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METHODS OF PROFILING OF THE METALLIC MATERIALS

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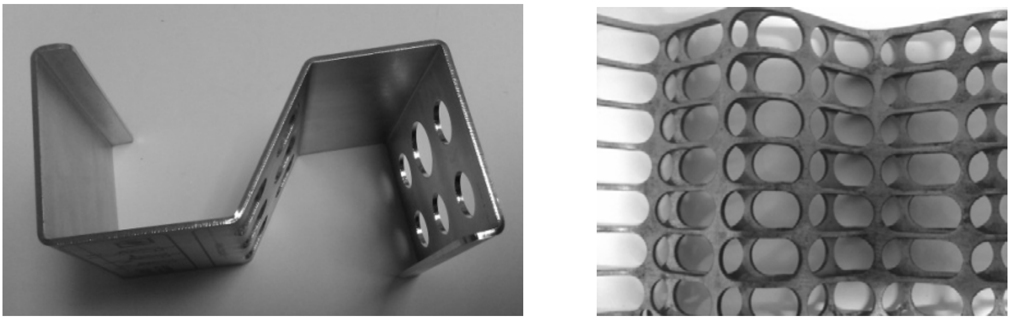
ABSTRACT
The aim of this work is to offer the effective methods of profiling of the perforated metallic materials that were achieved as a waste after punching and etc. Perforated metallic materials after profiling could be widely used in mechanical engineering and civil engineering. By profiling the constructions of different shapes and sizes may be produced. Main methods of profiling given in the paper are: bending in longitudinal and cross direction, rolling and twisting. Main attention is given for obtaining of profiles from steel perforated metallic bend, achieved after punching.
Keywords: perforated metal, profiling, technological waste

1. INTRODUCTION
Profiles from perforated metallic materials are used as base design elements during manufacturing of the different metal constructions in building and in storage, transport and production equipment manufacturing [1-3]. Using of such profiles allow to significantly reduce material consumption, speed up the assembling and mounting of constructions, reduce amount of welding operations and labour intensiveness.
Profiles from perforated metallic materials may be divided into two groups according to the application: profiles for pre-engineered structures and purpose-made profiles. Pre-engineered structures are made from angle and channel profiles, that could be assembled by bolted joint, that allows to achieve the metal constructions of different form and application. Purpose-made profiles have application only for specific purpose, for example, as spacers in concrete work, as elements for reinforcement of stone-works etc.
Profiling of the perforated metallic materials have common features with profiling of entire material, but there are some differences due to existence of perforated holes in metal. Most significant importance has the form and size of holes, specific area of perforations as well as perforation method [4,5].

2. METHODS OF PROFILNG OF METALLIC MATERIALS
According to direction of profiling distinguish the profiling in longitudinal and crosswise direction. Producing of profiles shown on Figure 1 was made by bending in stamp. More productive is the profiling by forge-rolling with profiled rollers (Fig.2). Profiling in longitudinal direction may be done using longitudinally bending machine or by rolling (Fig.3). In this case the length of a structure can be

unlimited. 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. Using of welding enables to obtain profiles with T and double-T shape.



a) b)

Figure 1. Crosswise profiles from perforated metallic materials achieved by band bending in single-impression die (a) and two bends sequential bending in multiple impression die (b).

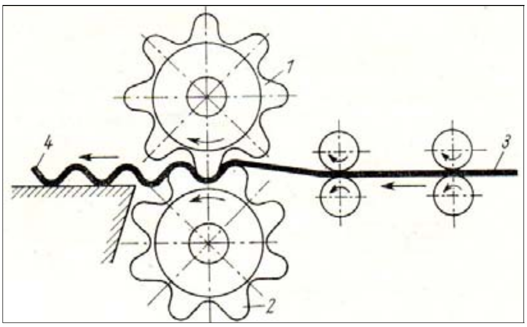


Figure 2. Scheme of crosswise profiling by forge-rolling with profiled rollers: 1 – upper roller; 2 – bottom roller; 3 – band before profiling; 4 – profiled band [6].

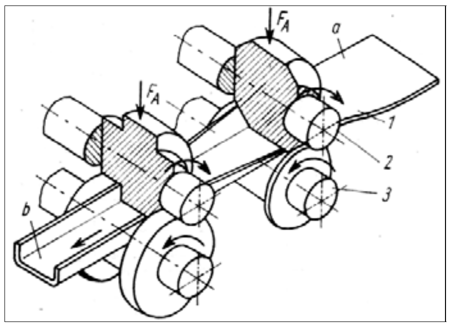


Figure 3. Scheme of of crosswise profiling by rolling: a – band before profiling; b – profiled band; 1 – band; 2, 3 - the upper and bottom rollers.

Another effective method for profiling of the perforated metallic materials is the method of twisting of the perforated band with consequently welding in the generating line. This is relatively simple and productive method for obtaining the cellular structures of cylindrical single-layer (Fig.4,a), cylindrical multi-layer (Fig.4,b) or conical type (Fig.4,c).

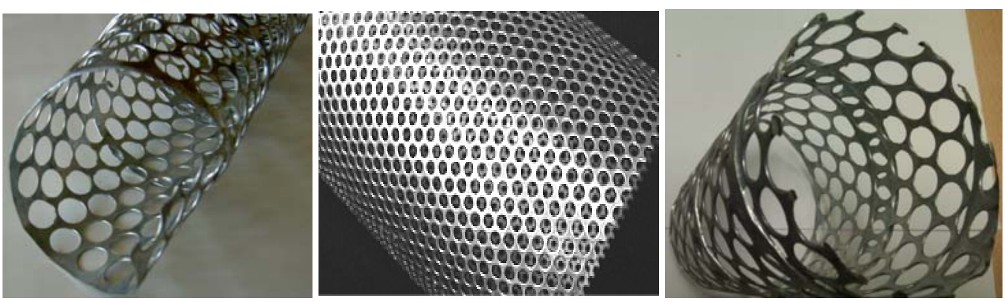
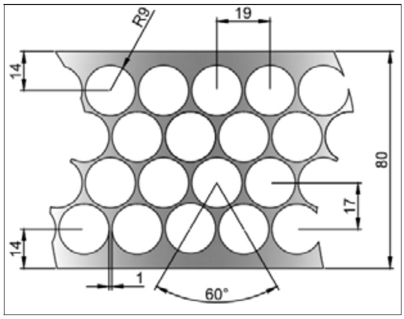


Figure 4. Fragments of tubular cellular construction from perforated band of cylindrical single-layer (a), cylindrical multi-layer (b) and conical (c) type [5].

3. PROFILES FROM TECHNOLOGICAL WASTE

Technological waste, i.e. perforated bands, achieved after punching could be effective reused for profiles manufacturing. This technological waste is practically ready raw material that may be directed for processing (Fig.5). The idea of recycling, reuse and remanufacturing has in recent times emerged with innovative and viable engineered materials, manufacturing processes and systems to provide multiple life-cycle products [7].

a)



b)

Figure 5. Rolls from perforated steel band, achieved after elements of driving chain (width 85 mm, thickness 1.2 mm) with longitudinal perforated holes (a) and circular perforated holes (b).

Application of profiles from perforated metallic materials is very wide and could be restricted only by mechanical properties of raw material and achieved profile. Some mechanical properties of perforated band from different materials are given in Table 1.

Table 1. Mechanical properties of metallic materials used in the production of perforated bands.

Materials	ρ, $\frac{kg}{m^3}$	*Re*, MPa	HB (MPa)	Marks of material
Steel	7700 – 7900	320 – 930	1310 – 2550	C50E, C22E, C8E, S235JRG2
Aluminium alloys	2700	60 – 310	520 – 847	AMg2H2, AD31T1
Copper alloys	8920 – 8980	220 – 640	1186 – 2430	M1-M3

Experiments were shown that the tensile strength of steel perforated bands achieved as a waste after punching is in the range of 100 – 250 MPa according to the type of perforation, width and thickness of band and base material. Example of achieved stress-strain diagrams is offered on Figure 6.

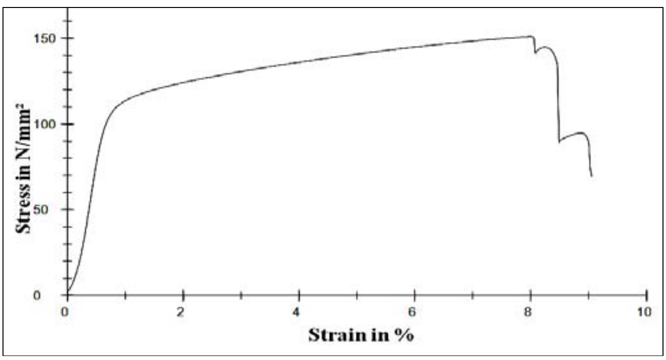


Figure 6. Stress-strain diagram of perforated steel band (thickness 1.2 mm, width 78 mm, steel S235JRG2).

Another significant factor, which influence on strength, is the direction of load and specific area of perforations (Fig.7).

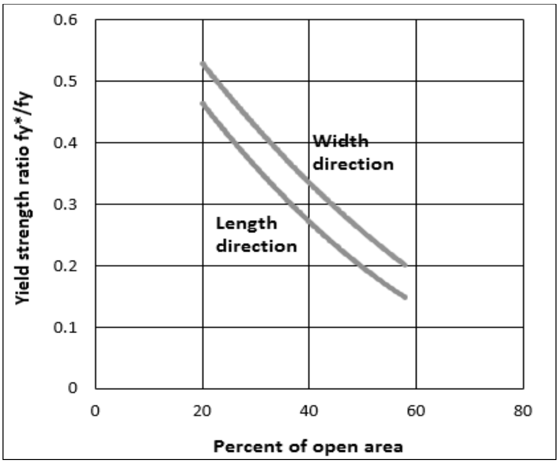


Figure 7. Yield strength ratio depending on percent of perforation, where fy - yield strength of perforated plate; fy - yield strength of unperforated plate [9].*

Percentage of perforation (%) of perforated bands, achieved after punching, is varied from 66 to 76 %, when thickness is in the range of 1.00 to 1.75 mm.

4. CONCLUSION

Good mechanical properties of metal waste (bands), achieved after punching, open up possibilities to recycle them into the different products such as elements of building constructions, filters, sandwich panels etc. For profiling of perforated metallic bands the bending in longitudinal and cross direction, rolling and twisting can be used. Strength of profiles depends on type of perforation, width and thickness of band and base material as well as on the direction of load and specific area of perforations.

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