**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**

**O. M. BEKETOV NATIONAL UNIVERSITY**
**of URBAN ECONOMY in KHARKIV**

METHODOLOGICAL RECOMMENDATIONS

for practical classes, organization of independent
work and performing course project
on an academic discipline

# «INSPECTION, RECONSTRUCTION AND STRENGTHENING OF BUILDINGS»

*(for forms students second (master's) degree all educational on specialty 192 – Building Industry and Civil Engineering,*
*of educational program «Civil and Industrial Engineering»)*

**Kharkiv**
**O. M. Beketov NUUE**
**2025**

Methodological recommendations for practical classes, organization of independent work and performing course project on an academic discipline «Inspection, reconstruction and strengthening of buildings» (for forms students second (master's) degree all educational on specialty 192 – Building Industry and Civil Engineering, of educational program «Civil and Industrial Engineering») / O. M. Beketov National University of Urban Economy in Kharkiv ; com. : Pavlo Firsov, Olena Lugchenko, Oleksandr Kulakov. – Kharkiv : O. M. Beketov NUUE, 2025. – 28 p.

Compliers: PhD (Tech.), Associate Professor Pavlo Firsov,
PhD (Tech.), Associate Professor Olena Lugchenko,
Assistant Oleksandr Kulakov

Reviewer

**Oleg Kalmykov**, PhD (Tech.), Associate Professor of Building Structures Department of O. M. Beketov National University of Urban Economy in Kharkiv

*Recommended by the Building Structures Department, record № 8 on 16.01.2025*

**CONTENT**

# INTRODUCTION

In the educational process, the discipline “Inspection, Reconstruction and Strengthening of Buildings” is one of basics during preparation of Master’s Degree students on specialty 192 – Building Industry and Civil Engineering of the educational program “Industrial and Civil Engineering”.

This discipline is intended for students of all educational forms and the methodological guidelines are compiled on the basis of and in accordance with the approved Work Program of O. M. Beketov NUUE in Khrakiv on the academic discipline “Inspection, reconstruction and strengthening of buildings”.

The most important requirement for the preparation of highly qualified specialists at the present stage is the development of the ability and skills of applicants to independently acquire knowledge and skills necessary for engineering solutions to the problems of calculation and design strengthened metal and reinforced concrete structures after graduating from an University. Therefore, the Work Program of the course provides not only for the transfer of certain scientific information by the lecturer, but also for the organization of independent cognitive activity of applicants by working with literature and regulatory documentation.

The main aim of the student’s independent work is to deeply study the theoretical part of the course, acquire skills in calculation and design of strengthened elements and joints of steel and reinforced concrete structures in accordance with current design standards, as well as skills in using regulatory and reference literature.

The independent work of applicants comes down to three tasks:

– studying the theoretical part of the course;

– acquiring skills in calculation of strengthened steel and reinforced concrete structures of common types;

– acquiring skills in design of strengthened steel and reinforced concrete structures of common types.

Applicants should organize their work in the indicated areas in accordance with the recommendations below, using methodological guidelines, educational, regulatory and reference sources indicated in the list.

Regulatory documents, textbooks, study guides, reference literature and methodological guidelines necessary for independent study of the theoretical part of the course and acquisition of the necessary practical skills are contained on the distance education website of the O. M. Beketov NUUE in Kharkiv at the URL: https://dl.kname.edu.ua.

## 1 STUDYING THE THEORETICAL PART OF THE COURSE

It is recommended to study the theoretical part of the course using normative and educational literature [1−12]. The list of program questions below contains a brief summary of each question and detailed references to literary sources available to students in paper or electronic form.

When studying program questions from the specified sources, it is advisable to make a brief summary according to the given question annotation. This will help to systematize knowledge on each question and speed up preparation for the differential test. During preparation of the test, the answers to the questions should be accompanied by sketches of reinforced structures, calculation diagrams, formulas and explanations, which should be found in the recommended textbooks [1; 5−12] and in current design standards [2−4].

In addition to theoretical questions, simple problems on the calculation of reinforcement of elements and connections of steel, reinforced concrete and timber structures are taken into account for the test, which are considered during practical classes. For each separate type of problem, recommendations for their solution are provided with mandatory references to design standards [2−4].

# 2 LIST OF PROGRAM QUESTIONS AND RECOMMENDATIONS FOR THEIR STUDY

Table 2.1 – Program questions

| Content of program questions | References |
|---|---|
| 1 | 2 |
| ***1 General provisions on the reconstruction of buildings and structures. Basic concepts of reconstruction***<br>Terminology on reconstruction issues and the main tasks of its implementation. Service life of buildings and structures and their individual structural elements. Classification of buildings by service life. The concept of repair and reconstruction of public buildings. Reasons for repair and reconstruction. Physical and moral tear of buildings. Volumetric-planning and design solutions for buildings, which are being reconstructed. Operating conditions of reconstruction site and adjacent areas | [1; 2; 3; 7; 11] |
| ***2 Inspection of buildings and structures. Quality control of building materials and structures***<br>Purpose and objectives of the inspection. Methods of inspecting the condition of buildings and structures. The essence of the general inspection. Detailed and comprehensive inspection. Safety precautions during inspection of buildings. Assessment of the technical condition of buildings in operation. Basic provisions on operation. Technical passport of the facility. Structural solutions of structures subject to reconstruction. Main types of defects in building structures. Purpose and objectives of instrumental examination. Characteristics of defects in building structures. Main types of defects. Devices and tools for conducting inspections of the technical condition of buildings and structures. Registration of inspection results. Examination algorithm | [5; 7; 9; 11] |
| ***3 Assessment of the quality of buildings and their degree of deterioration***<br>Calculation of tear. Verification and assessment of loads on buildings subject to reconstruction. Design strength characteristics of materials at the stage of inspection after long-term operation. Statistical processing of inspection data. Assessment of the bearing capacity of buildings and structures | [6; 11] |
| ***4 Examination, protection and restoration of bearing capacity of concrete and reinforced concrete structures***<br>Inspection of concrete and reinforced concrete structures. Classification features of categories of technical condition of reinforced concrete structures. Damage to reinforced concrete structures and their causes. Surface preparation for repair. Cracks in concrete and reinforced concrete structures. Repair and protection of surfaces of concrete and reinforced concrete structures | [3; 8; 10; 11] |
| ***5 Strengthening of reinforced concrete structures***<br>Main methods of strengthening structures. Strengthening structures by installing metal, concrete and reinforced concrete frames. Strengthening structures by injection and impregnation with solutions. Strengthening structures by external reinforcement | [5; 7; 11] |

Continuation of Table 2.1

| 1 | 2 |
|---|---|
| ***6 Inspection, repair and strengthening of stone and reinforced stone structures***<br>General provisions. Classification features of technical condition categories of stone and reinforced stone structures | [5; 9; 11] |
| ***7. Repair and strengthening of stone structures***<br>Strengthening of structures using injection mixtures. Reinforcement of stone structures using reinforced cement, concrete and steel frames. Reinforcement of stone structures by spatial compression | [2; 3; 4; 10] |
| ***8 Features of the technical condition of steel structures, which are in operation***<br>Causes of accidents. Engineering errors. Types of local defects and damage and their elimination | [9; 11] |
| ***9 Classification of methods for steel structures strengthening***<br>General requirements for the design of strengthening of steel structures. Existing methods of reinforcement of steel structures | [4; 8; 10; 11] |
| ***10 Principles of calculation and design of steel structures strengthening***<br>The procedure for calculating a bending element. The procedure for calculating a centrally compressed element. Features of reinforcing steel crane structures. Calculation and design of options for reinforcing steel trusses. Calculation and design of options for reinforcing an eccentrically compressed element | [2; 3; 4; 8; 10] |

# 3 QUESTIONS FOR SELF-CONTROL

## 3.1 Questions for self-control on CM 1

1. What normative requirements are given for buildings and structures?

2. What does the durability of buildings depend on?

3.What are the structural features of historic residential buildings?

4. What circumstances should be taken into account during inspection of historic buildings?

5. How many groups of capitality of residential buildings exist and what do they represent?

6. How many groups of capitality of public buildings exist and what are their characteristics

7. Depending on what conditions are the service life of buildings determined?

8. How is the physical tear of buildings determined?

9. How is the moral tear of buildings determined?

10. What factors characterize the durability and degree of tear of industrial buildings?

11. By what criteria are possible defects classified?

12. What can be said about the categories of defects?

13. How to characterize the main groups of requirements for the reliability and durability of structures?

14. What measures should be taken to extend the service life of structures?

15. What should be the main focus when assessing the technical condition of buildings, structures and their structural elements?

16. What is the basis for conducting building inspections?

17. What types of work are performed during the inspection process?

18. What does a comprehensive and selective examination involve?

19. What technical means and devices are used in the process of inspecting building structures?

20. What are local and general deformations of buildings?

21. What is the purpose of structural flaw detection?

22. What are the main defects of metal and timber structures?

23. What are the main defects of reinforced concrete structures?

24. What is the essence of the pulsed ultrasonic testing method?

25. What does the system of planned and preventive repairs of buildings and structures provide?

26. What is the current and major repairs of buildings?

27. How is the frequency of repairs of residential and industrial buildings determined?

28. What documentation is maintained by operational services?

29. Types of inspections of residential and industrial buildings and their timing?

30. The purpose of the reconstruction and modernization (renovation) of buildings?

31. What are the features of building maintenance? Typical damages that affect the failure of residential buildings.

### 3.2 Questions for self-control for CM 2

1. In what cases it is necessary to make strengthening of foundations?

2. How are foundations strengthened using banquettes?

3. How to strengthen the soles of foundations without compressing the foundations bases?

4. How is the sole of foundations reinforced with compacted base soils?

5. How is foundation strengthening made using flat jacks?

6. What are the ways to increase the depth of foundations?

7. What methods are used to increase the strength of the bases and foundations of buildings?

8. How is foundation strengthening designed by adding an additional foundation slab?

9. How foundations are strengthened using driven piles?

10. In what cases is flow technology used to strengthen foundations?

11. What are the main categories of condition of reinforced concrete structures do you know? Explain the content of each condition category.

12. What characteristics of defects, damage and possible consequences are revealed in the first state?

13. What characteristics of defects, damage and possible consequences are revealed in the second state?

14. What characteristics of defects, damage, and possible consequences are revealed in the third state?

15. What characteristics of defects, damage, and possible consequences are revealed in the fourth state?

16. In which condition categories is structural strengthening required and by what measures is this achieved?

17. What are the main methods used to strengthen reinforced concrete foundation structures? Explain the basic concepts.

18. How is the synergy of old and new reinforced concrete ensured?

19. What is the sequence of calculation of strengthening of a centrally compressed column with a reinforced concrete holder?

20. What is the sequence of calculation of strengthening of a centrally compressed column with prestressed struts?

21. Give the examples of design of strengthening of compressed reinforced concrete elements.

22. Give examples of design of strengthening for flexural reinforced concrete elements.

23. What is the sequence of calculating the strengthening of bending elements with sprengel tightening?

24. What is the sequence of calculating the strengthening of bending elements with horizontal ties?

25. What is the sequence of calculating the strengthening of bending elements by increasing the tensioned cross-sectional area?

26. What is the sequence of calculating the strengthening of bending elements by increasing the compressed cross-sectional area?

27. What is the sequence of calculating the strengthening of floor slabs by increasing the compressed cross-sectional area?

28. What is the sequence of calculating the strengthening of a brick column with a reinforced concrete and plaster holder?

29. Give the examples of the design of floor slab strengthening?

30. Give the list the principles of strengthening of stone buildings for overall stability and strength.

31. In what cases is stone structures reinforced?

32. What is the sequence of calculating the strengthening of stone partitions of buildings with a metal angle bracket?

### 3.3 Questions for self-control for CM 3

1. What are the features of the technical condition of steel structures in operation?

2. Define the types of defects and damage to steel structures. Methods for their detection and elimination?

3. What is the classification of methods for strengthening steel structures?

4. What are the general requirements for the design of reinforcement of steel structures?

5. What are the options for strengthening steel truss elements and the methodology for their calculation?

6. What are the options for strengthening steel beams and their calculation methods?

7. What are the options for strengthening steel crane beams and the method for calculating them?

8. What are the options for strengthening steel solid and through-centrally compressed columns and the methodology for their calculation?

9. How is the calculation of strengthening a centrally-compressed column by increasing the cross-sectional area performed?

10. How is the calculation of the reinforcement of a centrally compressed column with prestressed struts carried out?

11. Give the examples of design strengthening of compressed metal elements by increasing the cross-sectional area.

12. Give hexamples of design strengthening of bending metal elements by increasing the cross-sectional area.

13. How is the calculation of strengthening of bending metal elements by increasing the cross-sectional area carried out?

14. What are the features of assessing the technical condition of timber structures in operation?

15. Define the types of defects and damage to timber structures. Options for their detection and elimination?

16. Give the classification of methods for strengthening timber structures?

17. What are the general requirements for design of strengthening for timber structures?

18. What are the options for strengthening of timberr truss elements and the methodology for their calculation?

19. What are the options for strengthening of timber beams and their calculation methods?

20. What are the options for strengthening of timber verticals and the method of their calculation?

## 4 RECOMMENDATIONS FOR CONDUCTING PRACTICAL CLASSES

During preparation of practical classes, it is necessary to read the lecture notes, edit the text, write out definitions, formulas, and study the material. Active work at lectures and a good summary will facilitate understanding and assimilation of the material. During the process of work, applicants must check their knowledge, find out whether they correctly understand the material they are studying.

It is advisable to prepare for practical classes in the following order:

1. Familiarize yourself with the topic, lesson plan, recommended literature, read the lecture notes and understand the material on this topic.

2. Study the educational material, select additional literature.

3. Make a plan for solving a practical task, which is very important for systematizing and assimilating knowledge, and for a clear and consistent understanding of the material.

4. Systematically carry out self-control of the completeness of the assimilation of the material, answering the questions that are included in the textbooks at the end of each section, in the methodological guidelines and recommendations, as well as performing practical exercises and skills recommended for mastering when studying certain topics. Self-control is also carried out in conversations on certain issues with

other applicants. If gaps in knowledge and skills are found, you should once again refer to the educational literature, clarify unclear questions with the lecturer.

Answers in the lesson should be detailed, convincing, evidence-based and reasoned, should reveal the essence of the question, its significance, be accompanied by conclusions, generalizations. During the lesson, it is necessary to take notes. Practical classes (Table 4.1) cover almost all theoretical questions of the course and involve the participation of each applicant in their preparation and conduct.

Table 4.1 – Program Practical Exercises

| Topics of practical classes | References |
|---|---|
| 1 | 2 |
| ***1 Preparation of the technical passport of the facility***<br>Mechanism for conducting a technical inventory of real estate objects. Technical inventory of buildings and structures. Components of a technical passport | [2; 3; 7] |
| ***2 Identification of defects and damage to structures. Compilation of defect information***<br>Inspection and fixation of defects. Measuring the dimensions of buildings and structures. Drawing up a map of damages and defects by applying them to facade diagrams and plans. Drawing up a defect list in the form of a table indicating methods for eliminating the detected damages. Photo fixation of damages. Drawing up a conclusion | [6; 7] |
| ***3 Calculation of tear. Identification of reserves of bearing capacity of building structures***<br>Expert method for calculating physical tear. Assessment of physical tear of elements and systems, as well as determination of their specific weight at the restored value. Determination of the amount of corrective physical tear. Actual design loads and schemes of operation of structures | [9; 11] |
| ***4 Calculation and design of strengthening of reinforced concrete columns of industrial and civil buildings by increasing the cross-sectional area***<br>Methodology for calculating the strengthening of a reinforced concrete column with a reinforced concrete holder. Preparation of surfaces of reinforced concrete structures for strengthening. Design of strengthening of reinforced concrete columns of industrial and civil buildings by increasing the cross-sectional area | [8; 10; 11] |
| ***5 Calculation and design of strengthening of reinforced concrete columns of industrial and civil buildings with prestressed struts***<br>Methodology for calculating the strengthening of a reinforced concrete column with prestressed struts. Preparation of surfaces of reinforced concrete structures for strengthening. Design of strengthening of reinforced concrete columns of industrial and civil buildings with prestressed struts | [7; 6; 8] |

Continuation of Table 4.1

| 1 | 2 |
|---|---|
| ***6 Calculation and design of strengthening of reinforced concrete floor beams (crossbars) of industrial and civil buildings by horizontal and truss ties***<br>Methodology for calculating horizontal ties. Methodology for calculating sprengel. Design of reinforcement units for reinforced concrete floor beams (crossbars) of industrial and civil buildings with horizontal and sprengel ties | [7; 9; 11] |
| ***7 Calculation and design of strengthening of inclined cross-section of reinforced concrete floor beams (crossbars) of industrial and civil buildings under the action of transverse force***<br>Schemes of possible destruction of the inclined section of reinforced concrete floor beams. Identification of reserves of bearing capacity of the inclined section. Calculation and design of strengthening of the inclined section of reinforced concrete floor beams | [7; 8; 10] |
| ***8 Calculation and design of strengthening of reinforced concrete crane beams***<br>Schematic diagrams of strengthening of reinforced concrete crane beams. Establishing the possibility and feasibility of strengthening of crane beams. Calculation and design of strengthening of reinforced concrete crane beams | [7; 10; 11] |
| ***9 Restoration of load-bearing capacity of reinforced concrete ribbed slabs for covering and floors***<br>Methodology for restoring bearing capacity of reinforced concrete ribbed slabs for covering and floors. Schematic diagrams of strengthening of reinforced concrete ribbed slabs for covering and floors. Design of strengthening of reinforced concrete ribbed slabs for covering and floors | [7; 8; 9] |
| ***10 Calculation and design of strengthening of steel beams of industrial and civil buildings by increasing the cross-section***<br>Identification of bearing capacity reserves of steel beams of industrial and civil buildings. Methodology for calculating the reinforcement of steel beams of industrial and civil buildings by increasing the cross-sectional area. Determination of the length of the reinforcing element of a steel bent element | [8; 9] |
| ***11 Calculation and design of strengthening of steel columns of industrial and civil buildings by increasing the cross-sectional area***<br>Strengthening of steel columns with a significant change in flexibility and without affecting the flexibility of the element. Identification of bearing capacity reserves. Methodology for calculating the strengthening of steel columns of industrial and civil buildings by increasing the cross-sectional area. Design of strengthening of steel columns of industrial and civil buildings by increasing the cross-sectional area | [9; 10] |
| ***12 Calculation and design of strengthening of steel structures by changing the design scheme of the structure***<br>Methodology for calculating the strengthening of steel structures of industrial and civil buildings by changing the design scheme of the structure. Determining the possibility of strengthening of steel structures by changing the design scheme | [6; 8] |

# 5 RECOMMENDATIONS FOR PERFORMING COURSE PROJECT

Independent work on the discipline “Inspection, reconstruction and strengthening of buildings” involves completing a Course Project. Designing on this topic provides an opportunity to more deeply master the theoretical provisions of this discipline and the previously studied general courses “Metal structures”, “Reinforced concrete and stone structures”, “Design of reinforced concrete structures” and “Design of metal structures”, learn to develop solutions for rational strengthening of structures and perform calculations for these solutions.

In Part 1 “Strengthening of metal structures” of the Course Project, applicants design strengthening of the beams of the industrial workshop floor due to the increased load on the site (due to the modernization of the technological process in the workshop), using the method of increasing the cross-sections of elements.

In Part 1, it is also necessary to prepare strengthening of the cross-section of the main beam and column (according to the task). The scope of Part 1 of the Course Project: an explanatory note of 8−10 pages and 2 sheets of A3 format drawings. The drawings must provide: an assembly plan of the floor beams; a structural drawing of the strengthening of the main beam and column; a specification of the strengthening elements.

In Part 2 “Strengthening of reinforced concrete structures” of the Course Project, it is necessary to design the strengthening of the supporting reinforced concrete structure of the frame (beam, column) under the condition of additional load on the floors. The scope of Part 2 of the Course Project: an explanatory note of 8−10 pages and 2 sheets of A3 format drawings. The drawing must provide: a fragment of the plan and section of the building; a structural drawing of the strengthening of the proposed reinforced concrete elements; a specification of the strengthening elements.

Applicants take the initial data for design from Section 6 of the methodological guidelines according to the last two numebrs of students grade book.

# 6 TASKS FOR PERFORMING COURSE PROJECT

## Part №1 Strengthening of metal structures

Table 6.1 − Variants of tasks

| № | $L$ m | $l$ m | a m | $H_{bd}$ m | Normative load $V$, kN/m$^2$ | | Type of connection | Scheme of strengthening | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | column | beam |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 12,0 | 6,0 | 1,5 | 7,2 | 4,5 | 9,0 | FL | A | A |
| 2 | 11,2 | 6,2 | 1,6 | 6,9 | 5,0 | 9,5 | OL | B | B |
| 3 | 11,9 | 6,1 | 1,7 | 8,1 | 5,3 | 11,0 | FL | C | C |
| 4 | 10,8 | 5,9 | 1,8 | 7,7 | 5,5 | 12,0 | OL | D | D |
| 5 | 12,0 | 5,7 | 1,5 | 6,6 | 4,0 | 9,0 | FL | E | E |
| 6 | 11,2 | 6,0 | 1,6 | 6,7 | 3,5 | 8,5 | OL | A | A |
| 7 | 11,9 | 6,2 | 1,7 | 7,0 | 4,0 | 9,1 | FL | B | B |
| 8 | 10,8 | 6,1 | 1,8 | 7,1 | 3,0 | 8,3 | OL | C | C |
| 9 | 12,0 | 5,9 | 1,5 | 8,0 | 3,5 | 6,5 | FL | D | D |
| 10 | 12,0 | 5,7 | 1,5 | 7,2 | 6,0 | 9,0 | OL | E | E |
| 11 | 11,2 | 6,0 | 1,6 | 6,9 | 6,5 | 10,0 | FL | A | A |
| 12 | 11,9 | 6,2 | 1,7 | 8,1 | 7,0 | 10,5 | OL | B | B |
| 13 | 10,8 | 6,1 | 1,8 | 7,7 | 8,0 | 13,0 | FL | C | C |
| 14 | 12,0 | 5,9 | 1,5 | 6,6 | 4,0 | 7,0 | OL | D | D |
| 15 | 11,2 | 5,7 | 1,6 | 6,7 | 4,5 | 8,0 | FL | E | E |
| 16 | 11,9 | 6,0 | 1,7 | 7,0 | 7,0 | 11,0 | OL | A | A |
| 17 | 10,8 | 6,2 | 1,8 | 7,1 | 7,5 | 11,2 | FL | B | B |
| 18 | 12,0 | 6,1 | 1,5 | 8,0 | 6,2 | 10,0 | FL | C | C |
| 19 | 11,2 | 5,9 | 1,6 | 7,2 | 6,0 | 9,5 | OL | D | D |
| 20 | 11,9 | 5,7 | 1,7 | 6,9 | 5,5 | 8,0 | FL | E | E |
| 21 | 10,8 | 6,0 | 1,8 | 8,1 | 6,0 | 8,5 | FL | A | A |
| 22 | 12,0 | 6,2 | 1,5 | 7,7 | 6,3 | 10,0 | OL | B | B |
| 23 | 11,2 | 6,1 | 1,6 | 6,6 | 6,5 | 9,0 | FL | C | C |
| 24 | 11,9 | 5,9 | 1,7 | 6,7 | 7,0 | 10,0 | OL | D | D |
| 25 | 10,8 | 5,7 | 1,8 | 7,0 | 6,0 | 9,5 | FL | E | E |
| 26 | 12,0 | 6,0 | 1,5 | 7,1 | 8,0 | 11,0 | OL | A | A |
| 27 | 11,2 | 5,7 | 1,6 | 6,7 | 4,5 | 8,0 | FL | B | B |
| 28 | 11,9 | 6,0 | 1,7 | 7,0 | 7,0 | 11,0 | OL | C | C |
| 29 | 10,8 | 6,2 | 1,8 | 7,1 | 7,5 | 11,2 | FL | D | D |
| 30 | 12,0 | 6,1 | 1,5 | 8,0 | 6,2 | 10,0 | FL | E | E |

Table 6.2 − Variants of tasks

| № | *L* m | *l* m | a m | $H_{bd}$ m | Normative load *V*, kN/m² | | Type of connection | Scheme of strengthening | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | column | beam |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 13,5 | 6,0 | 1,5 | 7,2 | 4,5 | 9,0 | FL | A | A |
| 2 | 12,8 | 6,2 | 1,6 | 6,9 | 5,0 | 9,5 | OL | B | B |
| 3 | 13,6 | 6,1 | 1,7 | 8,1 | 5,3 | 11,0 | FL | C | C |
| 4 | 12,6 | 5,9 | 1,8 | 7,7 | 5,5 | 12,0 | OL | D | D |
| 5 | 13,5 | 5,7 | 1,5 | 6,6 | 4,0 | 9,0 | FL | E | E |
| 6 | 12,8 | 6,0 | 1,6 | 6,7 | 3,5 | 8,5 | OL | A | A |
| 7 | 13,6 | 6,2 | 1,7 | 7,0 | 4,0 | 9,1 | FL | B | B |
| 8 | 12,6 | 6,1 | 1,8 | 7,1 | 3,0 | 8,3 | OL | C | C |
| 9 | 13,5 | 5,9 | 1,5 | 8,0 | 3,5 | 6,5 | FL | D | D |
| 10 | 13,5 | 5,7 | 1,5 | 7,2 | 6,0 | 9,0 | OL | E | E |
| 11 | 12,8 | 6,0 | 1,6 | 6,9 | 6,5 | 10,0 | FL | A | A |
| 12 | 13,6 | 6,2 | 1,7 | 8,1 | 7,0 | 10,5 | OL | B | B |
| 13 | 12,6 | 6,1 | 1,8 | 7,7 | 8,0 | 13,0 | OL | C | C |
| 14 | 13,5 | 5,9 | 1,5 | 6,6 | 4,0 | 7,0 | OL | D | D |
| 15 | 12,8 | 5,7 | 1,6 | 6,7 | 4,5 | 8,0 | FL | E | E |
| 16 | 13,6 | 6,0 | 1,7 | 7,0 | 7,0 | 11,0 | OL | A | A |
| 17 | 12,6 | 6,2 | 1,8 | 7,1 | 7,5 | 11,2 | FL | B | B |
| 18 | 13,5 | 6,1 | 1,5 | 8,0 | 6,2 | 10,0 | FL | C | C |
| 19 | 12,8 | 5,9 | 1,6 | 7,2 | 6,0 | 9,5 | OL | D | D |
| 20 | 13,6 | 5,7 | 1,7 | 6,9 | 5,5 | 8,0 | FL | E | E |
| 21 | 12,6 | 6,0 | 1,8 | 8,1 | 6,0 | 8,5 | FL | A | A |
| 22 | 13,5 | 6,2 | 1,5 | 7,7 | 6,3 | 10,0 | OL | B | B |
| 23 | 12,8 | 6,1 | 1,6 | 6,6 | 6,5 | 9,0 | FL | C | C |
| 24 | 13,6 | 5,9 | 1,7 | 6,7 | 7,0 | 10,0 | OL | D | D |
| 25 | 12,6 | 5,7 | 1,8 | 7,0 | 6,0 | 9,5 | FL | E | E |
| 26 | 13,5 | 6,0 | 1,5 | 7,1 | 8,0 | 11,0 | OL | A | A |
| 27 | 12,8 | 5,7 | 1,6 | 6,7 | 4,5 | 8,0 | FL | B | B |
| 28 | 13,6 | 6,0 | 1,7 | 7,0 | 7,0 | 11,0 | OL | C | C |
| 29 | 12,6 | 6,2 | 1,8 | 7,1 | 7,5 | 11,2 | FL | D | D |
| 30 | 13,5 | 6,1 | 1,5 | 8,0 | 6,2 | 10,0 | FL | E | E |

Table 6.3 – Tasks variants

| № | $L$ m | $l$ m | a m | $H_{bd}$ m | Normative load $V$, kN/m$^2$ | | Type of connection | Scheme of strengthening | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | column | beam |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 12,0 | 6,0 | 1,5 | 7,2 | 3,5 | 9,0 | FL | A | A |
| 2 | 11,2 | 6,2 | 1,6 | 6,9 | 4,0 | 9,5 | OL | B | B |
| 3 | 11,9 | 6,1 | 1,7 | 8,1 | 4,3 | 11,0 | FL | C | C |
| 4 | 10,8 | 5,9 | 1,8 | 7,7 | 4,5 | 12,0 | OL | D | D |
| 5 | 12,0 | 5,7 | 1,5 | 6,6 | 3,0 | 9,0 | FL | E | E |
| 6 | 11,2 | 6,0 | 1,6 | 6,7 | 3,5 | 10,5 | OL | A | A |
| 7 | 11,9 | 6,2 | 1,7 | 7,0 | 4,0 | 11,1 | FL | B | B |
| 8 | 10,8 | 6,1 | 1,8 | 7,1 | 3,0 | 10,3 | OL | C | C |
| 9 | 12,0 | 5,9 | 1,5 | 8,0 | 3,5 | 9,5 | FL | D | D |
| 10 | 12,0 | 5,7 | 1,5 | 7,2 | 4,0 | 9,0 | OL | E | E |
| 11 | 11,2 | 6,0 | 1,6 | 6,9 | 4,5 | 10,0 | FL | A | A |
| 12 | 11,9 | 6,2 | 1,7 | 8,1 | 5,0 | 10,5 | OL | B | B |
| 13 | 10,8 | 6,1 | 1,8 | 7,7 | 6,0 | 13,0 | FL | C | C |
| 14 | 12,0 | 5,9 | 1,5 | 6,6 | 4,0 | 8,8 | OL | D | D |
| 15 | 11,2 | 5,7 | 1,6 | 6,7 | 4,5 | 9,7 | FL | E | E |
| 16 | 11,9 | 6,0 | 1,7 | 7,0 | 5,0 | 11,0 | OL | A | A |
| 17 | 10,8 | 6,2 | 1,8 | 7,1 | 5,5 | 11,2 | FL | B | B |
| 18 | 12,0 | 6,1 | 1,5 | 8,0 | 6,2 | 10,0 | FL | C | C |
| 19 | 11,2 | 5,9 | 1,6 | 7,2 | 6,0 | 9,5 | OL | D | D |
| 20 | 11,9 | 5,7 | 1,7 | 6,9 | 5,5 | 8,0 | FL | E | E |
| 21 | 10,8 | 6,0 | 1,8 | 8,1 | 4,0 | 8,5 | FL | A | A |
| 22 | 12,0 | 6,2 | 1,5 | 7,7 | 4,3 | 10,0 | OL | B | B |
| 23 | 11,2 | 6,1 | 1,6 | 6,6 | 4,5 | 9,0 | FL | C | C |
| 24 | 11,9 | 5,9 | 1,7 | 6,7 | 5,0 | 10,0 | OL | D | D |
| 25 | 10,8 | 5,7 | 1,8 | 7,0 | 4,0 | 9,5 | FL | E | E |
| 26 | 12,0 | 6,0 | 1,5 | 7,1 | 6,0 | 11,0 | OL | A | A |
| 27 | 11,9 | 6,0 | 1,7 | 7,0 | 5,0 | 11,0 | OL | B | B |
| 28 | 10,8 | 6,2 | 1,8 | 7,1 | 5,5 | 11,2 | FL | C | C |
| 29 | 12,0 | 6,1 | 1,5 | 8,0 | 4,2 | 10,0 | FL | D | D |
| 30 | 11,2 | 5,9 | 1,6 | 7,2 | 4,0 | 9,5 | OL | E | E |

Table 6.4 – Tasks variants

| № | *L* m | *l* m | a m | $H_{bd}$ m | Normative load *V*, kN/m² | | Type of connection | Scheme of strengthening | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | column | beam |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 12,0 | 6,0 | 1,5 | 7,2 | 4,5 | 9,0 | FL | A | A |
| 2 | 11,2 | 6,2 | 1,6 | 6,9 | 5,0 | 9,5 | OL | B | B |
| 3 | 11,9 | 6,1 | 1,7 | 8,1 | 5,3 | 11,0 | FL | C | C |
| 4 | 10,8 | 5,9 | 1,8 | 7,7 | 5,5 | 12,0 | OL | D | D |
| 5 | 12,0 | 5,7 | 1,5 | 6,6 | 4,0 | 9,0 | FL | E | E |
| 6 | 11,2 | 6,0 | 1,6 | 6,7 | 3,5 | 8,5 | OL | A | A |
| 7 | 11,9 | 6,2 | 1,7 | 7,0 | 4,0 | 9,1 | FL | B | B |
| 8 | 10,8 | 6,1 | 1,8 | 7,1 | 3,0 | 9,3 | OL | C | C |
| 9 | 12,0 | 5,9 | 1,5 | 8,0 | 3,5 | 7,5 | FL | D | D |
| 10 | 12,0 | 5,7 | 1,5 | 7,2 | 6,0 | 9,8 | OL | E | E |
| 11 | 11,2 | 6,4 | 1,6 | 6,9 | 6,5 | 10,9 | FL | A | A |
| 12 | 11,9 | 6,8 | 1,7 | 8,1 | 7,0 | 12,5 | OL | B | B |
| 13 | 10,8 | 6,6 | 1,8 | 7,7 | 8,0 | 13,6 | FL | C | C |
| 14 | 12,0 | 5,9 | 1,5 | 6,6 | 4,0 | 8,9 | OL | D | D |
| 15 | 11,2 | 5,7 | 1,6 | 6,7 | 4,5 | 10,0 | FL | E | E |
| 16 | 11,9 | 7,0 | 1,7 | 7,0 | 7,0 | 13,6 | OL | A | A |
| 17 | 10,8 | 7,2 | 1,8 | 7,1 | 7,5 | 12,9 | FL | B | B |
| 18 | 12,0 | 7,1 | 1,5 | 8,0 | 6,2 | 12,0 | FL | C | C |
| 19 | 11,2 | 6,9 | 1,6 | 7,2 | 6,0 | 11,5 | OL | D | D |
| 20 | 11,9 | 5,9 | 1,7 | 6,9 | 5,5 | 9,8 | FL | E | E |
| 21 | 10,8 | 6,7 | 1,8 | 8,1 | 6,0 | 11,5 | FL | A | A |
| 22 | 12,0 | 6,4 | 1,5 | 7,7 | 6,3 | 12,0 | OL | B | B |
| 23 | 11,2 | 6,7 | 1,6 | 6,6 | 6,5 | 11,0 | FL | C | C |
| 24 | 11,9 | 6,9 | 1,7 | 6,7 | 7,0 | 13,0 | OL | D | D |
| 25 | 10,8 | 6,7 | 1,8 | 7,0 | 6,0 | 11,8 | FL | E | E |
| 26 | 12,0 | 6,0 | 1,5 | 7,1 | 8,0 | 11,0 | OL | A | A |
| 27 | 11,9 | 5,7 | 1,7 | 6,9 | 5,5 | 8,0 | FL | B | B |
| 28 | 10,8 | 6,0 | 1,8 | 8,1 | 6,0 | 8,5 | FL | C | C |
| 29 | 12,0 | 6,2 | 1,5 | 7,7 | 6,3 | 10,0 | OL | D | D |
| 30 | 11,2 | 6,1 | 1,6 | 6,6 | 6,5 | 9,0 | FL | E | E |

CONDITIONAL DESIGNATIONS FOR TABLES 6.1−6.4

$L$ – column bay in longitudinal direction, m.

$l$ – column bay in transverse direction, m.

a – bay of beam decks, m.

$H_{bd}$ – height of top chord of the deck beam, m.

Type of beam connection: OL – in one level; FL – floored.

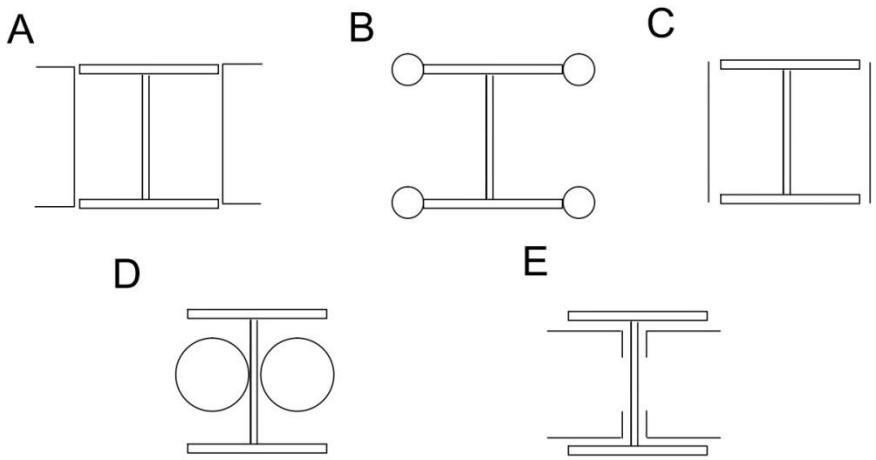


Figure 6.1 – Column strengthening schemes

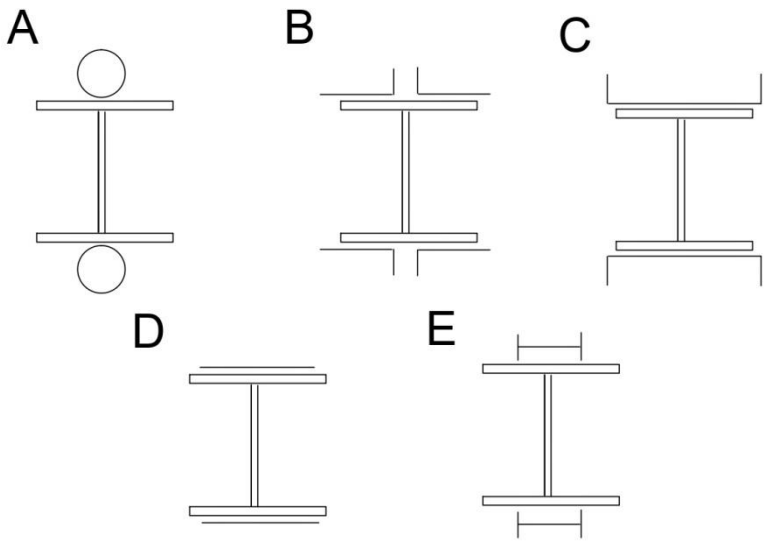


Figure 6.2 – Beams strengthening schemes

## Part №2 Strengthening of reinforced concrete structures

Table 6.5 – Variants of tasks

| № | $L_1$ m | $L_2$ m | $n_{fl}$ | $H_{fl}$ m | Normative load $V$, kN/m$^2$ | | Type of building | Element and method of strengthening |
|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 5,9 | 7,0 | 8 | 3,2 | 4,0 | 9,0 | C | C-S |
| 2 | 7,0 | 6,0 | 6 | 3,1 | 4,5 | 8,5 | C | C-S |
| 3 | 7,5 | 6,2 | 5 | 3,4 | 7,0 | 13,0 | I | C-S |
| 4 | 6,2 | 7,5 | 6 | 3,6 | 6,5 | 11,5 | I | C-S |
| 5 | 6,5 | 6,5 | 7 | 4,0 | 8,0 | 17,0 | I | C-S |
| 6 | 7,1 | 6,7 | 5 | 3,5 | 7,5 | 15,0 | I | C-S |
| 7 | 6,5 | 5,5 | 6 | 3,7 | 6,0 | 13,0 | I | C-H |
| 8 | 5,1 | 6,2 | 5 | 3,4 | 5,7 | 12,0 | I | C-H |
| 9 | 6,4 | 6,4 | 6 | 3,7 | 6,0 | 15,0 | I | C-H |
| 10 | 5,8 | 6,0 | 4 | 3,2 | 4,0 | 9,0 | C | C-H |
| 11 | 7,0 | 5,8 | 5 | 3,6 | 4,5 | 10,0 | C | C-H |
| 12 | 6,3 | 6,3 | 7 | 3,4 | 5,1 | 9,0 | C | C-H |
| 13 | 6,3 | 6,3 | 4 | 3,2 | 4,9 | 7,5 | C | C-HT |
| 14 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-HT |
| 15 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-HT |
| 16 | 5,9 | 6,3 | 6 | 4,0 | 4,5 | 8,3 | C | C-HT |
| 17 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-HT |
| 18 | 6,5 | 6,2 | 5 | 3,4 | 5,1 | 8,5 | C | C-HT |
| 19 | 6,1 | 6,5 | 6 | 3,4 | 3,5 | 8,0 | C | C-ST |
| 20 | 6,0 | 6,3 | 4 | 3,8 | 4,0 | 7,0 | C | C-ST |
| 21 | 6,4 | 5,9 | 7 | 3,0 | 3,0 | 5,6 | C | C-ST |
| 22 | 6,3 | 6,8 | 8 | 3,1 | 3,0 | 6,0 | C | C-ST |
| 23 | 7,0 | 6,1 | 5 | 3,6 | 3,5 | 6,1 | C | C-ST |
| 24 | 6,5 | 6,5 | 7 | 4,0 | 7,5 | 11,0 | I | C-ST |
| 25 | 6,0 | 6,7 | 6 | 3,2 | 6,0 | 8,0 | I | C-HT |
| 26 | 7,6 | 6,1 | 6 | 3,4 | 6,5 | 9,0 | I | C-HT |
| 27 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-S |
| 28 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-S |
| 29 | 5,9 | 6,3 | 6 | 4,0 | 4,5 | 8,3 | C | C-H |
| 30 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-H |

Table 6.6 − Variants of tasks

| № | $L_1$ m | $L_2$ m | $n_{fl}$ | $H_{fl}$ m | Normative load $V$, kN/m$^2$ | | Type of building | Element and method of strengthening |
|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 1 | 5,9 | 7,0 | 8 | 3,2 | 4,0 | 9,0 | C | C-S |
| 2 | 7,0 | 6,0 | 6 | 3,1 | 4,5 | 8,5 | C | C-S |
| 3 | 7,5 | 6,2 | 5 | 3,4 | 7,0 | 13,0 | I | C-S |
| 4 | 6,2 | 7,5 | 6 | 3,6 | 6,5 | 11,5 | I | C-S |
| 5 | 6,5 | 6,5 | 7 | 4,0 | 8,0 | 17,0 | I | C-S |
| 6 | 7,1 | 6,7 | 5 | 3,5 | 7,5 | 15,0 | I | C-S |
| 7 | 6,5 | 5,5 | 6 | 3,7 | 6,0 | 13,0 | I | C-H |
| 8 | 5,1 | 6,2 | 5 | 3,4 | 5,7 | 12,0 | I | C-H |
| 9 | 6,4 | 6,4 | 6 | 3,7 | 6,0 | 15,0 | I | C-H |
| 10 | 5,8 | 6,0 | 4 | 3,2 | 4,0 | 9,0 | C | C-H |
| 11 | 7,0 | 5,8 | 5 | 3,6 | 4,5 | 10,0 | C | C-H |
| 12 | 6,3 | 6,3 | 7 | 3,4 | 5,1 | 9,0 | C | C-H |
| 13 | 6,3 | 6,3 | 4 | 3,2 | 4,9 | 7,5 | C | C-HT |
| 14 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-HT |
| 15 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-HT |
| 16 | 5,9 | 6,3 | 6 | 4,0 | 4,5 | 8,3 | C | C-HT |
| 17 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-HT |
| 18 | 6,5 | 6,2 | 5 | 3,4 | 5,1 | 8,5 | C | C-HT |
| 19 | 6,1 | 6,5 | 6 | 3,4 | 3,5 | 8,0 | C | C-ST |
| 20 | 6,0 | 6,3 | 4 | 3,8 | 4,0 | 7,0 | C | C-ST |
| 21 | 6,4 | 5,9 | 7 | 3,0 | 3,0 | 5,6 | C | C-ST |
| 22 | 6,3 | 6,8 | 8 | 3,1 | 3,0 | 6,0 | C | C-ST |
| 23 | 7,0 | 6,1 | 5 | 3,6 | 3,5 | 6,1 | C | C-ST |
| 24 | 6,5 | 6,5 | 7 | 4,0 | 7,5 | 11,0 | I | C-ST |
| 25 | 6,0 | 6,7 | 6 | 3,2 | 6,0 | 8,0 | I | C-S |
| 26 | 7,6 | 6,1 | 6 | 3,4 | 6,5 | 9,0 | I | C-HT |
| 27 | 6,3 | 6,3 | 7 | 3,4 | 5,1 | 9,0 | C | C-H |
| 28 | 6,3 | 6,3 | 4 | 3,2 | 4,9 | 7,5 | C | C-HT |
| 29 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-HT |
| 30 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-HT |

Table 6.7 − Variants of tasks

| № | $L_1$ m | $L_2$ m | $n_{fl}$ | $H_{fl}$ m | Normative load $V$, kN/m² | | Type of building | Element and method of strengthening |
|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 5,9 | 7,0 | 8 | 3,2 | 4,0 | 9,0 | C | C-S |
| 2 | 7,0 | 6,0 | 6 | 3,1 | 4,5 | 8,5 | C | C-S |
| 3 | 7,5 | 6,2 | 5 | 3,4 | 7,0 | 13,0 | I | C-S |
| 4 | 6,2 | 7,5 | 6 | 3,6 | 6,5 | 11,5 | I | C-S |
| 5 | 6,5 | 6,5 | 7 | 4,0 | 8,0 | 17,0 | I | C-S |
| 6 | 7,1 | 6,7 | 5 | 3,5 | 7,5 | 15,0 | I | C-S |
| 7 | 6,5 | 5,5 | 6 | 3,7 | 6,0 | 13,0 | I | C-H |
| 8 | 5,1 | 6,2 | 5 | 3,4 | 5,7 | 12,0 | I | C-H |
| 9 | 6,4 | 6,4 | 6 | 3,7 | 6,0 | 15,0 | I | C-H |
| 10 | 5,8 | 6,0 | 4 | 3,2 | 4,0 | 9,0 | C | C-H |
| 11 | 7,0 | 5,8 | 5 | 3,6 | 4,5 | 10,0 | C | C-H |
| 12 | 6,3 | 6,3 | 7 | 3,4 | 5,1 | 9,0 | C | C-H |
| 13 | 6,3 | 6,3 | 4 | 3,2 | 4,9 | 7,5 | C | C-HT |
| 14 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-HT |
| 15 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-HT |
| 16 | 5,9 | 6,3 | 6 | 4,0 | 4,5 | 8,3 | C | C-HT |
| 17 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-HT |
| 18 | 6,5 | 6,2 | 5 | 3,4 | 5,1 | 8,5 | C | C-HT |
| 19 | 6,1 | 6,5 | 6 | 3,4 | 3,5 | 8,0 | C | C-ST |
| 20 | 6,0 | 6,3 | 4 | 3,8 | 4,0 | 7,0 | C | C-ST |
| 21 | 6,4 | 5,9 | 7 | 3,0 | 3,0 | 5,6 | C | C-ST |
| 22 | 6,3 | 6,8 | 8 | 3,1 | 3,0 | 6,0 | C | C-ST |
| 23 | 7,0 | 6,1 | 5 | 3,6 | 3,5 | 6,1 | C | C-ST |
| 24 | 6,5 | 6,5 | 7 | 4,0 | 7,5 | 11,0 | I | C-ST |
| 25 | 6,0 | 6,7 | 6 | 3,2 | 6,0 | 8,0 | I | C-H |
| 26 | 7,6 | 6,1 | 6 | 3,4 | 6,5 | 9,0 | I | C-S |
| 27 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-HT |
| 28 | 6,5 | 6,2 | 5 | 3,4 | 5,1 | 8,5 | C | C-HT |
| 29 | 6,1 | 6,5 | 6 | 3,4 | 3,5 | 8,0 | C | C-H |
| 30 | 6,0 | 6,3 | 4 | 3,8 | 4,0 | 7,0 | C | C-S |

Table 6.8 – Variants of tasks

| № | $L_1$ m | $L_2$ m | $n_{fl}$ | $H_{fl}$ m | Normative load $V$, kN/m$^2$ | | Type of building | Element and method of strengthening |
|---|---|---|---|---|---|---|---|---|
| | | | | | before | after | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 5,9 | 7,0 | 8 | 3,2 | 4,0 | 9,0 | C | C-S |
| 2 | 7,0 | 6,0 | 6 | 3,1 | 4,5 | 8,5 | C | C-S |
| 3 | 7,5 | 6,2 | 5 | 3,4 | 7,0 | 13,0 | I | C-S |
| 4 | 6,2 | 7,5 | 6 | 3,6 | 6,5 | 11,5 | I | C-S |
| 5 | 6,5 | 6,5 | 7 | 4,0 | 8,0 | 17,0 | I | C-S |
| 6 | 7,1 | 6,7 | 5 | 3,5 | 7,5 | 15,0 | I | C-S |
| 7 | 6,5 | 5,5 | 6 | 3,7 | 6,0 | 13,0 | I | C-H |
| 8 | 5,1 | 6,2 | 5 | 3,4 | 5,7 | 12,0 | I | C-H |
| 9 | 6,4 | 6,4 | 6 | 3,7 | 6,0 | 15,0 | I | C-H |
| 10 | 5,8 | 6,0 | 4 | 3,2 | 4,0 | 9,0 | C | C-H |
| 11 | 7,0 | 5,8 | 5 | 3,6 | 4,5 | 10,0 | C | C-H |
| 12 | 6,3 | 6,3 | 7 | 3,4 | 5,1 | 9,0 | C | C-H |
| 13 | 6,3 | 6,3 | 4 | 3,2 | 4,9 | 7,5 | C | C-HT |
| 14 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-HT |
| 15 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-HT |
| 16 | 5,9 | 6,3 | 6 | 4,0 | 4,5 | 8,3 | C | C-HT |
| 17 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-HT |
| 18 | 6,5 | 6,2 | 5 | 3,4 | 5,1 | 8,5 | C | C-HT |
| 19 | 6,1 | 6,5 | 6 | 3,4 | 3,5 | 8,0 | C | C-ST |
| 20 | 6,0 | 6,3 | 4 | 3,8 | 4,0 | 7,0 | C | C-ST |
| 21 | 6,4 | 5,9 | 7 | 3,0 | 3,0 | 5,6 | C | C-ST |
| 22 | 6,3 | 6,8 | 8 | 3,1 | 3,0 | 6,0 | C | C-ST |
| 23 | 7,0 | 6,1 | 5 | 3,6 | 3,5 | 6,1 | C | C-ST |
| 24 | 6,5 | 6,5 | 7 | 4,0 | 7,5 | 11,0 | I | C-ST |
| 25 | 6,0 | 6,7 | 6 | 3,2 | 6,0 | 8,0 | I | C-HT |
| 26 | 7,6 | 6,1 | 6 | 3,4 | 6,5 | 9,0 | I | C-HT |
| 27 | 7,2 | 6,2 | 7 | 3,3 | 6,4 | 9,2 | I | C-H |
| 28 | 5,5 | 7,0 | 6 | 4,1 | 5,5 | 9,1 | I | C-S |
| 29 | 5,9 | 6,3 | 6 | 4,0 | 4,5 | 8,3 | C | C-H |
| 30 | 5,8 | 5,8 | 7 | 3,5 | 4,0 | 7,0 | C | C-S |

## CONDITIONAL DESIGNATIONS FOR TABLES 6.5−6.8

$L_1$ – longitudinal span of building, м.

$L_2$ –transverse span of building, м.

$n_{fl}$ – number of floors of the building.

$H_{fl}$ – height of the floor, м.

*I, C* – type of building by purpose ( industrial or civil).

Element, requiring reinforcement, and method of strengthening: (C-S) – column with prestressed struts; (C-H) – column strengthened with reinforced concrete hoop; (C-HT) – crossbar strengthened with horizontal tie; (C-ST) – crossbar strengthened with a sprengel tie; (FS) – floor slab with increased cross-section.

## REFERENCES

1. Newman A. Structural Renovation of Buildings: Methods, Details and Design Examples / A. Newman. – New York : McGraw Hill, 2021. − 1079 p. − Web version exists. (Regime of access: https://oceanofpdf.com/authors/alexander-newman/pdf-epub-structural-renovation-of-buildings-methods-details-and-design-examples-download/, free).

2. ДСТУ Б В.2.6-7-95. Конструкції будинків і споруд. Вироби будівельні бетонні та залізобетонні збірні. Методи випробувань навантаженням. Правила оцінки міцності, жорсткості та тріщиностійкості. – Чинний від 1996−04−01. − Київ : Держбуд України, 1997. − 45 с. − Існує електрон. версія. (Режим доступу: https://www.ksv.biz.ua/GOST/DSTY_ALL/DSTY4/dstu_b_v.2.6-7-95.PDF, вільний).

3. ДСТУ Б В.3.1-2:2016. Ремонт і підсилення несучих і огороджувальних будівельних конструкцій та основ промислових будівель та споруд. − Чинний від 2016−06−24. − Київ : ДП «УкрНДНЦ», 2017. – 68 с. − Існує електрон. версія. (Режим доступу: https://uscc.ua/uploads/page/images/normativnye%20dokumenty/dstu/dstu_b_v_3-1-2_2016.pdf, вільний).

4. ДСТУ Б В.2.6-4-95. Конструкції залізобетонні. Магнітний метод визначення товщини захисного шару бетону і розташування арматури. – Чинний від 1995−07−01. − Київ : Державний комітет України у справах містобудування і архітектури, 1996. − 17 с. − Існує електрон. версія. (Режим доступу: https://ksv.do.am/GOST/DSTY_ALL/DSTY4/dstu_b_v.2.6-4-95.PDF, вільний).

5. Кліменко В. З. Випробування конструкцій, обстеження та моніторінг будівель і споруд / В. З. Кліменко, І. Д. Бєлов – Київ : Кондор, 2015. − 572 с. − Існує електрон. версія. (Режим доступу: http://pdf.lib.vntu.edu.ua/books/2022/Klimenko_2015_572.pdf, вільний).

6. Лучко Й. Й. Методи дослідження та випробування будівельних матеріалів і конструкцій / Й. Й Лучко. – Львів : Левада, 2020. − 495 с. − Існує

електрон. версія. (Режим доступу: https://repository.lnau.edu.ua/xmlui/handle/123456789/579, вільний).

7. Repair and Strengthening of Existing Reinforced Concrete Structures / Ed. by A. Lampropoulos. – Brighton : University of Brighton, 2024. − 315 p. − Web version exists. (Regime of access: https://www.mdpi.com/books/reprint/8690-repair-and-strengthening-of-existing-reinforced-concrete-structures, free).

8. P. C. Varghese P. C. Maintenance, Repair, Rehabilitation and Minor Works of Buildings / P. C. Varghese. – Delhi : PHI Learning, 2013. – 256 p. − Web version exists. (Regime of access: https://books.google.com.ua/books/about/MAINTENANCE_REPAIR_REHABILITATION_AND_MI.html?id=ZpBeBAAAQBAJ&redir_esc=y, free).

9. Савйовський В. В. Реконструкція будівель і споруд : навч. посіб. / В. В. Савйовський. – Харків : Ліра-К, 2019. – 320 с. − Існує електрон. версія. (Режим доступу: https://lira-k.com.ua/preview/12382.pdf?srsltid=AfmBOoouGrNvclLSX4efrlIEftk8HeIxvIKd1q5_xZ45E9AGHgLtMZi_, вільний).

10. Обстеження, випробування та експлуатація будівель і споруд: навч. посіб. / М. М. Корзаченко, І. О. Прибитько, Т. Р. Ганєєв, М. Г. Болотов. – Чернігів : НУ «Чернігівська політехніка», 2021. – 110 с. − Існує електрон. версія. (Режим доступу: https://ir.stu.cn.ua/jspui/handle/123456789/24114, вільний).

11. Клименко В. Є. Технічна експлуатація та реконструкція будівель і споруд : навч. посіб. / В. Є. Клименко. – Київ : Центр навчальної літератури, 2004. – 304 с. − Існує електрон. версія. (Режим доступу: http://pdf.lib.vntu.edu.ua/books/2016/Klimenko_2004_304.pdf, вільний).

12. Digital Repository of O. M. Beketov National University of Urban Economy in Kharkiv [Electronic resource] : site. – Electronic text data. – Constantly updated. – Regime of access: https://eprints.kname.edu.ua, free (date of the application: 25.03.2025), − Header from the screen.

*Електронне навчальне видання*

Методичні рекомендації
до проведення практичних занять, організації самостійної
та виконання курсової робіт
з навчальної дисципліни

**«ОБСТЕЖЕННЯ, РЕКОНСТРУКЦІЯ ТА ЗМІЦНЕННЯ БУДІВЕЛЬ»**

*(для здобувачів другого (магістерського) рівня вищої світи всіх форм навчання зі спеціальності 192 − Будівництво та цивільна інженерія, освітньо-професійна програма «Промислове та цивільне будівництво»)*

(Англ. мовою)

Укладачі: **ФІРСОВ** Павло Михайлович,
**ЛУГЧЕНКО** Олена Іванівна,
**КУЛАКОВ** Олександр Юрійович

Відповідальний за випуск *П. М. Фірсов*
*За авторською редакцією*
Комп'ютерне верстання *П. М. Фірсов*

План 2024, поз. 427М

Підп. до друку 31.03.2025. Формат 60 × 84/16.
Ум. друк. арк. 1,6.

Видавець і виготовлювач:
Харківський національний університет
міського господарства імені О. М. Бекетова,
вул. Чорноглазівська (Маршала Бажанова), 17, Харків, 61002.
Електронна адреса: office@kname.edu.ua
Свідоцтво суб'єкта видавничої справи:
ДК № 5328 від 11.04.2017.