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System analysis and contributions to the consolidation under exploitation of surface elements

Adina Victorita Lapuste[a,]*

[a]*Technical University of Cluj-Napoca,Civil Engineering Faculty,Structural Mechanics Department,C-tin Daicoviciu 15, 400020, Cluj Napoca, Romania*

Abstract

In the presented paper are analyzed rehabilitation problems of surface plane elements under exploitation. The aspects discussed will consist a solid recommendation for the design practice. The complexity of the consolidation issue of slabs under exploitation derives from the large number of parameters which define the initial situation and imposes the adoption of an optimal rehabilitation solution. The research objective is an analysis of the stiffness effect and the position of consolidated elements on the stress strain state under loads of slabs. The modelling focuses on an existing situation which consists of a continuous reinforced concrete slab supported on steel beams. Beam stiffnesses significantly influences the stresses in the slab. Inadequate values of these stiffnesses which are a consequence of the design process or execution errors and the need to increase the load capacity of the slab require the slab consolidation. The analysis process involves choosing the appropriate position and an adequate rigidity of the consolidated system. Its efficiency and implicitly the effect of the stress state on the consolidated element have a major significance.

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Keywords: Rehabilitation under exploitation; consolidation; strengthening surface elements; slab consolidation; optimization.

* Corresponding author. Tel.: +40-722-787-765.
E-mail address: adina.lapuste@mecon.utcluj.ro

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1. Considerations regarding the consolidation of surface plane elements

1.1. General considerations

Structural rehabilitation represents an important aspect of the construction industry and its significance is increasing. Several methods are available, each with different advantages and handicaps. However, little information is available and insufficient code guidelines are accessible. In fact, most repair and strengthening designs are based on the assessment of engineers only and, often, empirical knowledge and current practice have an important role in the decisions to be made [11].

The main issue in this study is to determine a range of structural techniques carried out in rehabilitation under exploitation design practice. The attention is focused on the approach and solving process of this type of problems' specific aspects.

Consolidation of plane surface elements usually involves the function discontinuity supported by the floor during the execution. This situation generates multiple problems, which justifies the analysis of under-consolidation solutions.

These solutions are especially advantageous for industrial buildings where the interruption of the production process causes significant losses [1]. Rehabilitation techniques involving the provision of the new elements (usually steel elements) are only conditioned in adherence to functional gauges.

These systems must satisfy a number of conditions:

- minimizing of the site operations,
- time optimization of system assemblage,
- possibility of system adjusting to the deviations from the designed structure's geometry that will be consolidated (execution deviations, accentuated deformations etc.),
- ensuring easy handling of the constituent elements of consolidation system,
- ensuring the instantaneous entry of the new system into the work space without losing significant waiting time periods,
- the ability of controlling the consolidation provisions and the intervention aiming a possible adjustment of their effect,
- the possibility of accurately assessing the consolidation effect on structure's stress strain state.

1.2. Design of plane surface elements

The rehabilitation of plane surface elements assumes the knowledge and characteristics of the elements that are consolidated in terms of the design solution [4].

The following aspects must be taken into account: the execution stages, the mechanical characteristics of the materials, the real value of dead actions and the exploitation loads and the deficiencies of the composite behavior.

Stress-strain analysis required for defining the rehabilitation solution is made after an elaborate research and adopting a proper static scheme of the plane surface elements.

The beam's stiffness significantly influence the stress-strain efforts, especially in the case of connections between the continuous reinforced concrete slab and the steel beams.

The consolidated slab's ultimate stress-strain state is usually obtained by overlapping the efforts developed under the existing permanent loads before the arrangement of the consolidation system and are being calculated on the static scheme of the unconsolidated structure.

Design of elements must take into account the possible different behavior on the intermediate supports of a continuous slab. In the same note the uniformity of the reinforcement in the supports area can lead to a different behavior of the supporting slab due to technological or practical considerations. Bearing capacity values on the intermediate supports area are affected, which leads to the requirement of a proper static scheme.

Process analysis assumes the choice of the right position and rigidity of the elements in the rehabilitated system. Its eficiency can also be defined by stress-strain state in the consolidated element.