Reinforcement of mounting seams in constructive systems with without a crossbar framework

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Abstract. The article considers the option of strengthening buildings with without a crossbar framework. To increase the strength and rigidity of the overlap, the use of adhesive fiberglass is proposed. The conclusion is made about the effectiveness and expediency of using such a method if it is necessary to strengthen the frames of buildings.

In Russia the construction constructive systems with without a crossbar framework which are characterized by speed of construction, architectural expressiveness and free internal planning of rooms with simultaneous ensuring durability, reliability and stability of the building were widely adopted [1]. However, as a result of a significant change in a number of standards and regulations in the field of construction [2-8], a large number of both operated and unfinished buildings designed according to previous standards did not meet modern requirements.

On problems of use of constructive systems with without a crossbar framework in construction practice there is a large number of scientific publications, however information on pilot studies of work of such systems under loading is very limited, there are no accurate recommendations about ensuring spatial rigidity of the building [9, 10]. Besides, considerable shortcomings – difficult technology and, respectively, labor input of execution of joints between plates and plates with racks are inherent in the known constructive systems that often leads to reduction of reliability of a system. Therefore, the search for effective options for improving the reliability and seismic resistance of buildings with without a crossbar framework seems relevant.

The buildings with without a crossbar framework of the KUB structural system have the form of flat reinforced concrete floors formed by smooth slabs that are rigidly interfaced with the columns supporting them [9]. The structural diagram is frame-connected in the presence of reinforced concrete stiffening diaphragms, vertical connections and stiffening cores.

The KUB-1 system provides for the arrangement of cross links due to the alternation of ascending and descending braces along the tiers. The frame is assembled from prefabricated reinforced concrete slabs, columns and stiffening elements, with subsequent grouting of the seams between the slabs and joints of the plates of overlapping with the column. In the operational stage, the frame is a monolithic structure (figure 1).

Floor panels are flat elements of the same type (2980×2980 mm) with a thickness of 160 mm. The panels are divided into floor slabs HII, mounted on columns; inter-column panels (beams) MII installed between floor slabs; medium (span) panels CII, installed in the middle of the cell (figure 2).
Figure 1. General view of the frame of the KUB system with without a crossbar framework.

Figure 2. Layout diagram of the KUB system with without a crossbar framework

Columns at the level of each floor have splines with bare reinforcement. In these places, a welded connection of the shell framing the hole in the plate with the column reinforcement is made, after which the place of the joint of the plate and the column is filled with concrete, forming a frame assembly of the framework.

To increase clutch forces and resistance to shear forces, slabs surfaces are corrugated in seams. The seams between the slabs shall provide rigid coupling. For this, according to the typical design of the KUB series, reinforcement ledges, passage of longitudinal reinforcement in the outlet loop and con-
Creating of the seam are provided. The width of the seams is 200 mm.

The most responsible unit in the system with without a crossbar framework of the KUB-1 structural system is the mounting seam (figure 3). The monolithic nature of the slab disk and the spatial invariability and seismic resistance of the entire structural system of the frame depend on the reliability and thoroughness of the seams. The technical examination of the unfinished building made it possible to identify numerous defects in the arrangement of mounting joints between the slabs of the framework floor - bare and intense corrosion of reinforcement in the seams, the presence of brick inclusions that violate the monolithic joints, as well as the biodegradation of concrete of the slabs. Detected defects reduce seismic resistance of the building.

Figure 3. Joint of floor slabs in the system KUB-1

In order to ensure the safety (strength, rigidity, reliability, seismic resistance) of the existing overlap, it became necessary to select and calculate the most rational in terms of economy, simplicity of design and efficiency of the method of strengthening the joints between the prefabricated slabs of the framework without a crossbar.

When analyzing possible methods of reinforcement of seams between slabs to increase the reliability and seismic resistance of the building, the following options were considered:
- pouring a layer of concrete over existing slabs using reinforced mesh;
- execution of reinforced dowels or reinforced dowels with bracket;
- reduction of overlap load by means of introduction into the design diagram of unloading devices - stiffening diaphragms or flexible struts, suspensions, connections:
  - application of surface-adhesive fiberglass.

Each method has its own advantages and disadvantages. As a result of the feasibility comparison of the variants, a method of reinforcing by gluing fiberglass was chosen, the use of which provides:
- equal joint strength of panels and mating elements;
- uniform distribution of the tensile or shear force, or a combination of these effects, over the entire length of the joint;
- exclusion of steel application during amplification;
- reduction of negative impact of uncleared seams between slabs on operation of hard disk of beam-free covering;
- possibility of deformation of the entire overlap disk as a whole, which increases the degree of static uncertainty of the structure and leads to redistribution of forces - formation of hinges [11].

As a result, the seismic resistance of the building as a whole is increased.

To determine the forces acting at the junction, a reasonable choice of the brand, the number and width of the glued layers of glass fabric, a computer model of the investigated object in the SCAD computing complex was developed. Calculations were carried out for a constant, temporary and seismic load of 8 points [3]. The calculation scheme is shown in figure 4.
The seams reinforced with glass fabric were calculated for the perception of maximum tensile and shear forces at the junction [11], which were 6,82 kN and 13,2 kN, respectively. Calculation for bending of reinforced floor was also performed according to the method [12]. The calculated external torque was 2,3 \( \tau \cdot m \), which does not exceed the limit internal bending torque of 2,33 \( \tau \cdot m \). Accordingly, the section strength condition of the bending element is satisfied.

Besides, the possibility of flaking of fiber glass fabric was checked if deformation in material isn't apprehended by the basis. For prevention of flaking of the strengthening layer it is necessary to limit the level of his deformations. With increase in rigidity of a layer the peeling probability increases, and, respectively, requirements to restriction of deformations become stricter. Calculations were executed with the assumption that the system of strengthening has to perceive the stretching efforts taking into account compatibility of deformations of external fittings and concrete of designs. Was accepted that communication of concrete and external fiber glass fabric rigid and keeps conditions of compatibility of deformations from the moment of strengthening of a design up to approach of a limit state.

According to the results of calculations, it was established that in order to ensure the strength of the overlap joints in the transverse and longitudinal directions when using glass fabric of grade Э3-200 [13], it is necessary to use three layers of material with a width of at least 440 mm.

It can be concluded that the method reviewed can be recommended if it is necessary to reinforce buildings with without a crossbar framework.

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