UDC 624.072.2

DESIGN OF BENDING CONCRETE ELEMENTS WITH RIGID REINFORCEMENT

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The article considers the main points of the construction of bent reinforced-concrete elements with rigid reinforcement in the form of metal-profile double-T or T-section paired. The possible application methods the rigid reinforcement in conjunction with flexible rods, whose task is to eliminate the possibility of spalling (flaking) of concrete from metal rolling profiles. The methods provide concrete collaboration and metal-rolling profile by means of the use of short stacks from the corner, as well as ensuring the anchorage all rolled sections in the body structure by the use of channel-short stacks at the ends of the profiles.

Application of structures with a rigid reinforcement is a less common phenomenon in the modern world of reinforced concrete structures, but it does not exclude the use of metal-profile as a design element - which will take the main tensile forces in bent elements.

Selection of rigid reinforcement must be made in accordance with the expectation of it as a metal beam on the load arising in the course of works, excluding working with concrete. In the future, during the transition to the operational loads corresponding concrete cross-section is taken into account, if necessary enhanced with flexible reinforcement. This order of selection of cross-sections serves for the minimum discharge of metal [1].

But some design requirements, such as conditions of beams contiguity to the purlins, prevention of chipping, etc., can induce usage of the profile of larger cross-section than that required by metal reinforcement beams work during erection.

The most common and frequently used type of rigid reinforcement beams is rolled *H* sections, cross sections are displayed in Fig. 1 *a*, *b*. When they need to ensure greater stability in the process of building twin beam channels can be applied to powerful beams, as shown in Fig. 1.

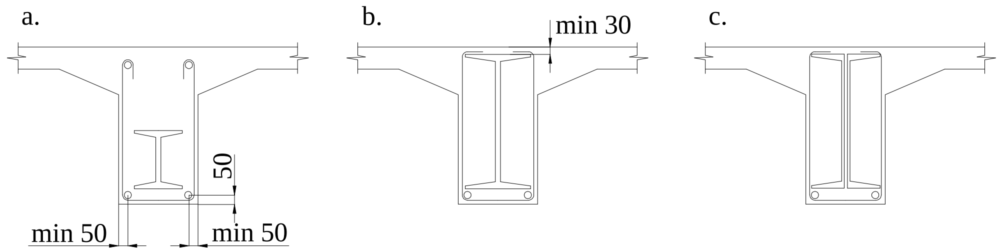


Fig. 1. The cross sections of bent elements with the use of rigid reinforcement

Rigid reinforcement from I-beams or twin channel bars can be located completely in the stretched beam area, and throughout the height of the section, entering the compressed zone, in this case, the metal-rolling profile perceives both tensile forces and compression, and a continuous design and appearance to outer parts of tensile stresses in the upper part of the section Metal-profile will used be to perceive the tension [1].

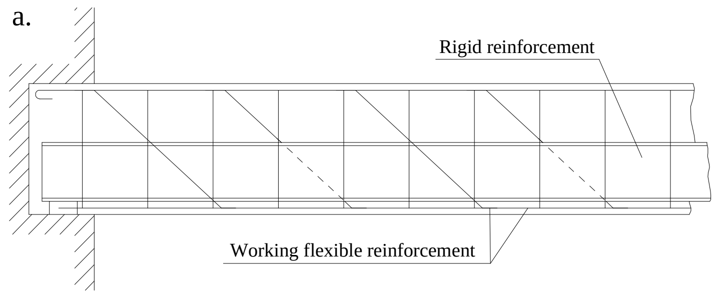
In designing of bent reinforced concrete structures with a rigid reinforcement the important factor which can not be ignored is the protective layer. The thickness of the lower protective layer in the beams with a rigid reinforcement must be at least 5 cm, to ensure the reliability of concrete casting of the lower layer and create a proper fire protection. The distance from the side edges to the wall or the edge of shelves profile rigid reinforcement should be selected taking into account the size distribution of coarse aggregate used concrete, but it is recommended to take no less than 5 cm, to ensure the density of the filling of the lower protective layer. The thickness of the upper protective layer, as compared with the bottom, can be reduced to 3 cm, as it does not affect the ease of beams concrete casting, with a fire protection point of view as the upper surface located in more favorable conditions.

In some exceptional cases, if the conditions permit exploitation of a plate, to simplify formwork and concrete casting the beam can be designed without the bottom protective layer. The lower bound of the beam will be confined to the lower shelf rigid reinforcement.

To improve the bearing capacity and crack resistance of the bent elements with hard reinforcement they can effectively use clamps and spirals that do not allow early spalling of concrete from the metal profile and concrete spalling from the inner part of the profile. Reinforcing straps should be considered necessary in all cases, except for the beams without the lower protective layer and reinforced profiles securely connected with the compressed area. Clamps are made 6–8 mm in diameter and are located through the 20–30cm. To connect the clamps mounting rods 8–10 mm in diameter are placed at top and bottom. (Fig. 1, *a*) When a high-profile rigid reinforcement is used, clamps can be mounted on top of the shelves of I-beams (Fig. 1, *b* and *c*). In this case, there's no in the upper mounting rods.

In the case of the beams reinforcement not only tough with sheet metal profile, but also with additional flexible reinforcement rods, the latter will also be used to link clamps and replace them with the appropriate parts of the mounting rods.

Reinforcement on chipping over clamps is necessary at a relatively low altitude rigid reinforcement, when concrete shear is likely to occur above the metal profiles. When more working flexible reinforcement is used in the beam, shearing can be performed with the corresponding bending of the rods as shown in Figure 2, *a*, and in the absence of operating rods in the bottom section or impossibility of attachment thereto, special oblique rods are welded to the upper shelf Profile rigid reinforcement (Fig. 2, *b*).



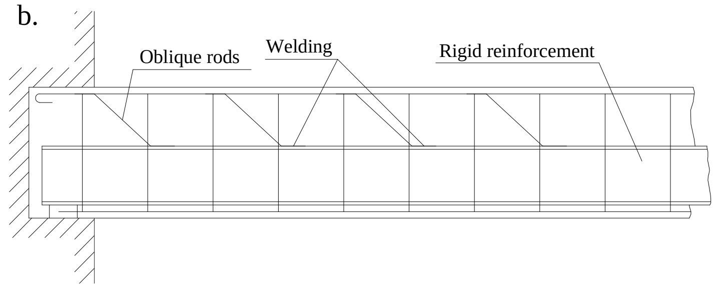


Fig. 2. Reinforcement beams oblique bars

At relatively high metal profiles welding oblique rods to the top shelf becomes irrational. In these cases, in the areas where reinforcement against chipping is needed, it is advisable to replace oblique rods with a spiral, which is made of round bars with a diameter of 12-14 mm (see Figure 3).

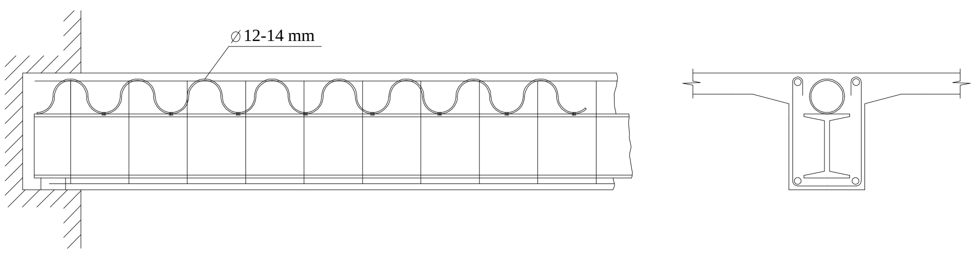


Fig. 3. Reinforcement beams rigid armature, fitted with spiral

Connection of rigid reinforcement with concrete compression zone can also be accomplished by welding transverse angled short stacks to the top shelf. This method of ensuring joint work of metal-profile and the concrete will be used in my doctoral research on the topic: "The bearing capacity and deformability of joints connections of reinforced concrete structures with a rigid reinforcement ".

Welds short stacks, and the spiral must be designed for full shear of shear forces.

Anchoring all rigid reinforcement beams improves the conditions of work and allows you to cut down a special reinforcement on chipping, but the full binding of all rigid rods can be achieved only in the frame, where the beams are rigidly connected to columns or girders riveted, welded or screwed. With the free support beams when the ends of the rigid reinforcement remain unanchored, special anchoring with welding plates or channel-short stacks at the ends of the profiles can be applied (Figure 4) [1].

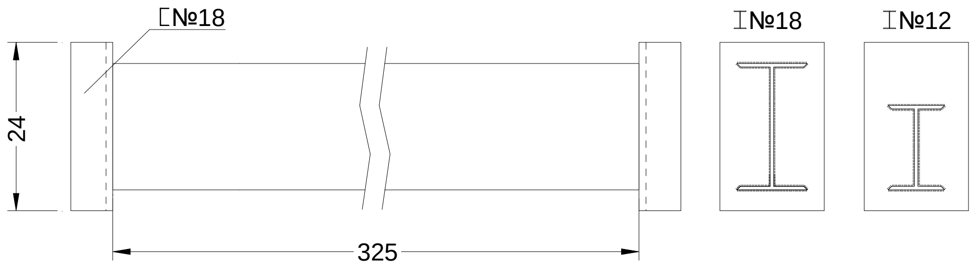


Fig. 4. Anchoring the ends of experienced rigid reinforcement beams

The continuous beams, girders and rigid reinforcing frame profiles at a relatively low height are located in the last zone of the transit portion of the stretched construction. However, they are not sufficient for the perception of the tensile forces on the supporting parts, as they are a large part of its cross section and are located in the compressed zone and excessively removed from the stretched fiber concrete. Under these conditions extra flexible reinforcement is required above the support.

At relatively high rigid reinforcement profiles tensile force can be perceived both in the middle and on the continuous beams support portions. However, in this case, it may be necessary to extra reinforce the beam support portions, as in the largest support moments rigid reinforcement, satisfying untrapped sections, may be insufficient. Strengthening of abutment sections can be made with flexible fittings and sheet riveted or welded to the shelves of rigid reinforcement sections.

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