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Technology and Automated Roll Forming Line for Manufacturing Safety Fence Shapes

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Results of putting into production the technology and automated roll forming line for manufacturing safety fence shapes of barrier type developed by UkrSSEC «Energostal» are given. The shape forming schemes, equipment layout of the line and its performance are provided.

Keywords: SAFETY FENCE SHAPES, PRODUCTION TECHNOLOGY, FORMING SCHEME, PROCESS STEPS, ROLL FORMING LINE, PERFORMANCE OF THE ROLL FORMING LINE

Introduction

With the increasing traffic intensity on the roads of our country, as well as current trend of building new high-speed freeways and highways issues of improving safety become of national importance. Annual losses from road accidents due to the poor condition of roads and lack of modern safety road fences cause substantial damage. Given the above, the expansion of industrial production of safety fences, which are mainly made of cold-formed sections, and their full supply for new construction and maintenance of existing roads is a very urgent task.

This paper presents the results of the implementation of technology and automated profiling lines for the manufacture of profiles for road fences of barrier type designed by UkrSSEC "Energostal" (Kharkiv). **

Results and Discussion

Currently, for the roads and bridges mainly one type of semi-rigid metal fence is used, consisting of a guide beam in the form of bent W-shaped profile, bolted to the rack (Σ-profile). Adopted for development on the established line of profiling assortment of cold-formed sections for road fences comprises four types of standard profiles, including three standard sizes of the guide beam and rack profile (Σ-profile) (**Figure 1**). All profiles of the guide beam have open cross-sectional shape and two of them are W-shaped, and the third-trough-shaped.

A characteristic feature of the profile design is the presence of the rack at the base of trapezoidal corrugation height of 26 mm with the adjacent through the bend side vertical walls, bent to an angle of 135 ° and containing on the edges shelves bent inside the profile to the angle of 90 °.

The material for the profiles is the steel billets according to GOST 14637-89 and GOST 16523-89.

Design features of profiles and set requirements for precision of geometric dimensions as per drawing and GOST 26804-86 "Road Metal Fences of Barrier Type" determined the choice of technological schemes of forming at roll-continuous process of profiling.

Technological schemes of forming the above profiles are shown in Figure 2a unspecified radii of curvature of the bend are presented in the table.

In 16 working stands using 4 intermediate non drive side rollers after the 1st, 2nd, 3rd and 4th mill stand according to scheme "a" (**Figure 2**) provides for the manufacture of two standard sizes of guide beams 312x83.7x4 mm and 306x80x3 mm and according to scheme "b" - the guide beams 310x78x3 mm. In contrast to these profiles, the production of the rack profile 100x55x16x4.2 mm as a more complex configuration is provided in 17 working stands with intermediate side rollers according to the scheme "c" (**Figure 2**).

Suggested for development profiles are produced by a combined grooving system of rolls in open and closed grooves. For all kinds of profiles grooving system with variables of the radii of the bent sections

** The work involved engineers A.A. Smolyakov and A.V. Pavlyuk

is used [1]. This grooving system provides easy access of the rolling tool to the places of bending, reduces metal thinning of bent sections, the load on the rolls and wear.

For the qualitative pre-bending of extreme flanges of sections during production of guide beams (**Figure 1**) the system of roll grooving with constant radii of bent sections (R = 9 mm) was used (**Figure 2**). Angles of pre-bending for passage in the manufacture of all profiles were 4-18 °, and only in the 9th mill of the 100x55x16x4.2 mm rack profile the angle of pre-bending for one passage made 19 °.

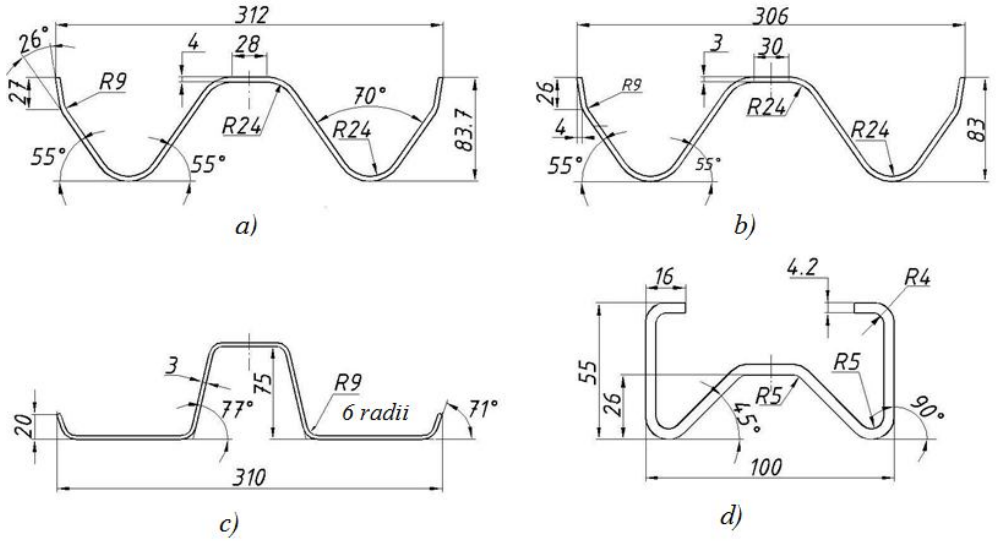

Figure 1. Range of profiles of road fences: a, b, c - guide beam profiles, d - rack profile

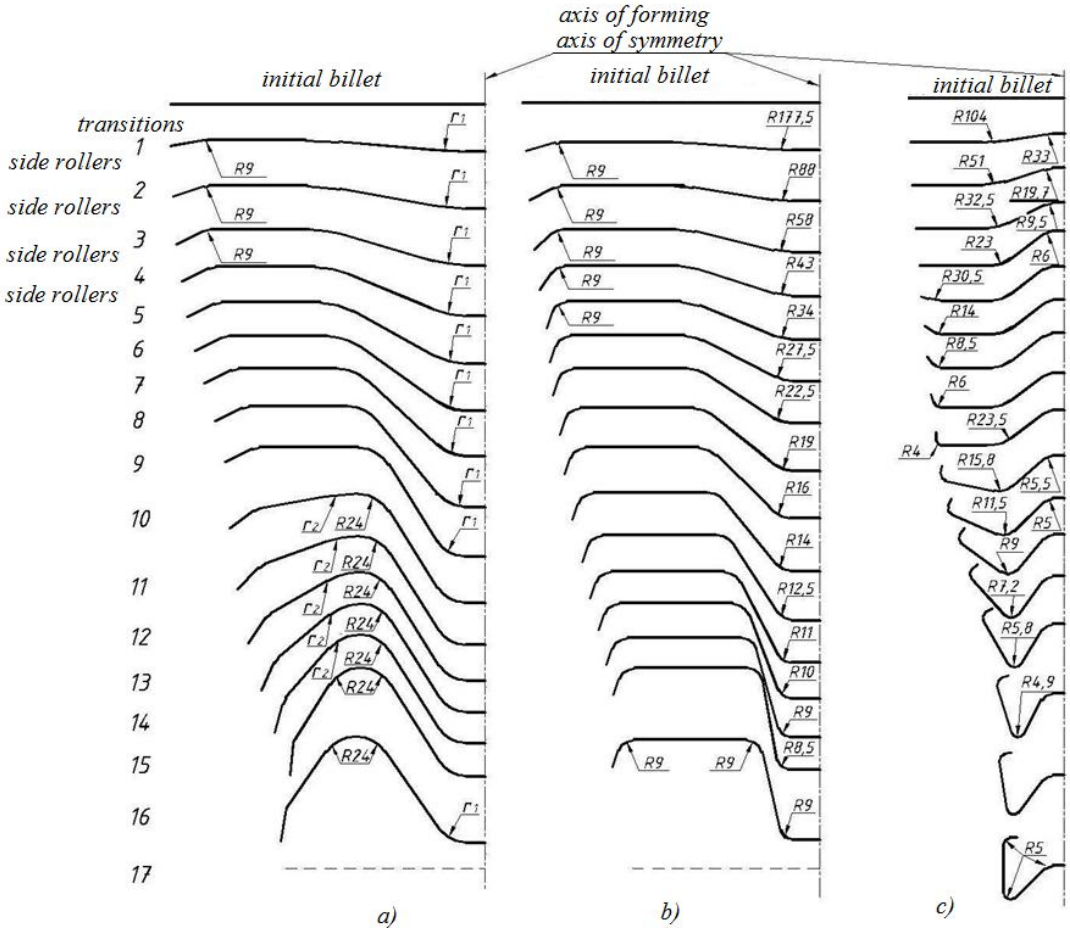

Figure 2. Technological schemes of forming profiles: a - scheme of forming the profile of a guide beam 312x83.7x4 and 306x80x3mm, b - scheme of forming the profile of a guide beam 310x78x3 mm, c - scheme of forming the rack profile 100x55x16x4.2 mm

Based on the chosen schemes and modes of forming with the PC we developed roll pass and working drawings of a rolling tool for four launch profiles. In the developed groovings execution of grooving the last stand, which provide the required dimensions of a ready profile at the outlet of the mill is provided.

Table 1. The radii of curvature of bent sections of profiles of guide beams 312x83,7x4 mm and 306x80x3 during technological transition

Technological transitions (stands)	Name and size of the profile			
	Guide beam 312x83,7x4 mm		Guide beam 306x80x3 mm	
	r_1, mm	r_2, mm	r1, mm	r_2, mm
1	281.0	–	278.5	–
2	132.5	–	132.0	–
3	83.5	–	83.0	–
4	60.5	–	60.5	–
5	46.5	–	46.5	–
6	37.0	–	37.5	–
7	30.5	–	31.0	–
8	26.0	–	25.5	–
9	24.0	–	24.0	–
10	24.0	139.0	24.0	138.0
11	24.0	68.0	24.0	68.0
12	24.0	45.0	24.0	45.0
13	24.0	33.0	24.0	33.0
14	24.0	26.0	24.0	27.0
15	24.0	24.0	24.0	24.0
16	24.0	24.0	24.0	24.0

Brief technical characteristics of profiling lines:

- Profiling method	continuous rolling
- Thickness of the profiled billet, mm	1.0–4.2
- Width of the profiled billet, mm	50–500
- Basic roll diameter , mm: upper lower	 360 160
- Maximum height of profiling, mm	90
- Linear velocity of profiling (adjustable), m/min	2–20
- Number of working stands, pc.	17
- Installed power, kW	80
- Dimensions of the line, mm: length width height	 28000 6400 2000
- Weight of the line, kg	25000

For the practical implementation of the developed grooving of rolls and production technologies of the mentioned four of profiles of safety fences was completed a working draft of automated profiling line (**Figure 3**) composed of decoiler (1), right-setting device (2), roll forming 17-stand mill with intermediate tables for setting non drive vertical rollers (3), non drive proper stand (turret) (3.1), cutting device (4), receiving roller conveyor-ejector (5), storage of finished products (6), control system (7), cooling and lubrication systems (8).

This line of profiling is made by the developed design documentation and in production facilities

of one of the industrial enterprises of Ukraine in Mykolayiv region installed and put into operation.

Technological process of bent profiles production on an automated line of profiling is as follows.

Roll billet of measuring width from the decoiler (1) shall be submitted in a properly-setting device (2), where it is editing. After editing billet is moved to the guide rollers of the driving table, and then - in the first working mill stand (3). In the working rolls of the mill the billet undergoes through successive hems of profile elements to the set of its configuration - profile with the mill goes to non drive proper stand (3.1), and after it - into cutting device (4) for cutting profiles into measured lengths.

After cutting profile is transferred to the receiving roller conveyor (5) and with a built-in ejector sent to storage of finished products (6).

All of the major process steps of the profiling line (unwinding roll workpiece, its editing, forming the profile and cutting into measured lengths and stacking of cut profiles in the store) are fully automated.

Constructive solutions feature of automated line of profiling in the part of the control system is to ensure high accuracy of the given size of finished profiles to length (length tolerance of profiles does not exceed ± 1 mm). This is ensured by the fact that in the process of profiling there is a constant measurement of the length of cut part of the profile, and after reaching the selected value mill stops, and then the command to profile cutting is given. Taking into account design features of profiles in the profiling line die cutting wasteless for open profiles (guide beams), and for the profile rack with cutting with a band saw are provided.

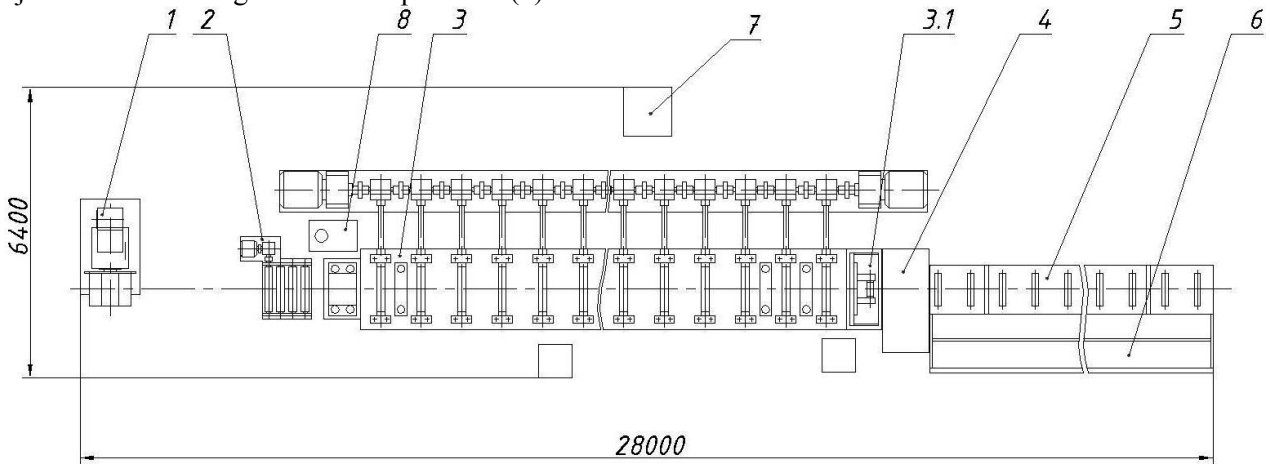

Figure 3. Arrangement of equipment of automated profiling line: 1 - decoiler 2 - right-setting device, 3 - roll forming mill, 3.1 - turhead, 4 - cutting device, 5 - roller conveyor-ejector, 6 - storage of profiles, 7 - control system, 8 - cooling and lubrication systems

Conclusions

Profiles made by the developed technology for automated line of profiling are characterized by good quality with no surface defects (ticks, scratches, dents and scuffing), the stability of geometric dimensions of the cross-section along their whole length (the deviation shall not exceed ± 2 mm) and accuracy of dimensions according to requirements of the drawing and GOST 26804-86 "Road Metal Fences of Barrier Type" when reached design capacity.

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Технология и автоматизированная линия изготовления профилей дорожных ограждений

Сталинский Д.В., Рудюк А.С., Солёный В.К., Крюков Ю.Б., Олейник Г.В., Паненко А.К.

Представлены результаты внедрения в производство технологии и автоматизированной линии профилирования для изготовления профилей дорожных ограждений барьерного типа, разработанных УкрГНТЦ «Энергосталь». Приведены схемы формовки профилей и состава оборудования линии и краткая техническая характеристика.