ARCHITECTURE AND CIVIL ENGINEERING

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EFFECT OF DIFFERENT TYPES OF SHEAR REINFORCEMENT ON THE STRENGTH, STIFFNESS AND CRACK RESISTANCE OF BENDING REINFORCED CONCRETE ELEMENTS

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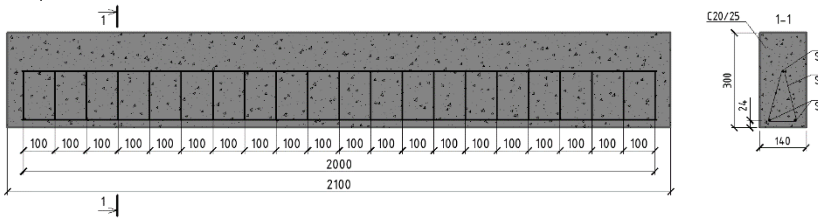
This article describes the effect of three different types of shear reinforcement on the strength, stiffness and crack resistance of bending reinforced concrete beams. This paper reports experimental data on the behavior of reinforced concrete beams, reinforced with different shear reinforcement. Tests were conducted on four reinforced concrete beams, one with stirrups and three with different types of shear lattice girder (truss) reinforcement. The behavior of the reinforced concrete beams is analyzed and supported with statistical evaluations. Conclusions are drawn, showing that the beams act differently under the action of the same subjected load, providing numerical data ensuring the effectiveness of the two types of shear reinforcement with respect to the standard widely used model (model with stirrups).

Introduction. Precast-insitu slabs are widely used in the construction of modern ceilings. This is attributed to the ease in construction, the strength, and effectiveness of such ceilings. Yet, in the construction industry, the beams (primary or secondary) have different types of reinforcement [1].

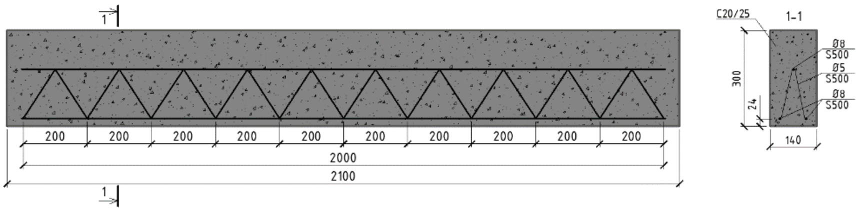
Task formulation. Analysis of the strength, stiffness and crack resistance of bending reinforced concrete beams, taking into consideration their different types of shear reinforcement.

The reinforcement frames of the beams:

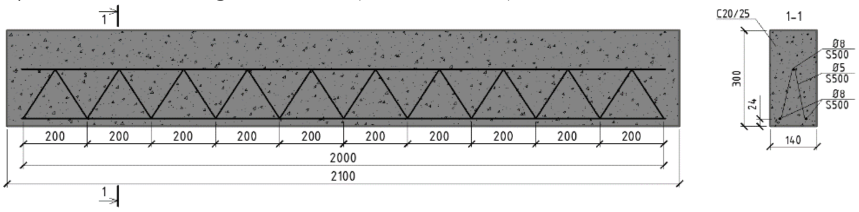
1) Beam with stirrups;



2) Beam with a symmetrical lattice girder frame;



3) Beam with a symmetrical lattice girder frame (control beam);



4) Beam with a non-symmetrical lattice girder frame.

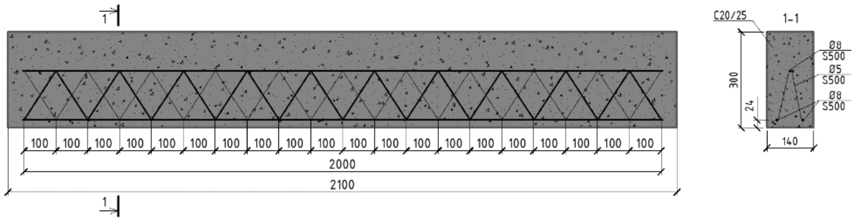


Figure 1. – Reinforcement frames

The experiments conducted in the 'Department of constructions' in the Polotsk state university laboratory, consisted of using a specific system to provide the beams with exact force values, insuring the fact of providing accurate data and results. This system included: a jack – to provide an accurate scalar value of the subjected to the beams loads , two cross-arms – one for transmitting the central force on the jack to two forces on the beams, and the second for bracing and fixing the structure in whole, and three deflectometers – subjected for measuring the deflections at different points of the beams. For evaluating the time of crack appearance, between the increasing of the load, a microscope is used. It is essential to state that the three beams where produced by the same constructional materials in the same day. The class of concrete used was $C_{24.3}^{/19.5}$. The class of the steel bars was S500, with three longitudinal re-bars of diameter 8mm, and shear (transverse) re-bars of diameter 5mm. The experimental scheme of the experiments is the same for all four beams.

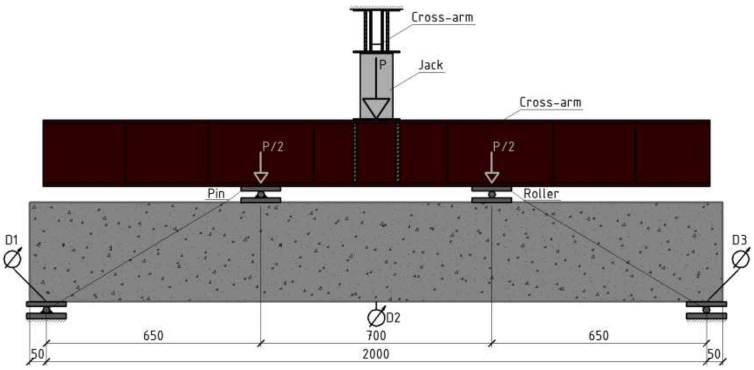


Figure 2. – Beam testing scheme

Cubic strength of the samples. It is essential to state that a statistical experiment was provided on 12 cubes, ensuring that the guaranteed cubic strength is 24.3 MPa.

Preliminary experiment. To form a general idea concerning the effect the three types of frames, a preliminary experiment was conducted for the frames. The four frames where subjected to 3 points loads in the same place for each respective one. Their deflections where calculated by using deflectometers.

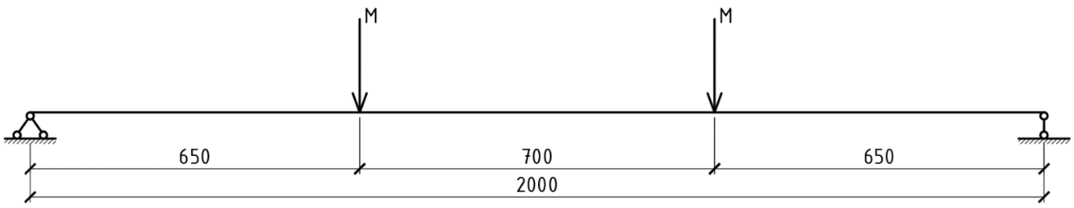
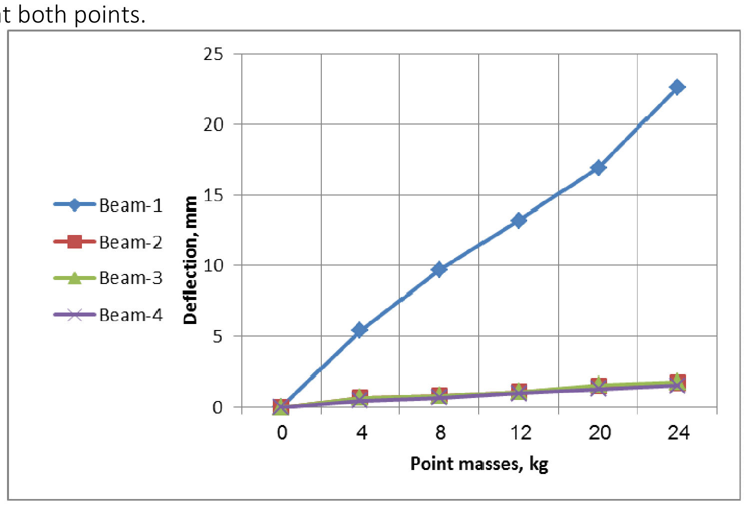


Figure 3. – Frame structural scheme of the frames subjected to several masses (M)

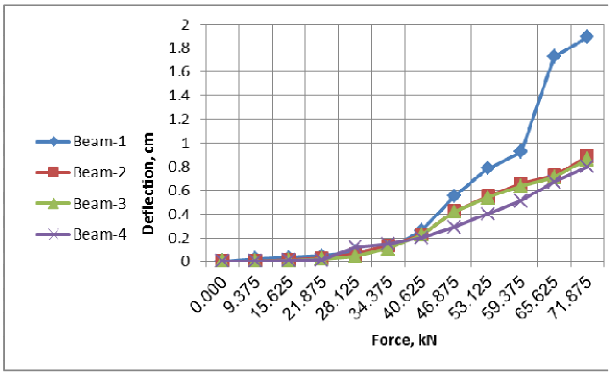
It can be stated, that both point masses are equal in their value, and the presented graph, is provided by the equivalent mass at both points.



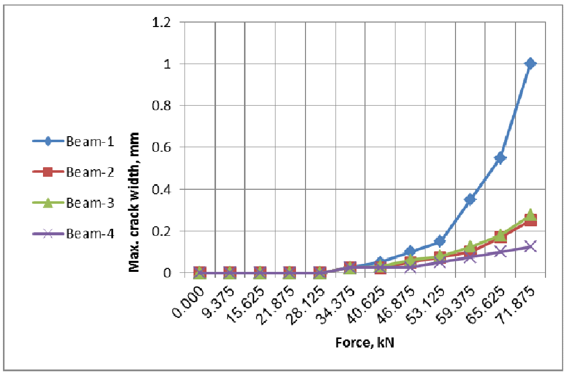
Graph. 1. The deflection (mm) of the frames under several points masses

The graph states that the first frame deflects the most.

Experiment. The four beams, subjected to same load, where analyzed and studied. The results show that on every studied aspect, the beams act differently.



Graph. 2. Deflection (cm) of the beams

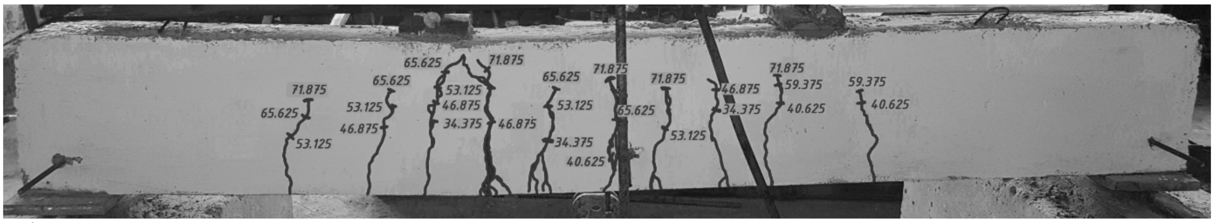


Graph. 3. Maximum width cracks (mm) in the beams

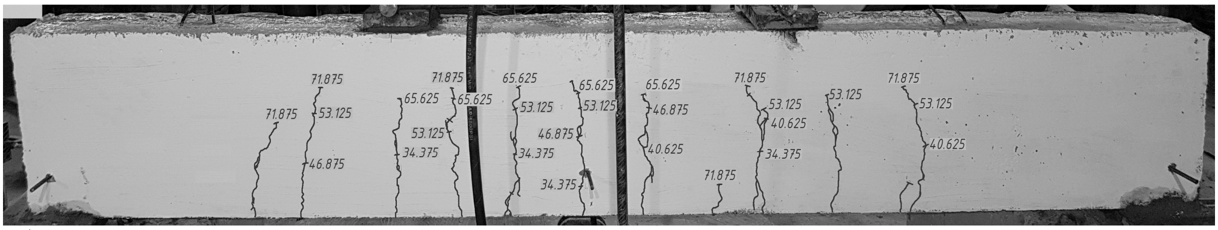
In the civil and structural engineering norms for reinforced concrete structures, the maximum allowable crack width is 0.3mm. The first beam exceeded this limit at the load P=59.375 kN. The destruction of all beams was by exceeding the crack width limit state.

Yet, it strictly important to state that this can be explained, by the fact that, shear rebars in the 2nd,3rd, and 4th beams, function in a way, enhancing the resistance of the beam to the acting bending moment.

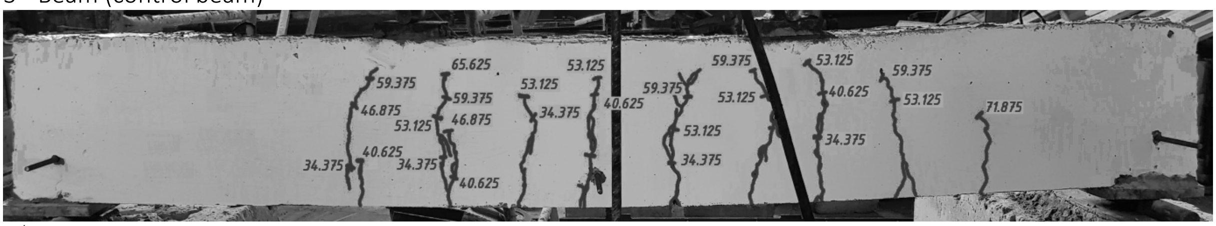
1st Beam



2nd Beam



3rd Beam (control beam)



4th Beam

Figue 4. – Deformation of the four beams

Conclusion. The research carried out in the work, allows us to formulate a general idea of the effect of the lattice-girded frame on the strength, stiffness, and crack resistance of bending reinforced concrete elements. According to the obtained results, we can draw the following conclusions:

1. The beams with a symmetrical and nonsymmetrical lattice-girder reinforcement, deflected 2 times less than the beam with stirrups. This can be explained by the fact that the truss increases the rigidity in the center of the beam, due to the redistribution of internal forces on the frame into longitudinal forces in its rods.
2. The number of cracks formed in the first beam is smaller in value, but their width is 2 times larger than in the other beams. However, in the second group of limit states, the first beam reached this limit at the load of 59.375 kN, whereas the rest at 71.875 kN.
3. The beams with a symmetrical and nonsymmetrical lattice-girder reinforcement have the strongest, and most durable cross-section. In each taken cross section, two additional rods interfere, which are included in the work of the beam's section.

REFERENCES

1. Effect of Type and Position of Shear Reinforcement of High-Strength Reinforced Concrete Deep Beams /Dr.Omar Qarani Aziz(Assist Prof.), Dr.Sinan Abdulkhaliq Yaseen/Civil Engineering Dept. / College of Engineering / University of Salahaddin-Hawler.