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Reinforcement of flexural reinforced concrete elements with pre-tensioned ropes

Volodymyr Vynokur, postgraduate [1], (ORCID: 0009-0002-3218-5620),
Nasser Abdelilah, student [1], (ORCID: 0009-0006-5041-8618)

[1] *Kyiv National University of Civil Engineering and Architecture, 31 Air Force Avenue, Kyiv, 03037, Ukraine*

ANNOTATION

Recently, in Ukraine, there has been a significant need to improve methods of strengthening building structures in both infrastructure and commercial facilities. This is due to the need to increase their strength and durability due to wear or increased loads. In this context, technologies for strengthening structures become crucial.

Key words: reinforcement, ropes, prestressing, bending elements.

1. INTRODUCTION

Prestressing technologies are gaining more and more popularity. One of these methods is the "post-tensioning" technology [1, 2, 3].

These strengthening methods can be used in commercial buildings, such as shops and warehouses, as well as in critical infrastructure facilities, including bridges and overpasses. Ensuring the durability and reliability of such structures is key to ensuring their safety and efficiency in the future.

2. PURPOSE OF THE WORK

Conduct an analysis of existing methods of strengthening reinforced concrete structures with pre-tensioning of ropes.

3. EXTERNAL POST-TENSIONING

External prestressing has become a popular method of increasing the load-bearing capacity of structures due to the use of economical materials and reduced labor costs. For the last twenty years, researchers have been actively studying the use of this technique to strengthen bending elements such as beams. However, research on the strengthening of reinforced concrete flexural elements using external prestressing is still insufficient. This technology allows you to avoid additional costs for concrete work by tensioning the structure with the help of anchors, which helps restore its initial characteristics and increase strength.

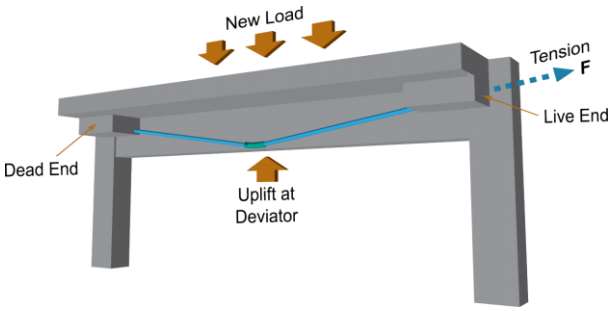

Figure 1. Schematic diagram of external reinforcement "External Post-Tensioning"

Figure 2. Use of external reinforcement "External Post-Tensioning"

4. INTERNAL POST-TENSIONING

Internal post-tensioning is a technique used to reinforce concrete structures by applying a tensile force to steel tendons or cables placed within the concrete before it sets. Steel tendons, encased in protective sheaths, are arranged in ducts that are embedded in the concrete. After the concrete has cured, the tendons are tensioned with hydraulic jacks, stretching them and anchoring them securely, which compresses the concrete and counteracts tensile stresses. Often, the ducts are filled with grout to protect the tendons from corrosion and bond them to the concrete. This method enhances the load-carrying capacity of the structure, reduces material usage, and improves crack control, making it ideal for large-scale projects like bridges, parking structures, and high-rise buildings.

The tensioning process is carried out using a jack.

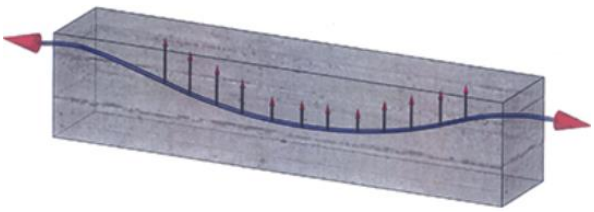

Figure 3. Schematic diagram of internal reinforcement "Internal Post-Tensioning"

Figure 4. Using internal amplification «Internal Post-Tensioning»

5. COMPARISON

Many researchers initially doubted the advisability of placing channels outside the working circuit of bending elements, after which they believed that the classical principles and recommendations for prestressing might become unsuitable.

However, the analysis showed that placing the loose rope inside or outside the reinforced concrete flexural member made no significant difference. It is worth noting that the ropes located inside the concrete do not ensure sufficient compatibility with the surrounding concrete, as they do not have a proper connection with it.

Therefore, when the ropes are placed outside the concrete, the defects in the interaction of the ropes with the concrete remain the same, but become more noticeable.

From a structural point of view, placing the ropes outside the existing flexural elements has several advantages. First, in contrast to freshly poured concrete, the anchor is usually installed on concrete that has already gained the necessary strength, which significantly reduces the probability of rupture under the influence of the loads of the anchor fastening. Second, the use of external reinforcement makes it easy to check the condition of ropes, supports and fasteners during construction and at any time in the future.

6. CONCLUSIONS

External and internal reinforcement systems ("External Post-Tensioning" and "Internal Post-Tensioning") are used to increase the strength and deformation resistance of reinforced concrete elements in construction. External reinforcement involves the installation of permanently tensioned cables or rods around or inside a concrete member, which allows additional load to be transferred from the outside. Internal reinforcement, on the other hand, consists of the integration of tension cables or rods inside the concrete structure, which provides increased strength and resistance to deformation by creating additional stress directly in the concrete.

Research and analysis show that both methods have their advantages and disadvantages:

- External reinforcement has advantages such as easy access for inspection and maintenance during construction and in the subsequent operational period. It allows for quick changes and adjustments without the need for significant dismantling work. However, external elements may be exposed to aggressive atmospheric conditions, which may require additional measures for protection.
- Internal reinforcement can be more difficult to implement and control during construction due to the need to integrate stress elements within the concrete structures. However, this method provides reliable protection of ropes from external factors, such as corrosion, and gives structures an aesthetically pleasing appearance thanks to hidden reinforcing elements. Internal reinforcement can also provide durability and less susceptibility to damage from service and weathering.

It is important to note that the location of the ropes—outside or inside the concrete—has a significant impact on their interaction with the structure. Examining these methods shows that although the differences in effectiveness may be small, each method has its own specific advantages and limitations. Therefore, it is necessary to carefully consider the pros and cons of each option when choosing the optimal solution for a specific structural element.

When choosing between external and internal reinforcement, one should take into account not only the technical characteristics and requirements of the project, but also the specific operating conditions, economic aspects and aesthetic requirements. The chosen method should ensure maximum strength and stability of the structure, as well as meet long-term operational requirements.

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