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PRECAST & PRESTRESSED CONCRETE STRUCTURES Course Code : 315317

Programme Name/s : Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Civil & Environmental Engineering/

Programme Code : CE/ CR/ CS/ LE

Semester : Fifth

Course Title : PRECAST & PRESTRESSED CONCRETE STRUCTURES

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I. RATIONALE

Precast and Pre-stressed Concrete construction technology is widely used across the world for its inherent advantages. It has been adopted in India from past many years, but was mostly limited to civil structures such as tunnels, bridges, flyovers and underpasses. Today, with critical housing shortages, rising labour and input costs and an increased emphasis on quality and timely delivery, more and more developers are opting for innovative construction practices like precast and pre-stressed concrete. Hence it is essential to make upcoming engineering community aware about this. This course is designed to provide basic knowledge of precast and pre-stressed elements, their design aspects, pre-stressing techniques, methods and basic design principles.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Execute effectively the construction work involving precast and pre-stressed concrete

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Propose the relevant precast concrete element for a given situation
- CO2 - Use the relevant components for the prefabricated structure.
- CO3 - Justify the relevance of pre-stressed concrete in a given situation.
- CO4 - Suggest the relevant methods / systems for given construction work.
- CO5 - Evaluate losses in a given pre-stressed concrete construction and Propose a suitable cable profile.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315317	PRECAST & PRESTRESSED CONCRETE STRUCTURES	PPC	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Justify the necessity of the precast concrete in civil engineering. TLO 1.2 Suggest the structural elements that can be casted in precast for the given situation. TLO 1.3 Describe the various components for a Prefabricated building TLO 1.4 Describe the various elements for Non-structural precast concrete. TLO 1.5 Elaborate the IS specifications and provisions for given pre-cast element. TLO 1.6 Conduct the given test on the given components of precast structure	**Unit - I Precast concrete and its Elements** 1.1 Definition and necessity of precast, Advantages and disadvantages. Materials used. 1.2 Study of Structural Precast concrete elements such as fencing poles, transmission poles, paver blocks, doors and window frames, Manhole covers, precast Mesh etc. 1.3 Study of Precast Structural Building components such as slab panels, beams, columns, footings, walls, lintels and chajjas, staircase elements. 1.4 Non-structural precast concrete elements such as bridge panels, tunnel lining, cannel lining, piles, box culvert etc. 1.5 Materials required, IS specifications, casting tolerances, fabricating systems, joints, testing, storage and transportation, equipment's for elements such as PCC, RCC, PSC, SCC, Ferro-cement, Autoclaved Aerated Concrete (AAC) and Foam concrete. 1.6 Testing of Precast components.	Demonstration Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the term, "Prefabricated Building Construction" TLO 2.2 Describe modular co-ordination with standard specifications for the given prefabricated elements. TLO 2.3 Classify different prefab systems used in civil engineering. TLO 2.4 Explain the requirements of structural joints of the given pre-fabricated elements. TLO 2.5 Elaborate the procedure of the storage, transportation and erection for a given precast element. TLO 2.6 Suggest the relevant combinations of mixed and composite construction for the given situation. TLO 2.7 Evaluate the effect of Prefabricated structure on the environment.	**Unit - II Prefabricated Buildings** 2.1 Concept and Benefits of Prefabricated Construction, Prefabricated Construction Process. 2.2 Precast load bearing and non-load bearing wall panels, floor systems, Material characteristics, Plans & Standard specifications, concept of modules, modular co-ordination, modular grids and finishes. 2.3 Prefab systems and its classification, structural schemes. 2.4 Joints – requirements of structural joints and their design considerations for above elements. 2.5 Manufacturing, storage, curing, transportation and erection of above elements, equipment needed. 2.6 Introduction to Mixed and composite construction. 2.7 Ecological aspect of use of Prefabricated building.	Demonstration Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations
3	TLO 3.1 Differentiate between pre stressing and post tensioning process used in civil construction TLO 3.2 Apply the prestressing techniques in the required situation. TLO 3.3 Distinguish the prestressed concrete material with other construction materials in given situation. TLO 3.4 Justify the need of high strength material for prestressed concrete. TLO 3.5 Suggest the relevant type of pre-stressing steel for given structural member.	**Unit - III Fundamentals of Pre-stressed Concrete** 3.1 Concept of pre stressing and post tensioning, basic terminology. 3.2 Applications of pre-stressed concrete. 3.3 Advantages and disadvantages of pre-stressed concrete with respect to other construction material. 3.4 Materials used and their properties, Necessity of high-grade materials. Types of Special concrete/ High Strength concrete and requirements for precast and prestressed members 3.5 Types of Pre-stressing steel -Wire, Cable, tendon, Merits-demerits and applications.	Demonstration Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Suggest the relevant method of pre-stressing for given structural element. TLO 4.2 Explain Hoyer system of pre-tensioning with labelled sketch. TLO 4.3 Explain relevant system of post- tensioning based on the given criteria with labelled sketch.	**Unit - IV Methods and Systems of pre- stressing** 4.1 Methods of pre-stressing : Internal and External pre-stressing, Pre and Post tensioning- applications, merits and demerits 4.2 Systems for pre tensioning: process, applications, merits and demerits - Hoyer system 4.3 Systems for post-tensioning - process, applications, merits and demerits - Freyssinet system, Magnel Blaton system, Gifford Udall system.	Demonstration Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations
5	TLO 5.1 Identify the reasons for loss of pre-stress in the given element. TLO 5.2 Describe the situations in which the given elements exhibit the loss of pre-stress. TLO 5.3 Elaborate the IS specifications and provisions for losses in case of Pre and Post tensioning. TLO 5.4 Explain the assumptions made in the analysis of pre-stressed concrete beams. TLO 5.5 Draw the cable profiles for various load combinations in the given situation. TLO 5.6 Evaluate the effect of the given cable profile on fiber stresses.	**Unit - V Losses of pre-stress and Analysis of Pre-stressed rectangular beam section** 5.1 Pre-stressing force in Cable, Meaning of Loss of Pre-stress. 5.2 Loss of pre-stress during the tensioning process - loss due to friction, length effect, wobbling effect and curvature effect, Loss of pre-stress at the anchoring stage, Loss of pre-stress occurring subsequently: losses due to shrinkage of concrete, creep of concrete, elastic shortening, and creep in steel. 5.3 IS recommendations for % losses in case of Pre and Post tensioning. 5.4 Basic assumptions in analysis of pre-stressed concrete beams. 5.5 Cable Profile in simply supported rectangular beam section – concentric, eccentric straight and parabolic 5.6 Effect of cable profile on maximum stresses at mid span and at support. (No Numerical problems in theory examination)	Demonstration Lecture Using Chalk-Board Presentations Site/Industry Visit Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Verify the actual dimension of precast element at site with that of drawing.	1	*Verification of the dimensions of any three precast elements mentioned in the drawing through physical inspection. (e.g. manhole covers, paver blocks, hollow blocks, solid blocks, curb stones etc)	2	CO1
LLO 2.1 Prepare report of field visit or video demonstration to a manufacturing unit of precast products with reference to the points such as manufacturing process, curing, stacking, handling, in-house inspec	2	*Prepare report of field visit or by video demonstration to a manufacturing unit (of precast elements such as bridges, girders, fencing pole, transmission pole, electric pole, concrete sleepers etc.)	2	CO1
LLO 3.1 Test the given solid or hollow precast blocks to determine its compressive strength and water absorption.	3	*Determination of compressive strength and water absorption of given solid or hollow precast blocks	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Test the given Auto clave Aerated Concrete Block (AAC) to determine its compressive strength and water absorption.	4	Determination of compressive strength and water absorption of given Auto clave Aerated Concrete Block (AAC).	2	CO1
LLO 5.1 Test the given paver blocks to determine its compressive strength and water absorption.	5	* Determination of compressive strength and water absorption of given paver blocks	2	CO1
LLO 6.1 Conduct the load test on the given manhole cover to predict its behavior after failure.	6	Carry out load test on given manhole cover as per IS 12592:2002 Annex C	2	CO1
LLO 7.1 Prepare a report on the basis of field visit or video demonstration of a precast manufacturing unit of building elements with reference to the points such as manufacturing process, curing, stacking, h	7	Organize field visit or video demonstration of precast manufacturing unit (such as lintel, chajja, door frame, wall panels, stair steps etc.)	2	CO2
LLO 8.1 Prepare a report on various types of pre-stressing wires / cables / strands for given situation on the basis of review of technical brochure/ specifications.	8	Collection of samples of various types of pre-stressing wires / cables / strands with their technical specifications/brochure.	2	CO3
LLO 9.1 Prepare a report on different types of joints for various precast components for a given situation.	9	*Collect information and photographs of for Various types of joints of precast members. (minimum five different type of joints)	2	CO2
LLO 10.1 Draw a detailed cross section of cable profile for a given situation. (Central point load and uniformly distributed load) for eccentric prestressing force and axial force.	10	*Draw a detailed longitudinal and cross section of cable profile for different loading conditions.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Collect pictorial information about precast structural elements (i. e. slab panel, wall panel, beam, column etc).
- Collect data of pre-stressed components manufactured in your vicinity.
- Write a detailed report of visit to any one prefabricated unit.
- Collect data for materials required for precast elements, with their suppliers, sale price etc.
- Prepare a power point presentation on systems of pre-stressing (minimum 8 slides)
- Present a seminar on testing of precast units.
- Collect samples of at least five precast elements from your area.
- Prepare a visit report on bridge site to know the panel sizes, method of pre-stressing.

Assignment

- Write stepwise procedure of Errection of prefabricated structures.
- Compare minimum five cast in situ and precast elements with respect to time required, quality and cost.
- Write stepwise procedure of pre tensioning of a bridge Girder by observing respective video demonstration.

- Write a stepwise procedure of post tensioning of Bridge panel or Flat Slab by observing respective video demonstration.
- Collect information of IS codes related to various precast elements.
- NOTE: The suggested micro project/ Assignments are optional and given for students additional learning.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Hot air electric oven having temperature range 50 C to 2500 C, removable 2-3 stainless steel shelves, thermostat, digital temp controller, with mineral wool insulation, door walls with silicon rubber gasket and lock	3,4,5
2	Compression Testing Machine: Digital display manual control compression testing; machine; Max. Capacity (KN): 2000 ; Measuring range: 4%-100% of FS; Max. distance between two platen (mm): 330; Compression plate size (mm): 220×220; Max. piston stroke (mm): 0-20; Max. piston speed (mm/min): Approx. 30; Column clearance 300×200; Oil pump motor power (KW): 1.5	3,4,5
3	Digital display balance of capacity 10 kg having LC 10 gm and of capacity 30 kg having LC 10 gm	3,4,5,6
4	Universal Testing Machine: Capacity – 1000 kN. Type: Mechanical type / digital, electrically Operated with accessories such as (1) Tensile test attachment for wire specimen, (2) Compression test attachment, (3) Transverse test attachment with bending Punch, along with service tools and operation manual	3,4,5,6
5	Test frame for load test for manhole covers	6

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Precast concrete and its Elements	CO1	8	2	8	4	14
2	II	Prefabricated Buildings	CO2	9	2	8	6	16
3	III	Fundamentals of Pre-stressed Concrete	CO3	7	2	4	6	12
4	IV	Methods and Systems of pre- stressing	CO4	6	0	4	6	10
5	V	Losses of pre-stress and Analysis of Pre-stressed rectangular beam section	CO5	10	4	8	6	18
Grand Total				**40**	**10**	**32**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests of 30 marks each will be conducted and average of two-unit tests considered. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- Pen and Paper Test (Written Test), Term Work, Practical examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	--	--	--	1	--	2			
CO2	2	2	1	2	1	1	2			
CO3	2	2	1	2	1	2	2			
CO4	1	2	2	2	2	1	2			
CO5	2	2	2	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Marzuki , Nor Ashikin	Pre-Cast and Pre-Stress Technology: Process, Method and Future Technology	Create space Independent Publication ISBN 10: 1499353391 ISBN 13: 978-1499353396
2	Elliott, Kim S.	Precast Concrete Structures	CRC Press, New York, 2011 ISBN- 13: 9781498723992
3	Lin, T.Y.	Design Of Pre-stressed Concrete Structures	John Wiley and Sons, New York, 2014 ISBN-8: 0471018988
4	Krishna Raju, N.	Pre-stressed Concrete	Tata McGraw Hill, New Delhi, 2012 ISBN 10: 1259003361 ISBN 13: 9781259003363
5	Nagarajan, Pravin	Pre-stressed Concrete Structures	Pearson Education India ISBN 9332517614, 9789332517615

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/WWm5S2L-VCI?si=30k3M9OWF0fyEqJk	Build a home in 8 weeks with Precast Concrete Homes.
2	https://youtu.be/nlgYwCQsoEs?si=Pexa85CsY9VEjBW3	Precast House
3	https://youtu.be/F-eiUHWN3-s?si=nB-fKEt7on-w2DLp	The Key Design Principles for Precast Concrete Design
4	https://youtu.be/hMwwPjKeHnc?si=7jieERxp6MoYWFpl	Watch How Precast Concrete Wall Panels are Installed for a House
5	https://youtu.be/2OUgqlzDIrw?si=GHRLAmm3VCr5UyrB	FOAM CONCRETE, affordable house built in 6 days!

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Sr.No	Link / Portal	Description
6	https://youtu.be/blM396ZtCY4?si=0qnjs1mMQdO-0Vi6	hollow block making process in India, concrete hollow bricks, hollow bricks machine
7	https://youtu.be/h3N0vzU5VO8?si=oYLDfBWYQY0ShLxy	AAC Block Making Process
8	https://youtu.be/4KYPltsNAWs?si=Ak_QoFz20p4IIsVf	Lecture 1 - Prestressing System by NPTEL
9	https://youtu.be/4NelroYGY3U?si=vhPOEijKq-U_5QWk	Lecture-2-Type of Prestressing
10	https://youtu.be/aJfCAgeJ55I?si=7c-VEBxz0KmqsWr5	Lecture-3-Prestressing System and Devices (Pre-Tensioning) by NPTEL
11	https://youtu.be/9ROVbBANMUU?si=4VVbRi8vS4JxIuJO	Lecture-4-Prestressing System and Devices (Post-Tensioning) by NPTEL
12	https://youtu.be/MIvfc6xScMo?si=uRxbbFL269c8-9jS	Pre-Tensioning VS Post Tensioning
13	https://youtu.be/yOuk_DSuTb0?si=wdq-wbMZSmleCFBp	Prestressed Concrete
14	https://youtu.be/mfZo_HvMmM8?si=mP0Bqf7vRdnN7Xke	Prestressed Concrete - Unbonded Post-Tensioning

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students