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Beam High Reliability for Moving Load

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The article contains the results of the development of new structural forms of beams with connections to the elements of high-strength bolts. Recommendations for the production of new beams, taking into account the features of compounds and technologies for their implementation.

Keywords: CRANE GIRDERS, HIGH-STRENGTH BOLTS, CONNECTIONS, FATIGUE

Introduction

The share of fatigue damage of structures, perceiving moving loads and other variables, is usually high. The appearance of fatigue cracks in the stress concentration points to the need of improving both types of compounds of elements of construction and the design of the unit. This applies especially to the crane girders and moving beams of ore-grab cranes, various work areas, handling and bunker flyovers.

The most common failure traditionally used beams is formation of fatigue cracks in the upper zone in the weld or rivet holes.

Important factors that determine the terms of normal operation beams are repeatedly recurring impact of local load under the roller, for example, a crane and a variable twist the upper zone due to the displacement of the rail project axes.

By significantly reduce of the impact of these factors was the development and research of traditional beams constructive form, in which the reduction of the stress concentration at the top zone achieved by using friction connections with high-strength bolts (**Figure 1**). In this case, the attachment of the bottom chord to the wall can be performed both bolts and welds.

We've got from both laboratory and field studies [1-3] design parameters strength of beams, which are included in the updated edition SNIP II-23-81 (SP 16.13330.2011). A distinctive feature of the regulated requirements for analysis of beams with high-strength bolts compounds is that their design resistance endurance is higher by 24% than the accepted norms in the calculation of welded beams, and the value of local stresses under the roller is 1.2 times less than of riveted beams and 1.4 times less than of welded.

As can be seen, the using of the friction connections with high-strength bolts improves the stress-strain state of the beams. And increased resistance to the torsion is achieved due to the concentration of the material in the upper zone of the beam. However, almost completely eliminate torsion possible in the case of bearing crane rail on the upper edge of the wall [3].

The beams, which were proposed by the authors of a new construction, the task is solved in the complex. So it realizes all the benefits of friction connections and torsion deformation in case of displaced crane rail axis is excluded from the project due to the location of horizontal shelves and the upper edge of the wall at different levels (**Figure 2**) or using beams with goffered wall (**Figure 3**).

The main problem of successful using beams of high reliability is to design a high-performance processing technology. As one of the most effective forms is beam with a protruding wall on 2-4 mm above the waist belt corners, the best technology choose of a such beam, for example, with the use of bolts M 24 has a number of features. The diameter of the holes in the wall (d_c) is assumed to be 30 mm, and in waist belt angles (d_w) 28 mm (**Figure 4**). Beam assembly is carried out in a vertical position, with the top waist belt down in a special jig. Aligned holes are being filled with high-strength bolts. Different diameter holes in the corners and wall with the specific design of the jig allow self-installing the beam wall, providing the desired ledge above the horizontal shelves over the waist belt corners. After that the tightening of the bolts on the regulatory effort is providing. Other technology offers are made with all characteristics of friction connections and technologies for their implementation. Based on the research [4], including the static and cyclic tests of samples of compounds with zinc surface and without one, high-performance method of group puncture holes in the elements of crane beams are recommended, connected with high-strength bolts, as in the

case of using low carbon steel up to 25 mm, and low alloy – up to 20 mm. Controlled high-strength bolts is recommended to perform the most efficient and well established in the installation of a single-stage design method, based on the work of bolts under the elastic-plastic deformation [5].

Positive technological quality beams with a connection of all elements and details of high-strength bolts is possibility to make it, eliminating the need for tilting the product that is required in the manufacture of welded beams. It helps to a significant reduction required production areas both growth of mechanization and automation of operations, the use of flexible manufacturing systems.

In connection with the detachable connections, beams differ by a high maintainability. Provides the ability to perform the repair without using of heavy crane equipment at the operating plant. Besides, there are conditions for increase, in an operational need, the carrying capacity of beams by replacing individual components and parts. Creation a new cross-section of the beam on the basis of the existing one.

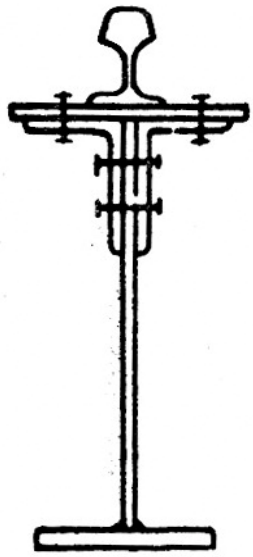
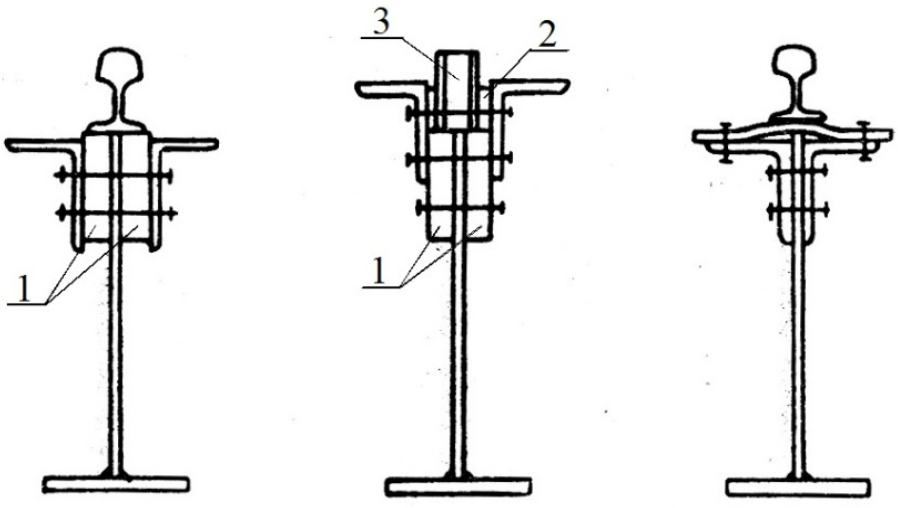


Figure 1. Beam with the traditional constructive shape and friction connections with high-strength bolts



a b c

Figure 2. Beam with the upper edge of the wall above (*a*), below (*b*) the upper waist belt and convex curvilinear upper waist belt (*c*): 1 – droppers; 2 – centering pads; 3 – rectangular rail

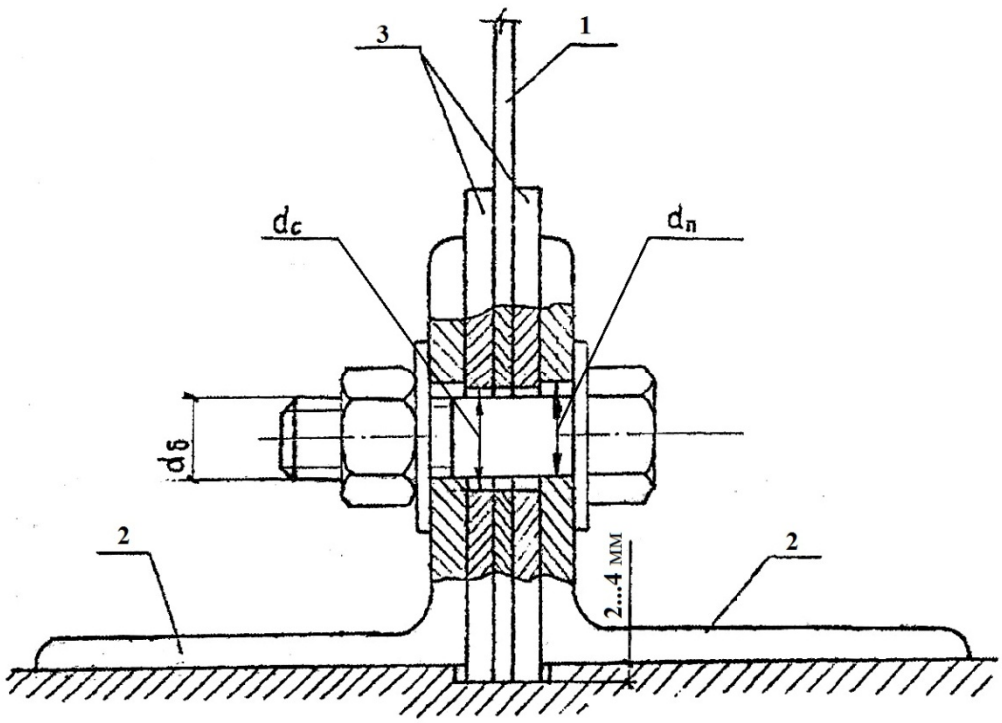


Figure 3. Beam with goffered wall: 1 – goffered wall; 2 – upper waist belt; 3 – connecting details

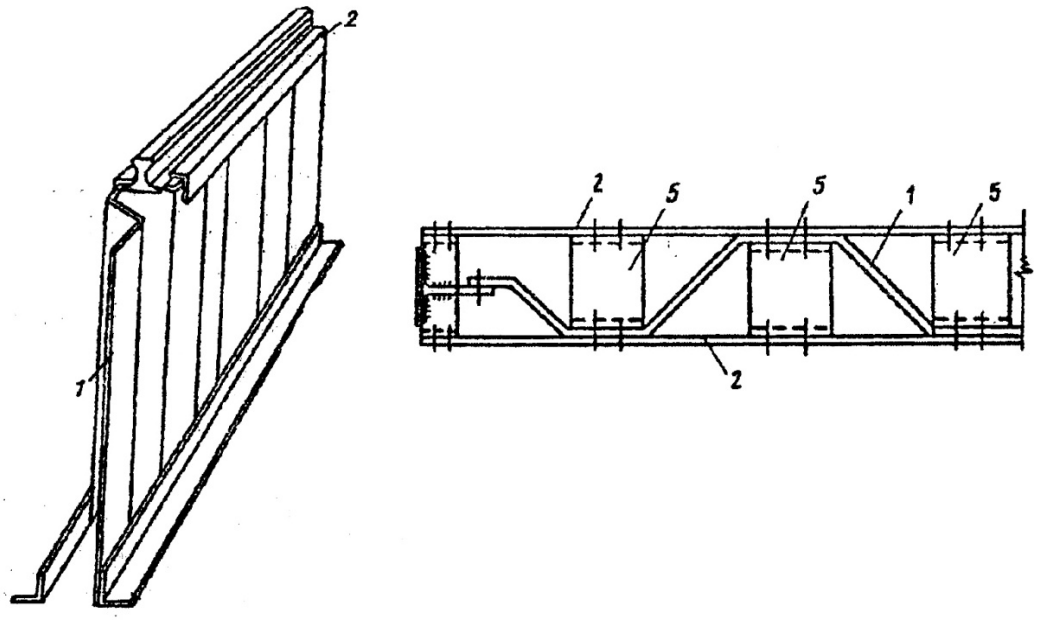


Figure 4. The scheme of assembly beam with a given excess droppers and wall above corners of the upper waist belt: 1 – wall beam; 2 – corners of the upper waist belt; 3 – droppers

Conclusion

Analysis of the results of research, experience in the design, manufacture and use of beams of high reliability in different branches of Ukraine and Russia industry, leads to the conclusion of possibility to increase its durability in 2-3 times compared to the traditionally used beams.

There is reason to believe that the efficiency can be increased by improving the methods of analysis and design of beams with experience of its operation.

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Балки повышенной надежности для подвижной нагрузки

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В статье содержатся результаты разработок новых конструктивных форм балок с соединениями элементов на высокопрочных болтах. Даны рекомендации по изготовлению новых балок с учётом особенностей соединений и технологии их выполнения.