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STEEL PROFILES FROM THE PERFORATED BANDS

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Abstract: *Steel profiles on the base of several types of steel bands, which are industrial wastes in many factories, are considered in the paper. Mechanical properties of perforated steel bands, differed by their thickness, widths, diameters and shapes of holes so as the grades of steel, have been investigated. Thicknesses and widths of the considered types of perforated steel band change from 1.05 to 3.5 mm and from 42 to 110 mm, respectively. Possibilities to obtain several kinds of cross-sections from the considered types of perforated steel band by the profiling were stated.*
It was shown, that the steel profiles on the base of perforated steel band are suitable for several structural applications, such as profiles for plastering and other types of finishing works, light weight beams and columns, as well as decorative elements.
Methods of corrosion protection of perforated steel band were considered.
Key words: *Steel profiles, Perforated steel band, Protective coatings, Industrial wastes.*

1. INTRODUCTION

Full-scale use of materials - one of the most essential problems of modern material science. One of probable ways of the decision of this problem is a reuse of industrial wastes. In Latvia, as well as in a number of other states, there are a lot of enterprises industrial wastes of which can be repeatedly used for various purposes. Perforated steel band can be considered as a good example of industrial wastes application. Now opportunities of use of the perforated steel band for various building purposes are shown, for example, for reinforcing of masonry and concrete elements (V.Mironov and D.Serdjuk, 2003). Possibility of applications of the perforated steel band as a material of load bearing elements of saddle-shaped cable roof is considered in work (D.Serdjuk, and V.Mironov 2002).
Profiling can increase efficiency of structural use of the perforated steel band. The perforated steel profiles made by some foreign firms (Catnic, Rannila, etc.), are used as the load bearing structural elements, and for plastering and finishing works. The perforated steel band and profiles, executed on its base, require corrosion protection.
The purpose of the paper is consideration of an opportunity of creation of profiles from the perforated steel bands and their use as a constructional material. Methods of anticorrosive protection of perforated steel band also should be offered.

2. CHARACTERISTICS OF THE PERFORATED STEEL BAND

Mechanical properties of the perforated steel bands as industrial waste products are investigated in this work. The perforated steel bands differ by their widths, shapes and dimensions of the holes, so as the grades of steel. Geometrical characteristics of some types of the perforated steel band are resulted in Tab.1., and the general view is shown in Fig. 1.

Table 1. A material and the sizes of some types of the perforated steel band from waste products.

No. of sample	Thickness and width of a tape, mm	Grade of steel
1	1.25 x 93	Ст 08 пс, ГОСТ 503-81
2	1.05 x 83	Ст 08 пс, ГОСТ 503-81
3	1.5 x 80	Ст 08 пс, ГОСТ 503-81
4	1.7 x 80	Ст 08 пс, ГОСТ 503-81
5	1.9 x 73	Ст 08 пс, ГОСТ 503-81
6	1.05 x 110	Ст 50 пс, ГОСТ 2284-79
7	1.3 x 80	Ст 50 пс, ГОСТ 2284-79
8	1.6 x 90	Ст 50 пс, ГОСТ 2284-79
9	1.75 x 75	Ст 50 пс, ГОСТ 2284-79
10	1.9 x 83	Ст 50 пс, ГОСТ 2284-79
11	2.4 x 50	Ст 50 пс, ГОСТ 2284-79
12	3.1 x 42	Ст 50 пс, ГОСТ 2284-79
13	3.5 x 52	Ст 50 пс, ГОСТ 2284-79

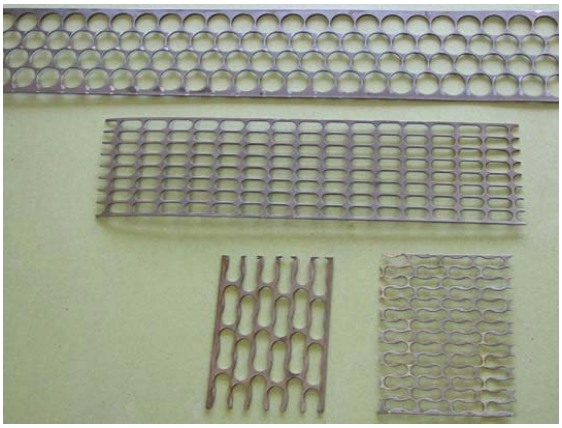

Fig. 1. Samples of waste products of a perforated steel band.

Samples of the perforated band have been tested by standard way for strength, and also on hardness by Brinell at loadings 50 and 300 N. Experiment has been carried out by means of the test machine RM-12, allowing to apply force up to 1000N. Results of tests of samples have shown, that ultimate strength changes from 830 up to 1030 MPa, and hardness from 830 up to 3030 MPa.
The received results have shown that mechanical properties of the considered types of waste products of the perforated steel

band are comparable to mechanical properties of steel bands, which are currently used for the various constructional purposes. For example, ultimate strength of the steel tapes used for load bearing elements of various types of roofs, is within the limits from 380 up to 900 MPa (V.Ermolov, 1991).

3. PROFILING

Process of profiling can be carried out on the machine for sheets bending. Disadvantages of this way: low productivity, necessity of preliminary careful material straightening and the limited length of a product (up to 1500-2000 mm) (V.Bogojavlensky and A.Neubauer, 1978).

More effective at significant volumes of a material is the method of band rolling by the rolls (Fig. 2).

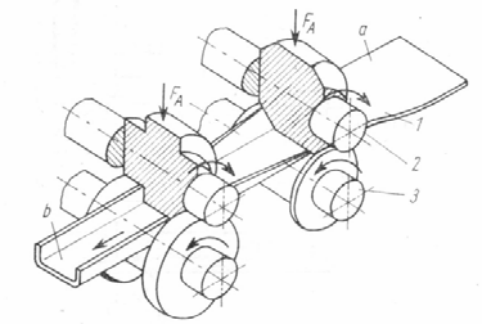

Fig. 2. The scheme of channel profile by the method of band rolling by the rolls: a) an initial state of the band; b) state of the band after rolling; 1 - product; 2, 3 - the top and bottom rolls.

In this case the length of a structure can be unlimited. Speed of submission reaches 50 m/min (V.Bogojavlensky and A.Neubauer, 1978).

Elastic deformation during the rolling is less than at linear bending. Lack of a method is the increased deterioration of the tool rolls and more complex their replacement.

Profiles on the base of perforated steel bands, which are industrial wastes, are shown on Fig.3.

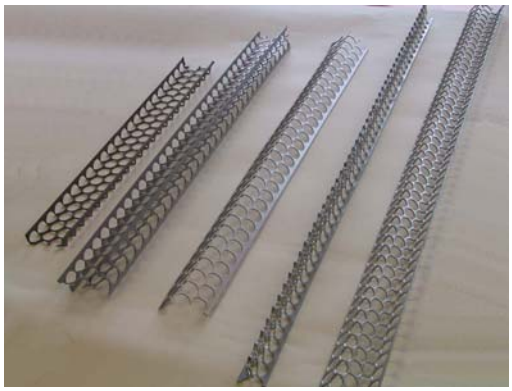

Fig. 3. Some types of profiles, made of perforated steel band with thickness 1.02 and width 80 mm.

4. INVESTIGATION OF MECHANICAL PROPERTIES OF ANTICORROSIVE COATINGS

For practical use of investigated perforated steel bands it was necessary to choose an economic anticorrosive coating. With this purpose it has been used two ways: traditional galvanizing and polymeric coating.

Some samples were coated with zinc as protection against corrosion. The thickness was of 30-40 μm. Testing of Brinel hardness on many areas and at different loads demonstrated retaining of initial hardness of HB = 1060-1200 MPa. Vickers microhardness measurements in the load range of 3mN to 1N were performed using a precision tester (I.Manika and F.Muktepavela, 1998) and in the load range of 2-10N using the standard microhardness tester PMT-3. The indentation depth (h) at each load was calculated as $h=d/7$, were d is the impression diagonal length. The depth dependence of microhardness was carried out for Zn galvanic coating on the steel and allows us to estimate mechanical properties and adhesion of the coating. Structure of coatings and deformation zone around the impression has been investigated with optical microscopy Neophot-30.

It is seen from the Fig.4 that the microhardness values (75MPa) for the depth range up to 10μm related to the Zn galvanic coating with good bonding. The increase of microhardness at higher indentation depth values is caused by the influence of hard steel substrate.

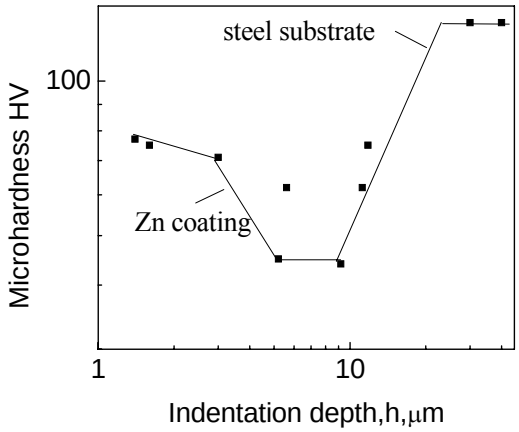

Fig.4. Microhardness as a function of indentation depth for Zn coating on steel substrate.

Cheaper way of protection against corrosion is drawing a polymeric covering. We use a method of drawing a small grain powder on a surface of the punched tape in an electrostatic field (by K.Poljakova and V.Pajma, 1972). After drawing a layer of 30-40 microns, the tape or a design from it was heated up in the chamber to temperature of polymerization of a covering. However adhesion of coupling of polymeric coverings in this case with a metal tape was insignificant. It is expedient to subject a tape to preliminary cleaning of traces of oils and pollution and to subject to chemical-thermal processing, for example, phosphorating. In this case durability of coupling rises.

5. CONSTRUCTIONAL APPLICATION

Structures and frameworks on the base of the perforated steel band are used for the following purposes:

- profiles for plastering and finishing works;
- load bearing structural elements;
- reinforcement of concrete and masonry elements.

Examples of use of structures on the base of the perforated band as load bearing elements are shown in Fig. 5.

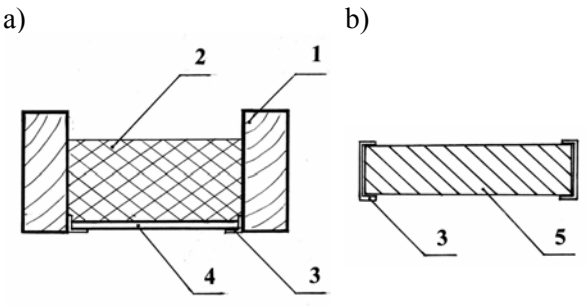

Fig. 5. Profiles use for heat insulation placement:
a) for ceiling structures; b) for wall structures; 1 - load bearing beam, 2 - heat insulation, 3 - profiles from the perforated steel band, 4 - protective plate, 5 - element of wall.

Utilization of channels and angle profiles for placement of heat insulation is shown on Fig. 5.

Load bearing capacity of axially loaded hinge supported elements with channel and angle cross-sections was evaluated. Dependence of load bearing capacity of elements on their flexibilities is shown in Fig. 6.

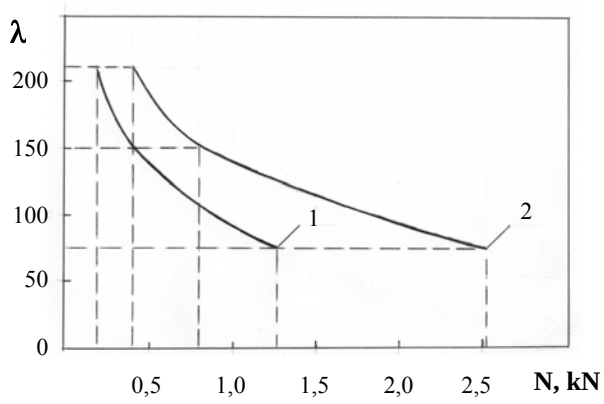

Fig. 6. Dependence of load bearing capacity of elements N on the flexibility λ; 1 - the element with the channel cross-section with the height h = 53 mm; 2 - the element with the double-tee cross-section with the height h = 53 mm.

Maximum load bearing capacity of the elements was obtained at flexibility, equal to 75. The limit of yielding of steel was equal to 350 MPa. Thus flange overhang was equal 15 mm both for the double-tee, and for a channel. The received values of load bearing capacities of elements are supposed to be checked up experimentally.

6. CONCLUSIONS

It is shown, that profiles on the base of the perforated steel band, made of waste products machine-building manufacture, can be used for following constructional purposes:

- profiles for plastering and finishing works;
- load bearing structural elements;
- reinforcement of concrete and masonry elements.

It is experimentally established, that ultimate strength of various types of the tape, used for profiles reception, there is within the limits from 830 up to 1030 MPa, and hardness by Brinel - from 830 up to 3030 MPa. Microhardness of anticorrosive zinc coating is 75 MPa. It was shown that Zn coating has good adhesion with steel. Value of hardness by Brinel is within the limits of 1060-1200 MPa.

It is shown, that load bearing capacity of long elements with double-tee profile from the perforated steel band is 0.4-2.6 κN at flexibility 75-220.

7. REFERENCES

V. Mironov, D. Serdjuks. Perforated Steel Band as a Constructional material. In: Scientific Proceedings of Riga Technical University, RTU, Riga, 2003, pp.157-162.

V. Mironov, D. Serdjuks. Perforated Steel Band in the Composite Saddle Shape cable roof. In: Proceedings of the 3rd International Conference Industrial Engineering - New Challenges to SME, Tallinn, Estonia, 2002, pp. 212-125.

I.Manika, F.Muktepavela, Microhardness and adhesion of TIN/AIN multilayer coatings. In:Surface and Coatings Technology, 1998, pp.333-357.

Bogojavlenskij V., Neubauer A., Ris V.W., Technologie der Fertigung von Leichtbau-profilen. VEB Deutscher Verlag für Grund toffindustrie. Leipzig, Deutschland, 1978.

Paljakova K.K., Pajma V.I., Technology and the equipment for drawing powder polymeric coverings. M., Mechanical engineering, 1972, 136 with.

SNiP, II-23-81, Steel structures [In Russian], Moscow, Russia, 1990, pp.94.