Appendix B-4: Principles of Concrete Structure design Syllabus

Appendix B-4

Principles of Concrete Structure design Syllabus

Course title	Principles of concrete structure design					Course number	9031112031
Applicable specialties	civil engineering						
Nature of the course	General education courses☐, subject foundation courses☐ professional core courses (elective☐ required☑), independent development courses (required☐ elective ☐), and concentrated practice courses☐						
Unit offering the course	School of Civil Engineering						
total class hours	120	credit	4	Contact hours	64	Self-study hours	56
Prerequisite courses	Civil engineering materials, structural mechanics, material mechanics						
Textbooks and teaching materials	Course materials: Shen Puseng. Principles of Concrete Structure Design [M]. Beijing: Higher Education Press, 20 20.5 Ye Jianshu. Principles of Structural Design [M]. Beijing: Peoples Communications Press, 20 19.7						
	References: Code for Design of Concrete Structures, Code for Load of Building Structures, Code for Design of Highway Reinforced Concrete and Prestressed Concrete Bridges and Culverts, General Code for Design of Highway Bridges and Culverts, Code for Design of Concrete Structures of Railway Bridges and Culverts Teaching website: Southeast University link, Cloud class link						

1. Course introduction

"Principles of Concrete Structure Design" is a core course in civil engineering. The main content includes the concepts and principles of concrete structure design, as well as the physical and mechanical properties of materials. It covers the analysis and section design and verification of flexural, compressive, tensile, and torsional members in reinforced concrete, deformation and crack width verification for concrete members, durability analysis, and the analysis of stress performance and load-bearing capacity calculations for prestressed concrete members. Through various teaching activities, students will master the design calculations and construction treatments for commonly used flexural (general beams and slabs) and compressive members in reinforced concrete, understand the stress characteristics and key points of tension, torsion, and prestressed members, and gain an overview of the development of concrete structures. Additionally, they will be able to apply their knowledge to practical situations.

2. The graduation requirements supported by this course and the implementation path

(1) The graduation requirements that this course can support

Number	Graduation requirement indicators	Specific content of graduation requirement indicators
1	Graduation requirements 1.3	Be able to use civil engineering professional knowledge and other learned knowledge to analyze, model and solve complex civil engineering problems, and have the ability to compare and synthesize solutions
2	Graduation requirements 2.4	Be able to use engineering principles and mathematical models to effectively express the analysis process and conclusions to guide the formulation of solutions
3	Graduation requirements 4.2	Have the ability of experimental (testing) operation, can scientifically design civil engineering experimental schemes according to the characteristics of objects, build experimental systems, carry out experiments safely, and correctly collect data

(2) The implementation path of graduation requirements in this course

1. Course objectives

Through the theoretical teaching and practical operation of this course, students will master the basic knowledge, have innovative ability and high quality. The specific course objectives are as follows:

Course Objective 1: Master the physical and mechanical properties of steel and concrete materials; understand the force characteristics, failure modes, design principles, and construction requirements of reinforced concrete members under bending, compression, tension, torsion, and prestress; grasp knowledge on crack and deformation verification for reinforced concrete members under bending, fostering engineering thinking and innovation capabilities. When solving complex civil engineering problems, be able to apply relevant knowledge to model construction, solution, and comparative analysis.

Course Objective 2: Be able to use the design principles and mathematical models of reinforced concrete flexural members to complete the design of simply supported cantilever beams, and be able to effectively express the analysis process and conclusions to guide the formulation of solutions.

Course objective 3: Be able to scientifically design the experimental scheme of the failure of the bent member and have the ability to operate the experiment.

2. The corresponding relationship between the course teaching objectives and the graduation requirements indicators

Graduation requirement indicators	**Course teaching objectives**

Graduation requirements 1.3	Course Objective 1
Graduation requirements 2.4	Course objective 2
Graduation requirements 4.2	Course objective 3

3. Intended learning outcomes and teaching details

(1) Intended learning outcomes

The intended learning outcomes of this course are:

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
1	Concrete structure design concept and principle	• General concept and development and application of concrete structure	L1	L1	1. List and define different types of concrete structures, describe their development prospects and applications	1
2	Properties of materials used in concrete structures	• Physical and mechanical properties of steel bars • Properties of concrete structural materials • The physical forces of concrete Learning ability • Bonding of steel bars and concrete	L1	L2	2. Explain the physical and mechanical properties of steel bars, and can be applied to the selection of steel in concrete components	1
			L1	L2	3. Explain the physical and mechanical properties of concrete and the selection of concrete in concrete components	1
			L1	L2	4. Understand the bonding performance, explain the composition of bonding force, and extend the explanation of measures to ensure bonding force in engineering	1
3	Analysis and calculation of load-	• General construction of a section under	L1	L2	5. The construction requirements of the bent member are applied in engineering practice	1

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
	bearing capacity of reinforced concrete flexural members	bending • Experimental study on the bending load-bearing capacity of the normal section and basic assumptions	L1	L2	6. Explain the force characteristics and three kinds of failure modes of the positive section of the bent member, explain the four basic assumptions in the calculation of the bearing capacity of the positive section of the bent member, complete the three kinds of failure experiments of the positive section, compare and analyze the experimental phenomena, and draw conclusions	1、3
			L1	L3	7. Derive the calculation formula of the positive section of the bent member, and explain the scope of application of the formula; discuss, summarize the design and bearing capacity verification of the rectangular and T-shaped sections of the bent member, and illustrate the application in actual engineering with examples	1、2
			L1	L2	8. Explain the force characteristics and three types of failure modes of the inclined section of the bent member; explain the influencing factors, extend the explanation of the model and basic assumptions of the bearing capacity calculation formula	1
			L1	L3	9. Derive the calculation	1、2

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
					formula of the inclined section of the bent member, and explain the scope of application of the formula; discuss, summarize and summarize the design and load-bearing verification of the inclined section of the bent member, and illustrate the application to actual engineering with examples	
			L1	L2	10. Explain the construction measures of longitudinal force-bearing steel bars, such as bending, cutting and anchoring, and understand the relationship between bending moment envelope diagram and resistance to bending moment diagram	1、2
4	Calculation and analysis of section bearing capacity of reinforced concrete compression members	• General construction of stressed members • Calculation of bearing capacity of the positive section of the axially compressed member • Calculation of bearing capacity of eccentrically loaded member in the positive section • Normal section bearing capacity N_u— M_uRelated curves and their applications • Calculation of	L1	L2	11. Explain the construction requirements of the stressed member and apply them to engineering practice	1
			L1	L3	12. Explain the two types of failure modes and characteristics of axially compressed members through experiments; derive the calculation formula of the cross-section of axially compressed members and explain the applicable range of the formula; be able to carry out the design calculation of axially compressed members and illustrate the application in actual engineering with	1

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
		shear bearing capacity of inclined section of eccentrically loaded member			examples	
			L1	L3	13. Explain two types of failure modes and failure characteristics of eccentrically loaded members; derive the calculation formula of the cross-section of an eccentrically loaded member and the scope of application of the formula; be able to design and calculate eccentrically loaded members, and illustrate their application in actual engineering with examples	1
			L1	L2	14. Interpretation N_u—M_uThe relevant curve shows the influence of N and M variation on the damage of large and small bias	1
			L1	L2	15. Express the formula for the calculation of the bearing capacity of the inclined section of the biased member, and discuss the similarities and differences with the formula for the calculation of the bearing capacity of the inclined section of the bent member	1
5	Calculation and analysis of load-bearing capacity	• Calculation of the bearing capacity of the positive section of the axially tensioned member	L1	L2	16. Confirm the force characteristics of axially tensioned members, illustrate the application of axially tensioned members in actual engineering, and	1

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
	of reinforced concrete tension members	• Calculation of the bearing capacity of the positive section of the eccentric tension member			explain the construction requirements of axially tensioned members	
			L1	L2	17. Distinguish between the concepts of large eccentric tension and small eccentric tension, describe the characteristics and design principles of large and small eccentric tension failure, be able to design and calculate eccentric tension members, and illustrate their application in actual engineering with examples	1
6	Calculation and analysis of section bearing capacity of reinforced concrete torsion members	• Experimental study of pure torsion components • Calculation of torsional section bearing capacity of pure torsion member with rectangular section • Load-bearing capacity calculation of bent shear members • Reinforcement construction requirements for twisted members	L1	L2	18. Explain the similarities and differences between the failure modes of pure torsion members of plain concrete and pure torsion members of reinforced concrete	1
			L1	L2	19. Explain the meaning of each symbol in the formula of bearing capacity of rectangular section torsion member, and analyze and explain the physical meaning of the applicable conditions of upper and lower limits	1
			L1	L2	20. Confirm the configuration method of bending, shear and torsion reinforcement for the member, determine the configuration scheme of bending and shear reinforcement for the member, and carry out the	1

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
					design calculation of the member, and illustrate the application in actual engineering with examples	
			L1	L2	21. Summarize the reinforcement construction requirements of torsion members, summarize and identify the reinforcement construction requirements of torsion members	1
7	Deformation, crack width verification and durability analysis of concrete components	• Analysis and calculation of component stiffness • Deflection verification of reinforced concrete flexural members • Crack width verification of reinforced concrete components • Durability of concrete structures	L1	L2	22. Give examples to illustrate the differences and similarities between the deformation calculation of reinforced concrete structure and ideal elastic material, explain the principle of minimum stiffness, and explain the meaning of the symbol in the stiffness calculation formula	1
			L1	L2	23. Apply the formula to calculate the maximum deflection value of reinforced concrete flexural members in the normal service limit state, list the deflection limit formula of various components, and explain the measures and methods taken when the stiffness does not meet the requirements	1
			L1	L2	24. Give an example of the cause of crack generation, discuss and analyze the theory of crack width calculation, explain the	1

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
					factors affecting the crack width of the component, calculate the maximum crack width of the component, and list the measures taken when the crack width verification is not satisfied	
			L1	L2	Discuss and illustrate the considerations in the design of durability of concrete structures	1
8	Calculation and analysis of stress performance of prestressed concrete members	• Basic concept of prestressed concrete • Methods and equipment for applying prestress • Tension control stress and prestress loss • Local bearing verification of anchorage zone at the end of post-tensioned components • Calculation of prestressed concrete axially tensioned and bent members • Brief description of some prestressed concrete and unbonded prestressed concrete structures • Construction requirements of prestressed concrete	L1	L2	26. Explain the advantages of prestressed concrete, identify three types of concrete structures and explain the stress characteristics of each structure	1
			L1	L2	27. Describe two methods and specific construction processes of prestressing, and explain the main equipment names and usage characteristics of prestressing	1
			L1	L2	28. Explain the concept of tension control stress, calculate and solve the tension control stress of different prestressed steel bars, and explain six types of prestress loss	1
			L1	L2	29. Explain the transmission length and anchoring length correctly, explain the requirements of local pressure zone construction reinforcement arrangement,	1

blocks of knowledge		knowledge point	Initial level	Degree of requirement	Intended learning outcomes	Corresponding curriculum objectives
		components			and select the type of construction reinforcement	
			L1	L3	30. Explain the calculation principle of prestressed concrete axially tensioned members and flexural members	1
			L1	L2	31. Explain the difference between the force of prestressed concrete flexural structure and prestressed concrete flexural structure, illustrate the advantages of unbonded prestressed concrete structure by example, and distinguish the force performance difference between pure unbonded prestressed concrete beam and bonded beam	1
			L1	L3	32. Explain the specific construction requirements of prestressed concrete components	1

(2) Course Assessment Rules

content of courses (blocks of knowledge)	Number of teaching hours	Expected Learning Outcomes (ILO)	Implementation links (in class, experiments, etc.)	instructional strategies
Concrete structure design concept and principle	2	1. List and define different types of concrete structures, describe their development prospects and applications; deepen the understanding of structural reliability and ultimate state design method	• In-class teaching	• lecture • Problem-oriented • case

Properties of concrete structural materials	4	2. Explain the physical and mechanical properties of steel bars, and can be applied to the selection of steel in concrete components 3. Explain the physical and mechanical properties of concrete and can be applied to the selection of concrete in concrete components 4. Understand the bonding performance, explain the composition of bonding force, and extend the explanation of measures to ensure bonding force in engineering	• In-class teaching • Study outside of class	• lecture • Problem-oriented guidance • deliberate • give an example
Calculation and analysis of load-bearing capacity of reinforced concrete flexural members	24	5. Explain the construction requirements of the bent member and apply them to engineering practice 6. Explain the force characteristics and three kinds of failure modes of the positive section of the bent member, explain the four basic assumptions in the calculation of the bearing capacity of the positive section of the bent member, complete the three kinds of failure experiments of the positive section, compare and analyze the experimental phenomena, and draw the experimental conclusions 7. Derive the calculation formula of the positive section of the bent member and explain the scope of application of the formula; discuss, summarize the section design and load-bearing verification of the rectangular and T-shaped sections of the bent member, and illustrate the application to practical engineering by example 8. Explain the force characteristics and three types of failure modes of the inclined section of the bent member; explain the influencing factors, extend the explanation of the model and basic assumptions of the bearing capacity calculation formula 9. Derive the calculation formula of the	• In-class teaching • Study outside of class • Extracurricular practice • field test • Big assignments	• lecture • Problem-oriented • deliberate, • Project-driven • case analysis

		inclined section of the bent member and explain the scope of application of the formula; discuss, summarize the design and bearing capacity verification of the inclined section of the bent member in various types, and illustrate the application in actual engineering with examples 1 0. Explain the construction measures such as bending, cutting and anchoring of longitudinal force-bearing steel bars, and understand the relationship between bending moment envelope diagram and resistance moment diagram		
Calculation and analysis of the section bearing capacity of reinforced concrete compression members	14	11. Explain the construction requirements of the stressed member and apply them to engineering practice 12. Explain the two types of failure modes and failure characteristics of axially compressed members through experiments; derive the calculation formula of the cross-section of axially compressed members and explain the applicable range of the formula; be able to carry out the design calculation of axially compressed members and illustrate the application to actual engineering with examples 13. Explain the two types of failure modes and failure characteristics of eccentrically loaded members; derive the calculation formula of the positive section of eccentrically loaded members, and explain the scope of application of the formula; be able to carry out design calculations of eccentrically loaded members, and	• In-class teaching • Study outside of class • Extracurricular practice	• lecture • Problem-oriented • deliberate • give an example

		illustrate their application in actual engineering with examples 14. Interpretation of Nu-M_uThe relevant curve shows the influence of N and M variation on the damage of large and small bias 15. Express the formula for the calculation of the bearing capacity of the inclined section of the biased member, and discuss the similarities and differences with the formula for the calculation of the bearing capacity of the inclined section of the bent member		
Calculation and analysis of load-bearing capacity of reinforced concrete tension members	2	16. Confirm the force characteristics of axially tensioned members, illustrate the application of axially tensioned members in actual engineering, and explain the construction requirements of axially tensioned members 17. Distinguish between the concepts of large eccentric tension and small eccentric tension, describe the characteristics and design principles of large and small eccentric tension failure, and be able to design and calculate eccentric tension members, and illustrate their application in actual engineering	• In-class teaching • Study outside of class	• lecture • Problem-oriented
Calculation and analysis of section bearing capacity of reinforced concrete torsion members	4	18. Explain the similarities and differences between the failure modes of plain concrete pure torsion members and reinforced concrete pure torsion members 19. Explain the meaning of each symbol in the formula for the bearing capacity of a torsion member with a rectangular section, and analyze the physical meaning of the applicable conditions for upper and lower limits 20. Confirm the method of configuring bending, shear and torsion reinforcement for bending and shear components, determine the	• In-class teaching • Study outside of class	• lecture • Problem-oriented guidance • deliberate

		configuration scheme of bending and shear reinforcement for bending and shear components, carry out design calculation of bending and shear components, and illustrate the application in actual engineering by example 21. Summarize the reinforcement requirements of the member under torsion, summarize and identify the reinforcement requirements of the member under torsion		
The deformation, crack width verification and durability analysis of the components are carried out	4	22. Give examples of the differences and similarities between the deformation calculation of reinforced concrete structure and ideal elastic material, explain the principle of minimum stiffness, and explain the meaning of the symbol in the stiffness calculation formula 23. Apply the formula to calculate the maximum deflection value of the reinforced concrete flexural member under the normal service limit state, list the deflection limit formula of various members, and explain the measures and methods taken when the stiffness does not meet the requirements 24. Give an example of the cause of crack generation, discuss and analyze the theory of crack width calculation, explain the factors affecting the crack width of the component, calculate the maximum crack width of the component, and list the measures taken when the crack width verification is not satisfied Discuss and illustrate the considerations in the design of durability for concrete structures	• In-class teaching • Study outside of class • Extracurricular practice	• lecture • Problem-oriented guidance • deliberate • case
Calculation and analysis of stress performance of	10	26. Explain the advantages of prestressed concrete, identify three types of concrete structures and explain the stress characteristics of each structure	• In-class teaching • Study outside of	• lecture • Problem-oriented • deliberate

prestressed concrete members		27. Describe two methods and specific construction processes of prestressing, and explain the main equipment names and usage characteristics of prestressing 28. Explain the concept of tension control stress, calculate and solve the tension control stress of different prestressed steel bars, and explain six prestress losses 29. Explain the transmission length and anchoring length correctly, explain the requirements for the arrangement of construction steel in the local pressure-bearing area, and select the type of construction steel 30. Explain the calculation principle of prestressed concrete axially tensioned members and flexural members 31. Explain the difference between the force of prestressed concrete flexural structures and the force of prestressed concrete flexural structures, illustrate the advantages of unbonded prestressed concrete structures by example, and explain the difference in force performance between pure unbonded prestressed concrete beams and bonded beams 32. Explain the specific construction requirements of prestressed concrete components	class • Extracurricular practice	

4. Course Assessment (Assessment Scheme)

(1) Course assessment structure

Examination items		scale	Requirement
in normal times mark	Process assessment	10%	The process assessment of learning is based on the comprehensive evaluation of students resource learning, participation in online discussion and answering questions, classroom performance and so on
	In-class test	20%	All knowledge points are mainly objective questions, with question bank and automatic scoring, to examine students mastery of basic

				knowledge
	school assignment		10%	There are two kinds of assignments: group work and individual work. The focus is on assessing students ability to analyze and calculate comprehensively
	cooperative project	Design of simply supported cantilever beam	10%	According to the design task book of simply supported cantilever beam provided, carry out the structural calculation of cantilever beam and complete the construction drawing of cantilever beam structure; group discussion and individual completion
		Bending test of simply supported beam	10%	The failure test of bent member was completed by the group
final			40%	The test uses subjective questions with engineering background, focusing on assessing students ability to use their knowledge to comprehensively analyze and deal with problems
total			100%	

Note: When the final exam score is lower than (excluding) 50 points, the regular score shall be no higher than 60 points.

(2) Course assessment rules

Assessment items		**Primary coverage**	
		Knowledge units/points	**Ability items**
school assignment		For all knowledge units, no less than 50% of all knowledge points should be assessed	1. Independent learning ability 2. Industry standard reading and application ability 3. Communication skills
In-class test		All the knowledge points	This is an objective question, all of which are tested in terms of knowledge
cooperative project	Section design of reinforced concrete simply supported beam	Analysis and calculation of load-bearing capacity of bent members	It focuses on examining students ability to effectively express the analysis process and conclusions of simply supported cantilever beams by using engineering principles and mathematical models
	Test of bending bearing capacity of	Bending member failure test	Focus on the ability of students to design experiments scientifically, operate on site and complete them

	concrete beam with straight section		cooperatively
final		The force characteristics, section design and bearing capacity verification of the bent member (positive section, inclined section) and the compressed member (axial compression, partial compression)	The test uses subjective questions with engineering background to focus on assessing students ability to use their knowledge to comprehensively analyze and handle problems

5. The tasks undertaken in the cultivation of "solving complex engineering problems" ability

1. Through the teaching of basic principles of concrete structure, students are trained to develop engineering thinking and innovation ability, so that they can use relevant knowledge to serve model construction, solution and comparative analysis when solving complex civil engineering problems;

2. In the process of designing simply supported cantilever beams, students design and analysis ability, effective expression of the analysis process and conclusion, and the ability to improve the ability to use design principles to guide the formulation of solutions are trained;

3. Guide students to design the failure test scheme of the bent member and the field test scheme, and carry out the field test to cultivate students experimental (test) operation ability.

6. Cultivation and observation of non- "technical ability"

Cultivation of non-technical ability: guide students to learn independently, adopt group assistance learning mode in discussion, and cultivate students team assistance ability and communication ability;

Observation: In the group assignment scoring, set up peer evaluation among students in the same group and inter-group evaluation between different groups to observe the performance of students in collaborative learning.

7. Course ideological and political design

This course is a highly theoretical core professional course that is also closely related to engineering practice, standards, and regulations. The teaching team uses "Cloud Classroom" as a technical support tool, guided by the OBE educational philosophy, integrating ideological and political education with engineering projects to foster innovation capabilities. It deeply incorporates national sentiment and a sense of responsibility, showcasing cultural confidence and embodying the spirit of craftsmanship—rigorous standards, truth-seeking, perseverance, virtue-bearing, and keeping pace with the times.

8. Course evaluation and continuous improvement mechanism

(1) Evaluation of course objectives achievement

The course evaluation cycle is once per semester.

The course evaluation cycle is set once per semester.

The following evaluation is made for the achievement of the course objectives:

The achievement of course objective 1 is evaluated by process assessment, in-class test, homework and final examination;

The achievement of course objective 2 is evaluated by comprehensive evaluation of the major assignment. The task requires students to review various specifications and other materials, carry out the structural design of simply supported cantilever beam, complete its hand calculation book, and draw the structural construction drawing;

The achievement of course objective 3 is evaluated by the bending test of simply supported beam in cooperative project.

The course evaluation is carried out as follows:

Program objective	Corresponding graduation requirements	Evaluation methodology	Remarks
Course Objective 1	1.3	The scoring method	Process assessment, in-class test, homework, final exam
Course objective 2	2.4	Project scoring method	Cooperative project-design of simply supported cantilever beam
Course objective 3	4.2	Project scoring method	Cooperative project-bending test

(2) Continuous improvement mechanism

(a) Establish a continuous improvement system

① Establish a continuous improvement group for this course;

② The head of the course continuous improvement group is responsible for organizing and supervising the continuous improvement process;

③ Develop continuous improvement measures.

(b) Establish a course continuous improvement group

Team leader: person in charge of the course team. Team members: persons in the course team

(3) Continuous improvement of the course

① Regular grade assessment mechanism: According to the learning situation of each class, teachers of the course team must summarize and calculate all indicators of regular grade assessment for

each unit, adjust the status of students in time and make corresponding records;

② Final examination assessment mechanism: analyze the final examination paper, count the score of each part of the test, and use the statistical results to conduct overall analysis and research on the course, so as to make improvements in the next class of students.

(c) Continuous improvement measures for the course

① For the assessment of regular grades, measures such as symposium, discussion group, establishment of study group and individual communication with students are adopted to improve;

② For the final examination, according to the problems that students have encountered in the examination and the key content of the course, unified guidance and other measures are taken to improve the students who take the make-up examination.

Formulator (signature):

Director (room) review (signature):

Professional person in charge of review (seal):