member reaches its yield point	
5	In the context of structural engineering, what does "L/r" represent when designing compression members?				[D] ✗
	A) The length of the member divided by its radius	B) The slenderness ratio of the member	C) The load acting on the member	D) The lateral support provided to the member	
6	Which equation is commonly used to calculate the critical buckling load for a compression member?				[C]
	A) Hooke's Law	B) Pythagorean Theorem	C) Euler's Formula	D) Archimedes' Principle	
7	What is the term for a compression member that is braced against lateral movement?				[D]
	A) Pinned column	B) Fixed column	C) Unbraced column	D) Braced column	
8	Which factor affects the slenderness ratio (L/r) of a compression member?				[B] ✗
	A) The material strength	B) The cross-sectional area	C) The length and radius of gyration	D) The axial load	
9	What does the "radius of gyration" (r) represent in the context of compression member design?				[C] ✗
	A) The member's actual radius	B) A measure of the member's	C) The distance between lateral	D) The load applied to the member	

		resistance to bending	supports		
10	What is the primary reason for designing compression members with adequate lateral bracing or support?				
	A) To increase the member's axial load-carrying capacity	B) To decrease the member's critical buckling load	C) To reduce the member's material strength	D) To prevent lateral buckling or instability	[D]
11	Which Microsoft Excel function is commonly used to calculate the critical buckling load in compression member design?				
	A) SUM	B) AVERAGE	C) IF	D) Solver	[C]
12	What is the primary purpose of applying safety factors in compression member design?				
	A) To increase the risk of failure	B) To decrease the applied axial load	C) To account for uncertainties and variations in design parameters	D) To ignore the effects of lateral bracing	[D]
13	Which of the following is NOT a common material used for compression members in building construction?				
	A) Steel	B) Concrete	C) Wood	D) Glass	[D]
14	What is the term for a compression member that is free to rotate at one end and fixed at the other end?				
	A) Pinned column	B) Fixed column	C) Cantilever column	D) Slenderness column	[C]
15	In Microsoft Excel, what function can be used to calculate the slenderness ratio (L/r) of a compression member?				
	A) VLOOKUP	B) INDEX	C) MATCH	D) DIVIDE	[D]
16	Which Excel tool is commonly used for creating charts and visual representations of compression member design results?				
	A) Excel Solver	B) Excel PivotTable	C) Excel Chart	D) Excel Filter	[C]
17	What is the primary objective of compression member design?				
	A) To maximize the member's axial load-carrying capacity	B) To minimize the member's slenderness ratio	C) To achieve an aesthetically pleasing design	D) To ignore lateral bracing requirements	[A]
18	What does the term "buckling" refer to in compression member design?				
	A) The load-carrying capacity of the member	B) The bending of the member due to lateral forces	C) The lateral instability or failure of the member	D) The compressive strength of the member	[C]
19	What is the primary objective of lateral-torsional buckling analysis in compression member design?				
	A) To calculate the member's axial load	B) To determine the member's yield point	C) To assess the member's resistance to bending and torsion	D) To ignore lateral stability	[C]
20	Which Excel function can be used to calculate the safety factor for a compression member design?				
	A) IF	B) MAX	C) SUM	D) AVERAGE	[A]

CERTIFICATE COURSE ON

Design of Compression members

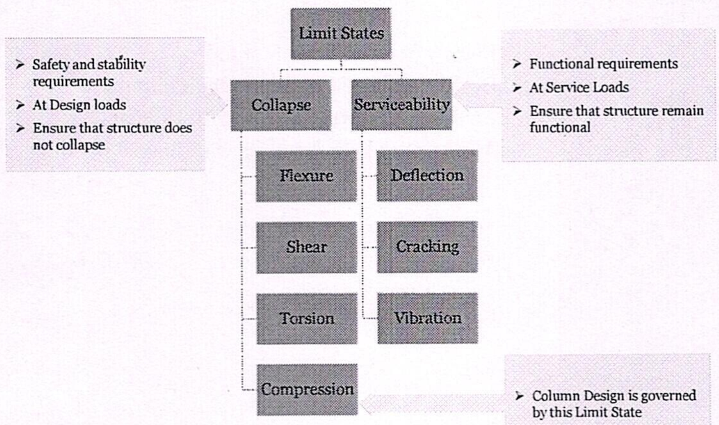
In This Workshop

- Review of Limit State Method
- Design of Short Axially Loaded Columns
- Analysis of Short Columns with Uniaxial Bending
- Analysis of Short Columns with Biaxial Bending

Review – What is a Limit State?

1. A Limit State is a state of impending failure, beyond which a structure ceases to perform its intended function in terms of safety and serviceability
2. On attainment of a Limit State a structure may either collapse or become unserviceable
3. Types of Limit States
   i. Limit States of Collapse
   ii. Limit States of Serviceability

Review – Types of Limit States



Review – Stress-Strain Diagrams for Fe415 Steel

Design Curve for Fe415

Stress Level	Elastic Strain	Inelastic Strain	Total Strain	Design Stress
0.800 f_y/1.15	0.00144	0.0000	0.00144	288.7
0.850 f_y/1.15	0.00153	0.0001	0.00163	306.7
0.900 f_y/1.15	0.00162	0.0003	0.00192	324.8
0.950 f_y/1.15	0.00171	0.0007	0.00241	342.8
0.975 f_y/1.15	0.00176	0.0010	0.00276	351.8
1.000 f_y/1.15	0.00180	0.0020	0.00380	360.9

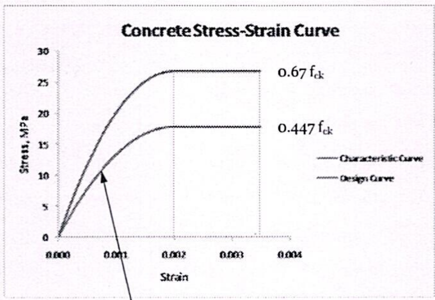
Review – Stress-Strain Diagrams for Fe500 Steel

Design Curve for Fe500

Stress Level	Elastic Strain	Inelastic Strain	Total Strain	Design Stress
0.800 f_y/1.15	0.00174	0.0000	0.00174	347.8
0.850 f_y/1.15	0.00185	0.0001	0.00195	369.6
0.900 f_y/1.15	0.00196	0.0003	0.00226	391.3
0.950 f_y/1.15	0.00207	0.0007	0.00277	413.0
0.975 f_y/1.15	0.00212	0.0010	0.00312	423.9
1.000 f_y/1.15	0.00217	0.0020	0.00417	434.8

Review – Stress-Strain Diagrams Concrete

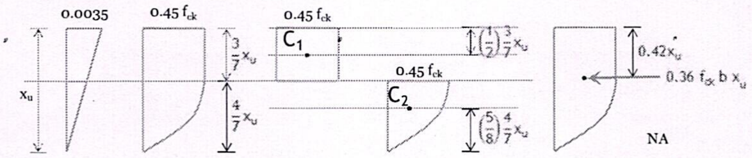
Characteristic and Design Curves



$$f_c = 0.447 f_{CK}\left[2\left(\frac{\varepsilon}{0.002}\right) - \left(\frac{\varepsilon}{0.002}\right)^2\right] \quad 0 \le \varepsilon \le 0.002$$

Review – Concrete (Full) Stress Block Parameters

Concrete Stress Block Parameters



Force $C_1 = b*0.45\ f_{ck}*\frac{3}{7}x_u = 0.193\ f_{ck} b\ x_u$ acting at $\frac{3}{14}x_u$ from top

Force $C_2 = b*\frac{2}{3}\ (0.45\ f_{ck})*\frac{4}{7}x_u = 0.17\ f_{ck} b\ x_u$ acting at $\frac{20}{56}x_u$ from NA

Total $C = (0.193+0.170) f_{ck}\ b\ x_u = 0.36\ f_{ck}\ b\ x_u$

$$\text{Location of C from Top} = \frac{0.193\ f_{ck}\ b\ x_u\left(\frac{3}{14}x_u\right) + 0.17\ f_{ck} b\ x_u\left(x_u - \frac{20}{56}x_u\right)}{0.36\ f_{ck}\ b\ x_u} = 0.42\ x_u$$

By This Time...

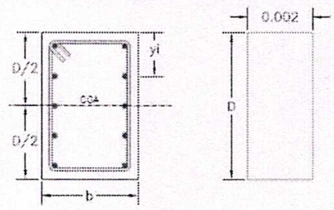
- Review of Limit State Method
- Design of Short Axially Loaded Columns
- Analysis of Short Columns with Uniaxial Bending
- Analysis of Short Columns with Biaxial Bending

Design of Axially Loaded Short Column

- A compression member is considered as short if slenderness ratio is less than 12 (§25.1.1)
- Maximum strain in axial compression is taken as 0.002 (§39.1.a)
- Minimum Eccentricity for design shall be (§25.4)
  - $e_{min} = l/500 + b/30$
  - $e_{min} = 20$ mm
- If $e_{min} < 0.05$ times lateral dimension, the design equation is given by §39.3

The member shall be designed by considering the assumptions given in 39.1 and the minimum eccentricity. When the minimum eccentricity as per 25.4 does not exceed 0.05 times the lateral dimension, the members may be designed by the following equation:

$$P_u = 0.4 f_{ck} . A_c + 0.67 f_y . A_{sc}$$



1. Pure Axial Compression (e=0)

Design of Axially Loaded Short Column

- For $\varepsilon = 0.002$, the design stresses are
  - For concrete : $0.447\ f_{ck}$
  - For Fe250 : $0.870\ f_y$
  - For Fe415 : $0.790\ f_y$
  - For Fe500 : $0.746\ f_y$
- Then Design strength is

$$P_u = 0.447\ f_{ck} A_g + (f_{sc} - 0.447\ f_{ck})\ A_{sc}$$

$$P_u = 0.447\ f_{ck} A_c + f_{sc} A_{sc}$$

- Code reduces the strength by about 10% and gives the Design strength as

$$P_u = 0.4\ f_{ck} A_c + 0.67\ f_y A_{sc}$$

- The required condition is $e \leq 0.05$ * lateral dimension

By This Time...

- Review of Limit State Method
- Design of Short Axially Loaded Columns
- Analysis of Short Columns with Uniaxial Bending
- Analysis of Short Columns with Biaxial Bending

Analysis of Short Column with Uniaxial Bending

Assumptions

- Plane sections normal to the axis remain plane after bending ⇒ strain varies linearly across the section
- The maximum strain in concrete (at highly compressed edge) is taken as

  $\varepsilon_{cu} = 0.0035$ if $x_u \leq D$ (⇒ section has both tension & compression)

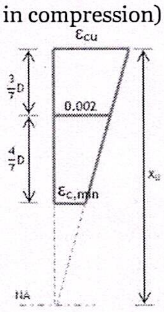
  $\varepsilon_{cu} = 0.0035 - 0.75\,\varepsilon_{c,min}$ if $x_u \geq D$ (⇒ total section is in compression)

The strain ε at any depth y from the most compressed edge is

$$\varepsilon = \varepsilon_{cu} - \frac{\varepsilon_{cu} - \varepsilon_{c,min}}{D}\,y$$

$$\varepsilon = \varepsilon_{cu} - \left[\frac{7}{3}\varepsilon_{cu} - \frac{4}{3}\,0.0035\right]\frac{y}{D}$$

$$\varepsilon = 0.002 \;\; at\; y = \frac{3}{7}D$$



- Tensile strength of concrete is ignored
- Stress in steel is derives from its representative stress-strain curve

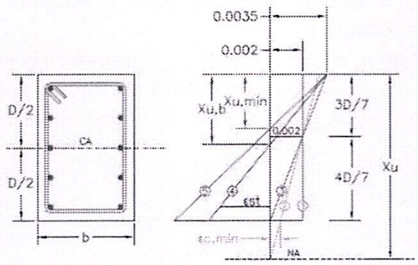
Analysis of Short Column with Uniaxial Bending

General Analysis Steps for a given Strain Profile

- Draw the stress diagram for concrete and find total compressive force C_u
- Calçulate the moment M_{uc} of C_u about the centroidal axis
- From strain profile determine strain ε_i in all steel bars and read corresponding stress f_{si} for each of the bars
- Calculate the total force in steel bars as $\Sigma C_{si} = \Sigma(f_{si} - f_{ci})A_{si}$. f_{ci} is the stress in concrete at the level of steel bar i
- Calculate moment of forces in steel bars about centroidal axis as ΣM_{si}
- Ultimate axial load $P_u = C_u + \Sigma C_{si}$
- Ultimate moment is $M_u = M_{uc} + \Sigma M_{si}$

Analysis of Short Column with Uniaxial Bending

General Strain Profiles at Limit State

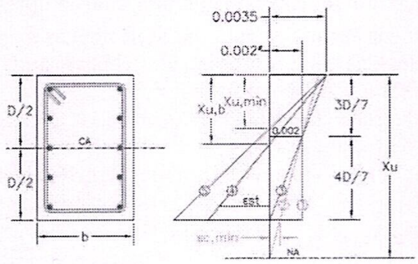


Case (1)

- Uniform compressive strain of $\varepsilon_{cu} = 0.002$ across the column section
- Eccentricity is zero ($e = 0$ and $M_u = 0$)
- Neutral axis is at infinity ($x_u = \infty$)

Analysis of Short Column with Uniaxial Bending

General Strain Profiles at Limit State

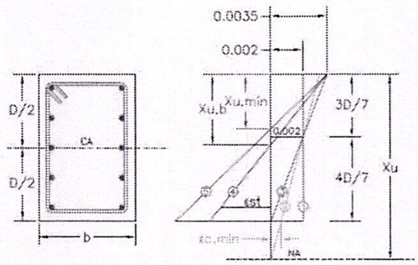


Case (2)

- General case of uniaxial compression ($M_u \neq 0$, $P_u \neq 0$)
- NA lies outside of section and $e_D < e < \infty$
- Strain varies linearly from ε_{cu} (<0.0035) to $\varepsilon_{c,min}$
- There is no tension in the column section

Analysis of Short Column with Uniaxial Bending

General Strain Profiles at Limit State

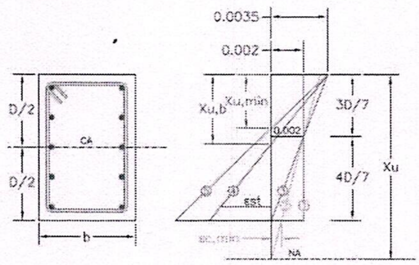


Case (3)

- NA coincides with the least compressed edge and $e = e_D$
- For $e > e_D$, entire section is under compression and NA lies outside of section
- For $e < e_D$, tension also exists, NA lies with the section and $\varepsilon_{cu} = 0.0035$

Analysis of Short Column with Uniaxial Bending

General Strain Profiles at Limit State

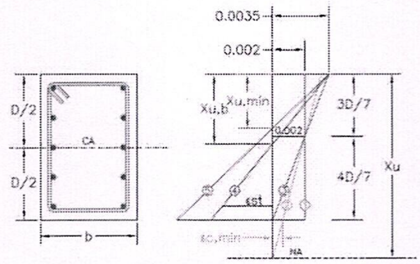


Case (4)

- Is called the balanced failure condition which is a tension failure
- NA depth is $x_{u,b} = d(\varepsilon_{cu}/(\varepsilon_{cu}+\varepsilon_{st}))$
- Maximum concrete strain $\varepsilon_{cu} = 0.0035$
- Maximum steel in steel $\varepsilon_{st} = \varepsilon_{yd}$

Analysis of Short Column with Uniaxial Bending

General Strain Profiles at Limit State

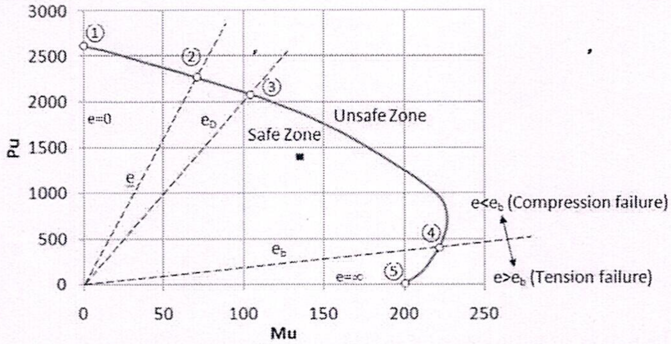


Case (5)

- Section is subjected to pure bending and axial load $P_u = 0$
- NA depth is minimum at $x_{u,min}$
- If $x_u < x_{u,min}$ then section is under axial tension and moment
- $x_{u,min}$ is found by trails

Analysis of Short Column with Uniaxial Bending

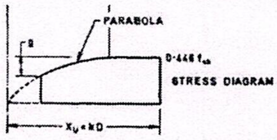
Interaction Curve



- Represents the design strength for a given column section
- If a design point (Mu, Pu) falls with in the design interaction, the section is safe; otherwise it is not

Analysis of Short Column with Uniaxial Bending

Stress Block Parameters for $x_u > D$



Let $x_u = kD$ and let g be the difference between the stress at the highly compressed edge and the stress at the least compressed edge. Considering the geometric properties of a parabola,

$$g = 0{\cdot}446 f_{ck} \left[\frac{\frac{4}{7}D}{kD - \frac{3}{7}D} \right]^2$$

$$= 0{\cdot}446 f_{ck} \left(\frac{4}{7k-3} \right)^2$$

Area of stress block

$$= 0{\cdot}446 f_{ck} D - \frac{g}{3}\left(\frac{4}{7}D\right)$$

$$= 0{\cdot}446 f_{ck} D - \frac{4}{21} gD$$

$$= 0{\cdot}446 f_{ck} D \left[1 - \frac{4}{21}\left(\frac{4}{7k-3}\right)^2\right]$$

The centroid of the stress block will be found by taking moments about the highly compressed edge.

Moment about the highly compressed edge

$$= 0{\cdot}446 f_{ck} D \left(\frac{D}{2}\right) - \frac{4}{21} gD \left[\frac{3}{7}D + \frac{3}{4}\left(\frac{4}{7}D\right)\right]$$

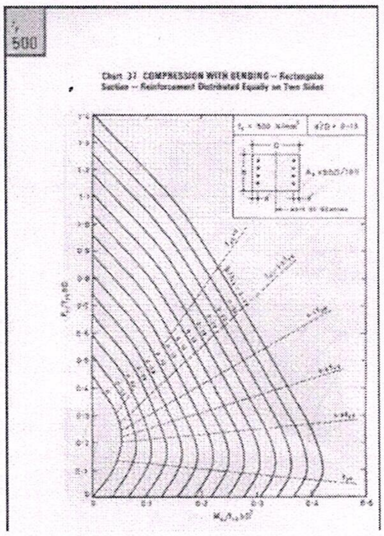
$$= 0{\cdot}446 f_{ck} \frac{D^2}{2} - \frac{8}{49} gD^2$$

The position of the centroid is obtained by dividing the moment by the area. For different values of k, the area of stress block and the position of its centroid are given in Table H.

Design of Short Column with Uniaxial Bending

Design of Section Using SP16

- Design charts are provided for rectangular and circular section
- Different configurations of steel placement for rectangular sections
- Charts for Fe250, Fe415 and Fe500
- Now-a-days computer programs are used for design



By This Time...

- ✓ Review of Limit State Method
- ✓ Design of Short Axially Loaded Columns
- ✓ Analysis of Short Columns with Uniaxial Bending
- Analysis of Short Columns with Biaxial Bending

Design of Short Column with Biaxial Bending

Simplified Code Procedure for Design

39.6 Members Subjected to Combined Axial Load and Biaxial Bending

The resistance of a member subjected to axial force and biaxial bending shall be obtained on the basis of assumptions given in **39.1** and **39.2** with neutral axis so chosen as to satisfy the equilibrium of load and moments about two axes. Alternatively such members may be designed by the following equation:

$$\left[\frac{M_{ux}}{M_{ux1}}\right]^{\alpha_n} + \left[\frac{M_{uy}}{M_{uy1}}\right]^{\alpha_n} \leq 1.0$$

where

M_{ux}, M_{uy} = moments about x and y axes due to design loads,

M_{ux1}, M_{uy1} = maximum uniaxial moment capacity for an axial load of P_u, bending about x and y axes respectively, and

α_n is related to P_u/P_{uz}

where $P_{uz} = 0.45 f_{ck} \cdot A_c + 0.75 f_y \cdot A_{sc}$

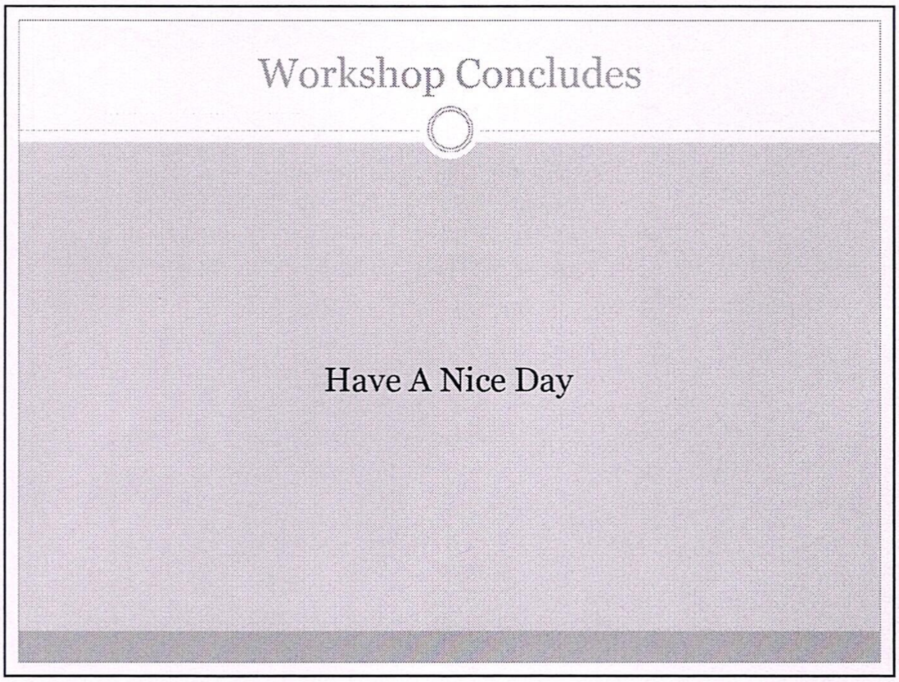
For values of P_u/P_{uz} = 0.2 to 0.8, the values of α_n vary linearly from 1.0 to 2.0. For values less than 0.2, α_n is 1.0; for values greater than 0.8, α_n is 2.0.

By This Time...

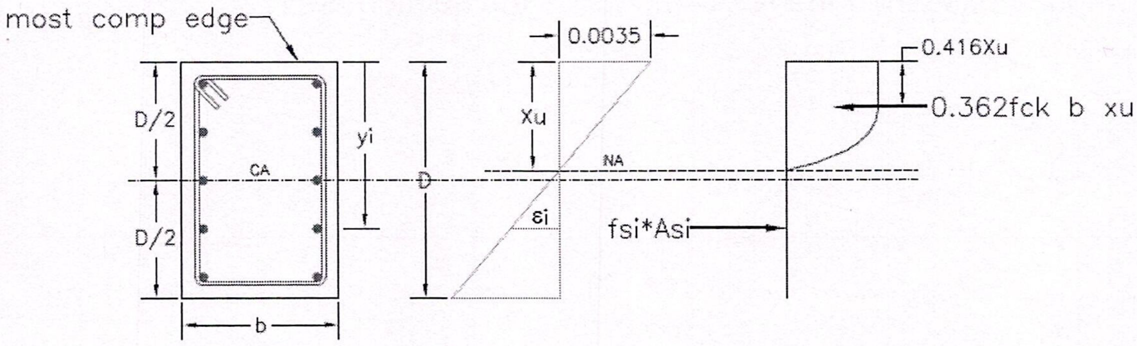
- Review of Limit State Method
- Design of Short Axially Loaded Columns
- Analysis of Short Columns with Uniaxial Bending
- Analysis of Short Columns with Biaxial Bending

Discussion

Queries Please!!!


Workshop Concludes
Have A Nice Day

Computations when the NA lies inside the section (k≤1)



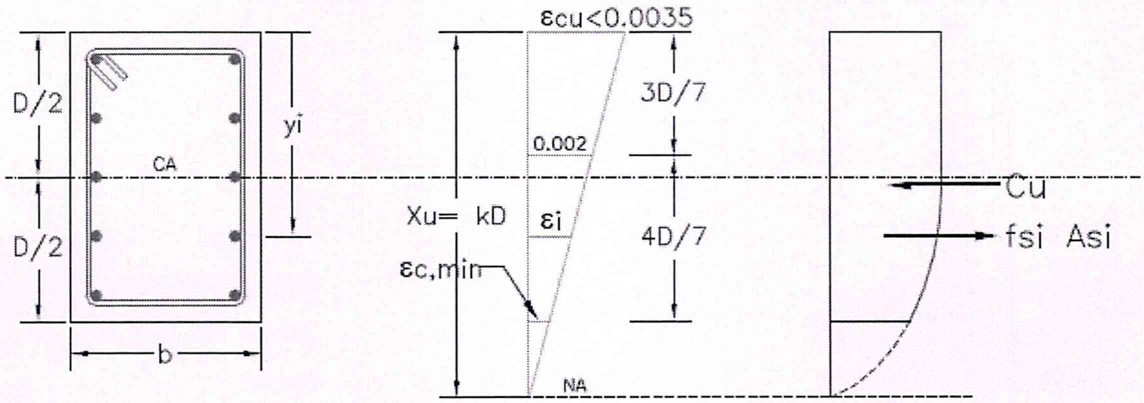
Neural Axis Inside the Section

For this case:

1. Both tension and compression exist in the section
2. Ratio $k = x_u/D \leq 1$
3. Maximum strain in concrete $\varepsilon_{CU} = 0.0035$
4. The condition $\varepsilon_{CU}=0.0035$ and maximum $\varepsilon_{Si} = 0.002+0.87f_y/E_S$ is balanced failure for which $X_U = (0.0035/(0.0055+0.87f_y/E_S)(D-c')$; c' is effective cover
5. $X_U \geq X_{UMIN}$, otherwise column will under tensile force. X_{MIN} is found by trials
6. The condition $X_U = X_{UMIN}$ is pure flexure failure $\Rightarrow P_U = 0, e = \infty$

Depth of NA	X_U (known or assumed)	
Force in concrete	$C_{UC} = 0.362\ f_{CK}\ b\ X_U$	
Moment of C_{uc} about CA	$M_{UC} = C_{UC}\ (\frac{1}{2}D - 0.416\ X_U)$	
Strain in concrete/steel in layer i	$\varepsilon_i = 0.0035\left(\frac{x_u - y_i}{x_u}\right)$	
Stress in concrete in layer i	$f_{Ci} = 0$	if $\varepsilon_i < 0$
	$f_{ci}=0.447f_{CK}\left[2\left(\frac{\varepsilon_i}{0.002}\right)-\left(\frac{\varepsilon_i}{0.002}\right)^2\right]$	if $0\leq \varepsilon_i \leq 0.002$
	$f_{Ci} = 0.447\ f_{CK}$	if $\varepsilon_i > 0.002$
Stress in Steel in layer i	Read f_{Si} from corresponding stress-strain curve	
Force in Steel in layer i	$C_{Si} = (f_{Si} - f_{Ci})\ A_{Si}$	
Moment of C_{Si} about CA	$M_{Si} = C_{Si}\ (\frac{1}{2}D - y_i)$	
Ultimate Axial load capacity	$P_U = C_{UC} + \Sigma C_{Si}$	
Ultimate Moment capacity	$M_U = M_{UC} + \Sigma M_{Si}$	

Computations when the NA lies outside the section (k>1)



Neutral Axis Outside of Section (0<e<eD)

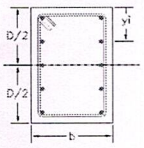
For this case:

1. Entire section is in compression
2. Ratio $k = x_u/D > 1$
3. Maximum strain ε_{CU} in concrete is such that $0.0020 \le \varepsilon_{CU} \le 0.0035$
4. The condition $\varepsilon_{CU} = 0.002$ is pure axial compression $\Rightarrow M_U = 0,\ e = 0\ \&\ X_U = \infty$

Description	Equation/Symbol	
Factor	$k = X_U/D$	
Force in concrete	$C_{UC}=0.447\left[1-\frac{4}{21}\left(\frac{4}{7k-3}\right)^2\right] f_{CK}bD$	
Moment of C_{UC} about CA	$M_{UC}=C_{UC}\left[0.5-\frac{0.5-\frac{8}{49}\left(\frac{4}{7k-3}\right)^2}{1-\frac{4}{21}\left(\frac{4}{7k-3}\right)^2}\right]D$	
Strain in concrete/steel in layer i	$\varepsilon_i=0.002\left(\frac{x_u-y_i}{x_u-\frac{3}{7}D}\right)$	
Stress in concrete in layer i	$f_{Ci} = 0$	if $\varepsilon_i < 0$
	$f_{ci}=0.447f_{CK}\left[2\left(\frac{\varepsilon_i}{0.002}\right)-\left(\frac{\varepsilon_i}{0.002}\right)^2\right]$	if $0 \le \varepsilon_i \le 0.002$
	$f_{Ci} = 0.447\ f_{CK}$	if $\varepsilon_i > 0.002$
Stress in Steel in layer i	Read f_{Si} from corresponding stress-strain curve	

Force in Steel in layer i	$C_{Si} = (f_{Si} - f_{Ci})\ A_{Si}$
Moment of C_{Si} about CA	$M_{Si} = C_{Si}\ (½D - y_i)$
Ultimate Axial load capacity	$P_U = C_{UC} + \Sigma C_{Si}$
Ultimate Moment capacity	$M_U = M_{UC} + \Sigma M_{Si}$

Analysis and Design of RCC Column
Case: Axial load with Uniaxial moment
Configuration: Equal on Two faces

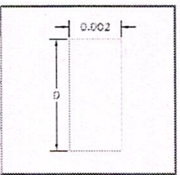


Section Properties			
Width	b=	300	mm
Depth	D=	500	mm
Clear Cover	c=	40	mm
Tie Diameter	Φv=	8	mm
Main Bar Diameter	Φ=	25	mm
Effective Cover	d'=	60.5	mm
Ratio	d'/D=	0.12	

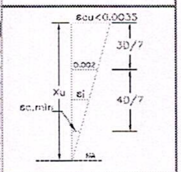
Materials and Design Loads			
Concrete Grade	fck=	25	MPa
Steel Grade	fy=	415	MPa
Factored Load	Pu=	1400	kN
Factored Moment	Mu=	135	kN
Eccentricity	e=	96	mm

Reinforcement			
% Steel	p=	1.90	%
No. of Layers	n=	3	
No. of Bars		6	

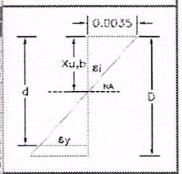
Case 1. Pure Axial Load Condition				xu=	∞	k=	∞
Layer	Yi	As	ε	fs	fc	P	M
1	60.5	950.0	0.002	327.7	11.2	300.7	57.0
2	250.0	950.0	0.002	327.7	11.2	300.7	0.0
3	439.5	950.0	0.002	327.7	11.2	300.7	-57.0
In Steel						902.2	0.0
In Concrete						1676.3	0.0
Total						2578.5	0.0



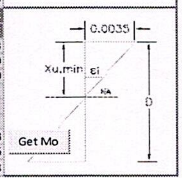
Case 2. NA outside section			xu=	650.0 mm		k=	1.300
Layer	Yi	As	ε	fs	fc	P	M
1	60.5	950.0	0.00271	350.4	11.2	322.3	61.1
2	250.0	950.0	0.00184	319.6	11.1	293.0	0.0
3	439.5	950.0	0.00097	193.7	8.2	176.2	-33.4
In Steel						791.6	27.7
In Concrete						1539.0	24.5
Total						2330.5	52.2



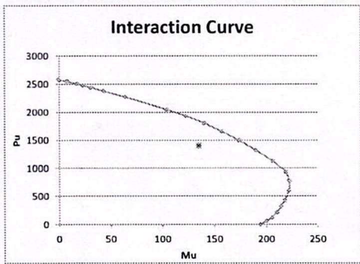
Case 4. Balanced Condition			xu,b=	210.6 mm		k=	0.421
Layer	Yi	As	ε	fs	fc	P	M
1	60.5	950.0	0.00249	345.0	11.2	317.1	60.1
2	250.0	950.0	-0.00066	-131.4	0.0	-124.8	0.0
3	439.5	950.0	-0.00381	-360.9	0.0	-342.9	65.0
In Steel						-150.6	125.1
In Concrete						571.7	92.8
Total						421.1	217.9



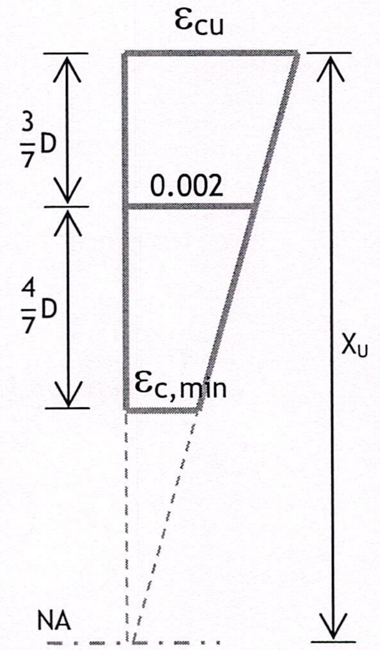
Case 5: Pure Flexure Condition			xu,min=	139.0 mm		k=	0.278
Layer	Yi	As	ε	fs	fc	P	M
1	60.5	950.0	0.00198	326.9	11.2	299.9	56.8
2	250.0	950.0	-0.00279	-352.1	0.0	-334.5	0.0
3	439.5	950.0	-0.00757	-360.9	0.0	-342.9	65.0
In Steel						-377.4	121.8
In Concrete						377.4	72.5
Total						0.0	194.3



Interaction Curve						
P	M	e	k	x	Remark	
0.0	194.3	∞	0.278	139.0	Flexure	
59.7	200.3	3352.3	0.307	153.3		Tension->
124.6	205.6	1649.9	0.335	167.6		
214.3	210.3	981.5	0.364	181.9		
322.8	214.4	664.4	0.393	196.3		
421.1	217.9	517.5	0.421	210.6	Balanced	
605.6	222.0	366.6	0.479	239.5		<-Compression
775.3	222.4	286.9	0.537	268.5		
938.5	219.0	233.4	0.595	297.4		
1128.2	206.5	183.0	0.653	326.3		
1320.8	190.1	143.9	0.711	355.3		
1496.3	173.8	116.2	0.768	384.2		
1658.4	157.4	94.9	0.826	413.2		
1801.4	140.3	77.9	0.884	442.1		
1929.1	122.9	63.7	0.942	471.1		
2048.4	104.3	50.9	1.000	500.0	e=eD	
2268.3	64.0	28.2	1.200	600.0		
2376.3	43.3	18.2	1.400	700.0		
2439.0	31.1	12.7	1.600	800.0		
2479.7	23.1	9.3	1.800	900.0		
2507.7	17.5	7.0	2.000	1000.0		
2550.6	7.9	3.1	3.000	1500.0		
2578.5	0.0	0.0	∞	∞	Axial	



$$f_c = 0.447 f_{CK} \left[2\left(\frac{\varepsilon}{0.002}\right) - \left(\frac{\varepsilon}{0.002}\right)^2 \right] \quad 0 \leq \varepsilon \leq 0.002$$

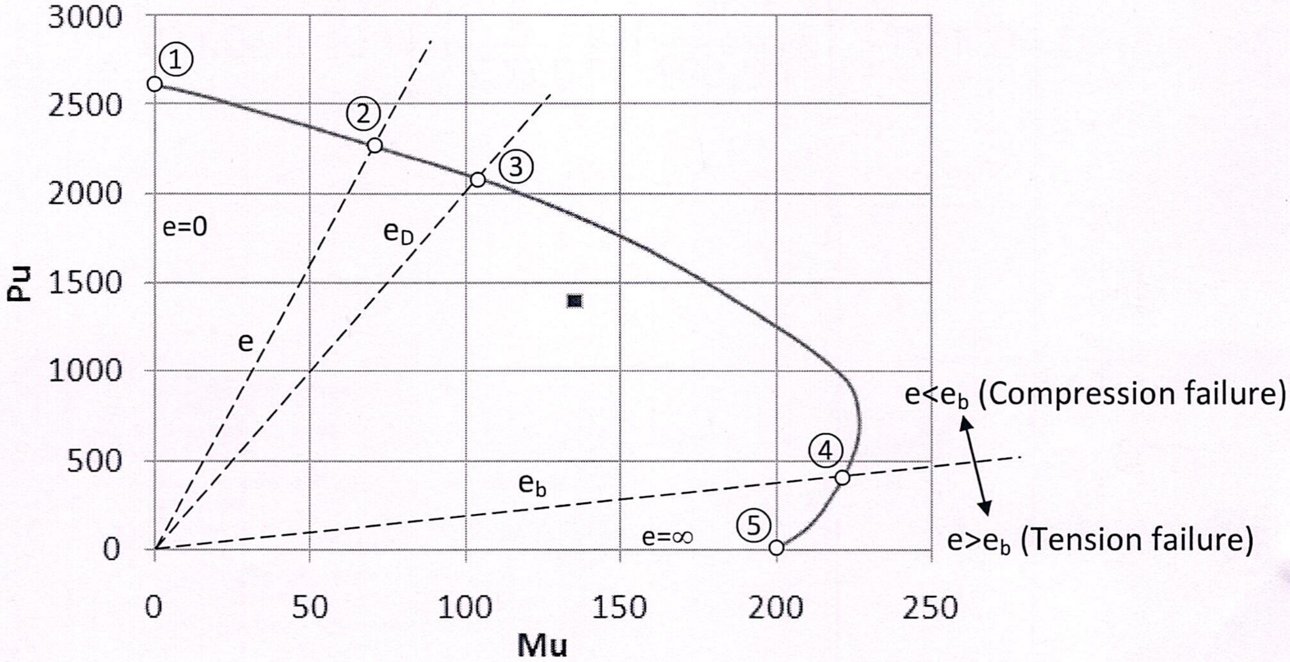


The strain ε at any depth y from the most compressed edge is

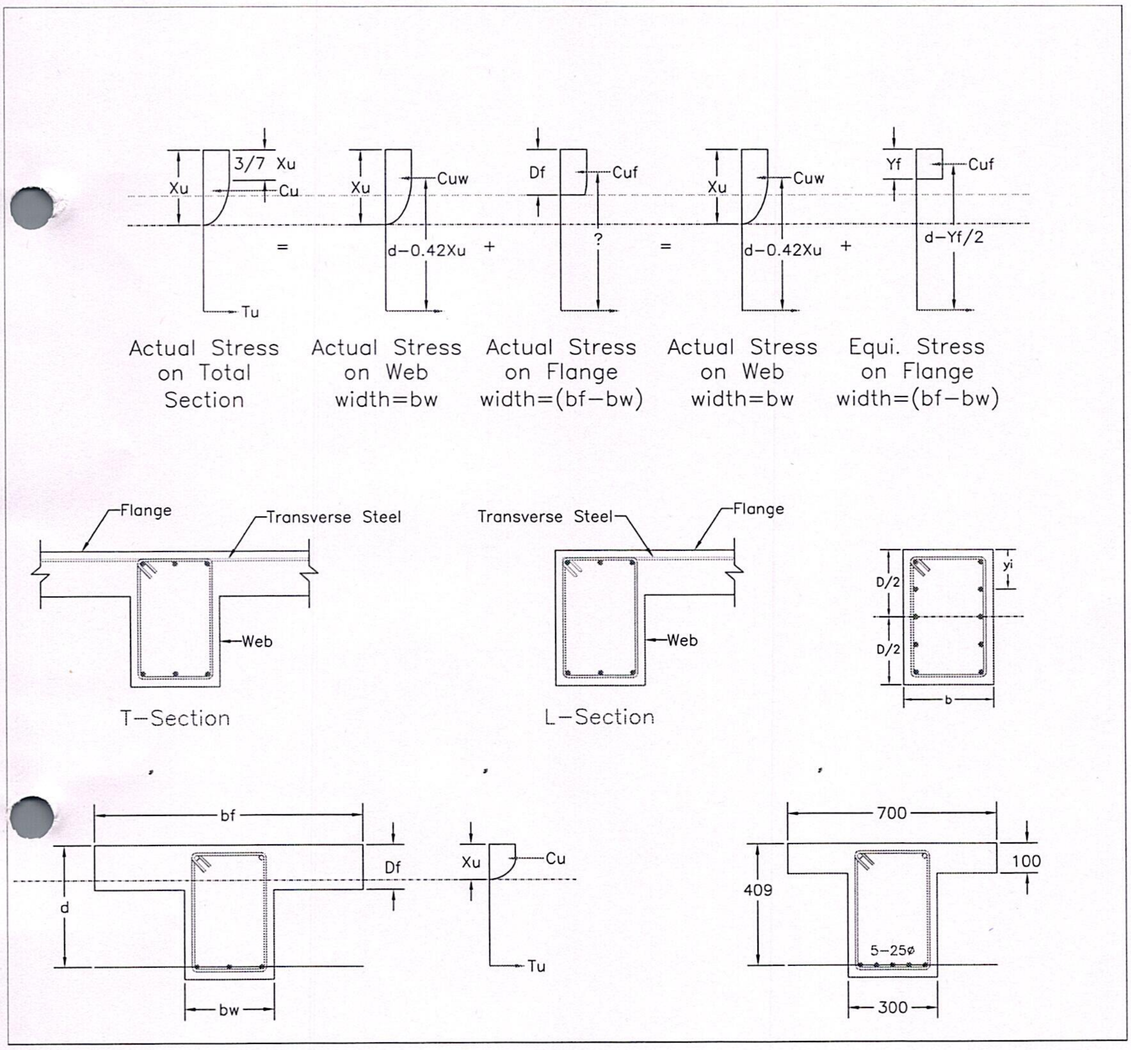
$$\varepsilon = \varepsilon_{cu} - \frac{\varepsilon_{cu} - \varepsilon_{c,min}}{D} y$$

$$\varepsilon = \varepsilon_{cu} - \left[\frac{7}{3}\varepsilon_{cu} - \frac{4}{3}\, 0.0035\right]\frac{y}{D}$$

$$\varepsilon = 0.002 \ \ at\ y = \frac{3}{7} D$$

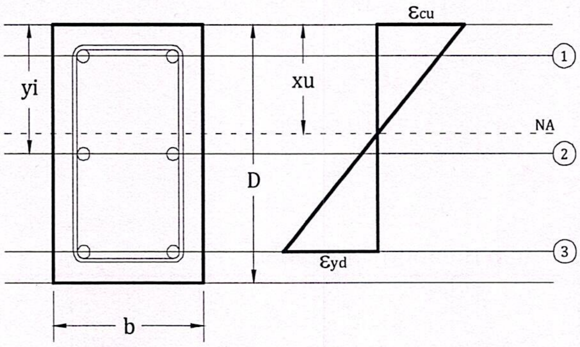


3000
2500
2000
1500
1000
500
0
Pu
0
50
100
150
200
250
Mu
①
②
③
④
⑤
e=0
e
eD
eb
e=∞
e<eb (Compression failure)
e>eb (Tension failure)



3/7 Xu
Xu
Cu
Tu
=
Xu
Cuw
d−0.42Xu
+
Df
Cuf
?
=
Xu
Cuw
d−0.42Xu
+
Yf
Cuf
d−Yf/2
Actual Stress on Total Section
Actual Stress on Web width=bw
Actual Stress on Flange width=(bf−bw)
Actual Stress on Web width=bw
Equi. Stress on Flange width=(bf−bw)
Flange
Transverse Steel
Web
T−Section
Transverse Steel
Flange
Web
L−Section
D/2
D/2
yi
b
bf
Df
d
bw
Xu
Cu
Tu
700
100
409
5−25ø
300

A 300x500 mm column is reinforced with 6-25ϕ bars. Find the design strength components Pu and Mu corresponding to the condition of balanced failure. Use M25 concrete and Fe415 steel. Consider the loading eccentricity with respect to major axis. Assume 40 mm clear cover to ties. Diameter of ties is 8 mm.



1. Given data
   a. Section properties

Width	=b	=	300 mm
Depth	=D	=	500 mm
Clear cover	=c	=	40 mm
Main bar size	=ϕ	=	25 mm
Size of tie	$=\phi_T$	=	8 mm

   b. Material properties

Concrete strength	$=f_{ck}$	=	25 MPa
Steel strength	$=f_y$	=	415 MPa

2. Analysis
   a. Depth of neutral axis

For balanced failure condition:

Strain in most compressive conc fibre	$=\varepsilon_{cu}$	=	0.0035
Strain in most tensile steel layer	$=\varepsilon_{st}=0.002+0.87f_y/E_s$	=	0.0038
Depth to most tensile steel layer	$=d=D-c-\phi_T-\phi/2$	=	439.5 mm
Depth of neutral axis	$=x_u=d(\varepsilon_{cu}/(\varepsilon_{cu}+\varepsilon_{st}))$	=	210.6 mm

   b. Force and moment due to concrete (moment about centroidal axis)

Compressive force in concrete	$=C_c=0.362f_{ck}bx_u$	=	571.7 kN
Moment of C_c about centroidal axis	$=M_c=C_c(0.5D-0.416x_u)$	=	92.8 kNm

c. Force and moment due to steel (moment about centroidal axis)

Let y_i=depth to steel layer from most compressed fibre. Then at layer i

Strain in steel $\varepsilon_{si}=0.0035(1-y_i/x_u)$; is +ve if compression

Stress in steel f_{si} is read from design stress-strain curve

Stress in concrete $f_{ci} = 0.447 f_{ck}\left[2\left(\frac{\varepsilon_i}{0.002}\right)-\left(\frac{\varepsilon_i}{0.002}\right)^2\right]$ for $\varepsilon_{si}>0$ else $f_{ci}=0$

Force in steel $C_{si}=(f_{si}-f_{ci})A_{si}$

Moment of f_{si} $M_{si}=f_{si}(0.5D-y_i)$

Design axial load $P_u=C_c+\Sigma C_{si}$

Design moment $M_u=M_c+\Sigma M_{si}$

The calculations are given in the following table

Layer	y_i	A_{si}	ε_{si}	f_{si}	f_{ci}	C_{si}	M_{si}
	mm	mm^2		MPa	MPa	kN	kNm
1	60.5	981.7	0.00249	345.0	10.5	328.4	62.2
2	250.0	981.7	-0.00066	-131.4	0.0	-129.0	0.0
3	439.5	981.7	-0.00381	-360.9	0.0	-354.3	67.1
					Sum	-154.9	129.4

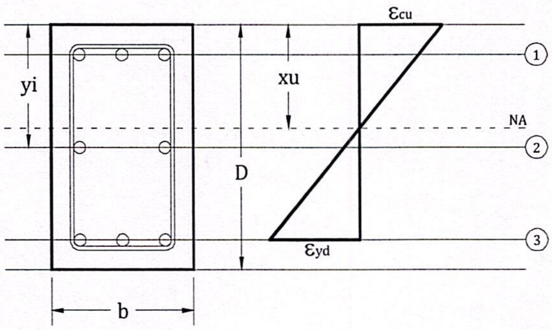
d. Balanced failure design forces

Axial load capacity $P_u=C_c+\Sigma C_{si}$ = 416.7 kN

Moment capacity $M_u=M_c+\Sigma M_{si}$ = 222.2 kNm

Balanced failure eccentricity $e_b=M_u/P_u$ = 533.2 mm

A, 4 m long, 300x500 mm column is subjected to a factored load of 1400 kN and factored moment of 280 kNm with respect to major axis. Design the longitudinal .reinforcement. Use M25 concrete and Fe415 steel. Assume effective length coefficient as 0.8.



1. Given data
   a. Section properties

Width	=b	=	300 mm
Depth	=D	=	500 mm
Length	=l	=	4000 mm
Let effective cover	=c'	=	50 mm

   b. Material properties

Concrete strength	$=f_{ck}$	=	25 MPa
Steel strength	$=f_y$	=	415 MPa

   c. Factored forces

Factored axial load	$=P_u$	=	1400 kN
Factored moment	$=M_{u1}$	=	280 kNm

2. Design forces

Effective length	$=l_e$	=	3200 mm
Slenderness ratio	$=\lambda$	=	6.4 <12
Hence, consider minimum eccentricity and neglect slenderness effects			
Minimum eccentricity	$=e_{min}=l_e/500+D/30>=20$ mm	=	23.1 mm
Moment due to e_{min}	$=M_{umin}$	=	32.3 kNm
Hence, design moment	$=M_u=Max(M_{u1}, M_{umin})$	=	280.0 kNm
Arrangement of steel	=equally distributed on four faces		
No of bars	=8		

3. Design procedure
   a. Assume a suitable value of A_{sc} and x_u
   b. Estimate force capacity P_u' and M_u'
   c. If $P_u=P_u'$ goto step (e) else revise x_u & goto step (b)
   d. If $M_u=M_u'$ goto step (f)
   e. If Mu>Mu' increase A_{sc} else decrease A_{sc} & goto step (b)
   f. Required A_{sc} is obtained

4. Formulae for estimating P_u' and M_u' (in 3(b))

Concrete force and moment =

$$\text{Total compressive force } C_c = a f_{ck} b D$$

$$\text{Moment of } C_c \text{ about centroidal axis } M_c = C_c\left(\frac{D}{2} - \bar{x}\right)$$

$$\text{where } a = 0.362\frac{x_u}{D} \quad \text{for } x_u \le D$$

$$= 0.447\left(1 - \frac{4g}{21}\right) \quad \text{for } x_u > D$$

$$\bar{x} = 0.416 x_u \quad \text{for } x_u \le D$$

$$= \frac{\left(0.5 - \frac{8g}{49}\right)}{\left(1 - \frac{4g}{21}\right)} D \quad \text{for } x_u > D$$

$$\text{and } g = \frac{16}{\left(\frac{7x_u}{D} - 3\right)^2}$$

Steel force and moment =

$$\text{Total compressive force } C_s = \sum (f_{si} - f_{ci}) A_{si}$$

$$\text{Moment of } C_s \text{ about centroidal axis } M_s = \sum (f_{si} - f_{ci}) A_{si}\left(\frac{D}{2} - y_i\right)$$

$$\text{where } f_{ci} = 0 \quad \text{for } \varepsilon_{si} \le 0$$

$$= 0.447 f_{ck} \quad \text{for } \varepsilon_{si} \ge 0.002$$

$$= 0.447 f_{ck}\left[2\left(\frac{\varepsilon_{si}}{0.002}\right) - \left(\frac{\varepsilon_{si}}{0.002}\right)^2\right] \quad \text{otherwise}$$

$$\text{and } \varepsilon_{si} = 0.0035\left(1 - \frac{y_i}{x_u}\right) \quad \text{for } x_u \le D$$

$$= 0.002\left(1 + \frac{\frac{3}{7}D - y_i}{x_u - \frac{3}{7}D}\right) \quad \text{for } x_u > D$$

5. Calculation (final iteration)

Assumed percentage steel	=p	=	2.96 %
Area of steel	$=A_{sc}$	=	4440 mm^2
Assumed neutral axis depth	$=x_u$	=	350 mm

Layer	y_i mm	A_{si} mm^2	ε_{si}	f_{si} MPa	f_{ci} MPa	C_{si} kN	M_{si} kNm
1	50.0	1665.0	0.00300	353.9	11.2	570.6	114.1
2	250.0	1110.0	0.00100	200.5	8.4	213.2	0.0
3	450.0	1665.0	-0.00100	-200.5	0.0	-333.8	66.8
					Sum	450.1	180.9

Compressive force in concrete	$=C_c$	=	950.3 kN
Moment of C_c about centroidal axis	$=M_c$	=	99.2 kNm
Axial load capacity	$P_u'=C_c+\Sigma C_{si}$	=	1400.3 kN
Moment capacity	$M_u'=M_c+\Sigma M_{si}$	=	280.1 kNm

Hence calculated P_u'=given P_u and calculated M_u'=given M_u

Required steel	$=A_{sc}$	=	4440 mm^2
Required diameter of each bar	$=\phi$	=	26.6 mm
Hence provide 8-28ϕ bars giving	$=A_{sc}$	=	4926 mm^2
Percentage steel	=p	=	3.3 %
			>0.8%
			<4% Hence Ok