Imperial College London

Department of Civil and Environmental Engineering

Prestressed Concrete

Course leader:	Dr Ana Ruiz-Teran
Other contributors:	
Module status:	Concrete Structures (Core); General Structural Engineering (Elective)
Pre- or co-requisites:	CIVE97094 (for CIVE97095) and CIVE97154 (for CIVE97006)
Term:	Autumn
Contact hours:	30
ECTS units:	5
FHEQ Level:	7
Assessment:	Coursework (only for CIVE97095) , written examination

1.0 Aims

- To introduce the fundamental principles about the structural behaviour and design criteria of Prestressed Concrete Structures.
- To introduce the fundamental mechanics to define the internal forces.
- To review the current technology available to prestress concrete structures.
- To introduce the formulae to estimate the initial and time-dependent losses.
- To emphasis the fundamentals but reference is made to Eurocode 2.
- To present the serviceability limit states that are critical for the design of conventional prestressed concrete structures and the inequalities to fulfil such limit states are derived, allowing the prestressing force and its eccentricity to be determined.
- To cover the specific implications for the ultimate limit states.

2.0 Syllabus

- Concept of prestressing (historical approach, and prestressing types).
- Structural analysis of prestressed statically determinate structures including: Anchorage and deviating forces introduced by the tendons; Internal forces and strains due to prestressing; Tendon centroid, and prestressing layouts; Mechanical properties before and after grouting; Introduction of self-weight during prestressing in post-tensioned structures; Introduction of lateral bending during prestressing in post-tensioned structures.
- Structural analysis of prestressed statically indeterminate structures including: methods for the analysis of prestressed statically indeterminate structures: Primary, secondary and total internal forces due to prestressing.
- Prestressing technology including: Steel products and technologies for prestressing (strands, tendons, bars); Anchorage systems, ducts, couplers; Technological requirements for the prestessing layouts; Threading, prestressing, and grouting; External prestressing technology.
- Prestressing losses: Concept of loss and classification of losses (initial and long-term losses); Frictional losses; Elastic shortening losses; Anchorage drawn-in losses and transmission lengths;

Prestressing strategies; Prestressing losses due to concrete creep, concrete shrinkage and steel relaxation.

- Serviceability limit state including: SLS of normal tension stresses (decompression, cracking, and crack opening limit states); SLS of normal compression stresses; SLS deformation, SLS vibration; Prestressing approaches and classes.
- Design of prestressed structures: Central kern; Inequality equations for the design of prestressed concrete structures; Magnel diagrams; Regions where the centroid of the prestressing layout has to be located; Relation between section efficiency and amount of prestressing.
- Specific implications for ultimate limit states.
- Anchorage zones.
- Prestressed concrete slabs.

No.	Topic	Staff
01	Concept of prestressing. Historical approach Different types of prestressing Prestressing by tendons Prestressing types according to the moment in which the prestressing is applied Prestressing types according to the location of the tendons in relation to the concrete section Prestressed tie (including examples)	ART
02	Structural analysis of prestressed statically determinate structures Anchorage and deviating forces introduced by the tendons Internal forces due to prestressing in statically determinate structures Strains due to prestressing Prestressing of in-situ concrete beams (post-tension) Tendon centroid Prestressing of precast concrete beams (pre-tension). Prestressing layouts Mechanical properties before and after grouting Introduction of self-weight during prestressing in post-tensioned structures Introduction of lateral bending during prestressing in post-tensioned structures Example	ART
03	Structural analysis of prestressed statically indeterminate structures Methods for the analysis of prestressed statically indeterminate structures Static internal forces due to prestressing; Secondary internal forces due to prestressing; and Total internal forces due to prestressing Examples	ART
04	Prestressing technology Steel products and technologies for prestressing (strands, tendons, bars) Mechanical properties of steel products Anchorage systems. Types Ducts Couplers Prestessing layout Introduction of prestressing elements, prestressing, Grouting Jacks	ART

	External prestressing technology	
05	Prestressing losses Concept of loss Classification of losses (initial and long-term losses) Initial Prestressing losses Frictional looses Elastic shortening losses Anchorage drawn-in losses Transmission lengths Initial internal forces due to prestressing Prestressing strategies Examples	ART
06	Long-term Prestressing losses Historical introduction Concrete creep and shrinkage Steel relaxation Prestressing losses due to concrete creep, concrete shrinkage and steel relaxation Example Coursework is set	ART
07	Serviceability limit state. SLS of normal tension stresses (decompression, cracking, and crack opening limit states) SLS of normal compression stresses SLS deformation, SLS vibration Prestressing approaches and classes Tutorial (Coursework)	ART
08	Design of prestressed structures Central kern Inequality equations for the design of prestressed concrete structures Magnel diagrams Regions where the centroid of the prestressing layout has to be located Relation between section efficiency and amount of prestressing Examples Ultimate limit states Ultimate limit state of normal stresses Example Ultimate limit state of shear stresses Coursework submission	ART
09	Anchorage zones Prestressed concrete slabs Course work feedback	ART
10	Revision	ART

3.0 Intended learning outcomes

On successfully completing this course unit, students will be able to:

- Obtain the internal forces due to the prestressing in a prestressed concrete structure, being able to identify the primary and secondary components of the total internal forces.
- Evaluate the initial and time-dependent losses.
- Propose an appropriate system to prestress a particular structure.
- Design the prestressing layout and the prestressing force that fulfils the relevant limit states.

4.0 Teaching methods

A combination of lectures and tutorials.

5.0 Assessment

Assessment will be 75% written examination and 25% coursework (MSc)/100% written examination (UG).

6.0 Recommended textbooks

Category as defined by Central Library: C = Core, S = Supplementary

S	Robert, B. The design of prestressed concrete bridges: concepts and principles, Taylor & Francis, London, 2008. ISBN: 0415235995.
S	Hurst, M K. Prestressed Concrete Design. E&FN Spon, London, 1997. (ISBN 0419218009).
S	Leonhardt, F. Prestressed Concrete. Wilhelm Ernst & Sohn. Belin. Munich. 1964.
S	Menn, C. Prestressed concrete bridges. Birkhauser Verlag. 1990 (ISBN 3-7643-2414-7).
S	Post-tensioning in buildings. Bulletin 31. FIB. 2005. (ISBN 2-88394-071-1).

7.0 Subject threads

The table below shows how the themes of design, sustainability and health & safety risk management are embedded in the curriculum (as defined by the JBM degree guidelines).

Key: Primary (P), Secondary (S) and Contributory (C).

Design	Health & Safety Risk Management	Sustainability
P	**C**	**-**