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СИСТЕМИ РОЗРОБЛЕННЯ ТА ПОСТАНОВЛЕННЯ ПРОДУКЦІЇ НА ВИРОБНИЦТВО. ІНДУСТРІЯ 4.0. СУЧАСНИЙ НАПРЯМОК АВТОМАТИЗАЦІЇ ТА ОБМІНУ ДАНИМИ У ВИРОБНИЧИХ ТЕХНОЛОГІЯХ

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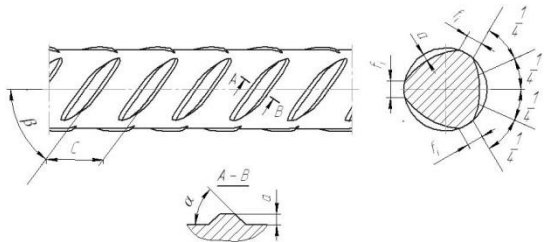
ABOUT THE PERSPECTIVE OF ENTRY OF UKRAINIAN ENTERPRISES TO THE INTERNATIONAL SALES MARKET OF THE COLD-DEFORMED WIRE FOR REINFORCEMENT

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Introduction. The real integration of Ukraine into the European Union as an industrially developed country is impossible without entry of the Ukrainian metallurgical enterprises to the European sales market that produces products in accordance with the requirements of the International standards. Cold-deformed wire for reinforcement as one of the main elements of the reinforced concrete for the civil and industrial buildings is a product of metalwork with increasing volumes of production in the World Market and with constantly increasing quality requirements. International standard ISO 10544 [1] provides the production of the cold-deformed wire for reinforcement with diameters of 4...16 mm on the basis of the national standards of the main exporting countries of this product. Ukrainian industry of metalwork producing the wire for reinforcement with diameters of 3...5 mm in accordance with GOST 6227 [2] for the needs of domestic construction industry must develop new methods of production of competitive products using own raw materials and machine building potential of Ukraine in the absence of financial possibilities of purchasing of the imported equipment and technologies applicable for the traditions of the domestic metalwork production. The increase in range of the diameters and strength properties of the cold-deformed wire for reinforcement in accordance with ISO 10544 provides savings of metal up to 30 % during construction and in the absence custom barriers for importing of the wire produced in accordance with International standard objectively creates the conditions when domestic metalwork enterprises lose the external sales market and the internal sales market of metalwork of Ukraine.

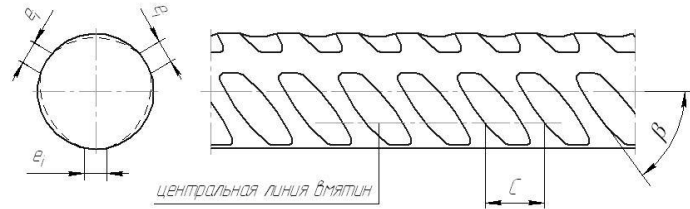
The aim of the work. Comparative analysis of imported and domestic equipment, production technology and testing of cold-deformed wire for reinforcement produced in accordance with the requirements of the International standard ISO 10544 in conditions of work of metalwork enterprises of Ukraine and development of recommendations on usage of scientific and industrial experience for development of the production of competitive cold-deformed ribbed wire with three rows of ribs and indented wire (fig. 1, fig. 2).

The main part. On the basis of analyses of the requirements of the national standards [3-6] it is not definite that country-buyer will agree to purchase a wire at high price produced in accordance with the ISO 10544, but not corresponding to the national standard (table 1).



β – inclination of rib relative to the axis of wire;
 a – rib height; c – rib spacing; α – rib flank inclination;
 f_i – 1/3 of the transversal ribless perimeter

Fig.1. Ribbed wire with three rows



β – inclination of the indentation relative to the axis of wire;
 a – indentation depth; c – indentation spacing; α – inclination
of the surface of indentation;
 e_i – 1/3 of the transversal indentationless perimeter

Fig.2. Indented wire with three rows

Table 1.

Mechanical properties of the cold-deformed wire for the reinforcement concrete constructions [7]

Standard	Proof stress, N/mm ²		Tensile stress, N/mm ²		Elongation, %	
	in accordance with standard (no less)	actual value	in accordance with standard (no less)	actual value	in accordance with standard (no less)	actual value
D.M. 14/2/92	390	530	440	580	8	9
DIN 488, BSt 500M	500	530	550	580	8	9
BS 4482	485	530	550	580	-	-
ASTM A82	483	530	550	580	-	-

D.M.-standard of Italy, DIN-standard of the German Institute for Standardization, BS-British standard, ASTM-standard of American Society for Testing and Materials.

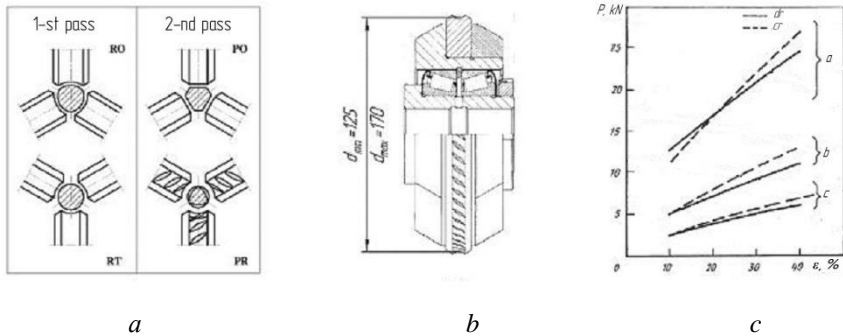
It must be added that it is not guaranteed that the wire produced in accordance with the requirements of national standards to the geometry, physical characteristics, chemical composition will be competitive. For example, DIN 488 [3] prescribes that the wire necessarily must be marked (ISO 10544 does not prohibit this) and this guarantees the competitiveness of the product. At the same time Ukraine does not have the International code of the country of the manufacture of the wire for reinforcement. If Ukraine receives the International code of the country of the manufacture of the wire for reinforcement then the influence of Ukrainian metalwork industry in the World Market will be stronger. The first steps to obtain International code are the development of the technology of production of the wire for reinforcement in accordance with ISO 10544 and the development of the corresponding national standard also [8]. The limited value of production of the wire for reinforcement with three rows in Ukraine (ribbed wire and indented wire) is produced using imported rolling draw plates designed in accordance with model «Turkish design» [7]. Technical characteristics of the block of "IMPIANTI" are given in the table 2.

Table 2.

Technical characteristics of the block of cold rolling of wire designed in accordance with model GL 26/30 [7]

PARAMETERS	VALUE
Diameter of the hot rolled stock, mm	5,5 - 16
Diameter of the finished wire, mm	4 - 14
Number of rolls in the rolling cage, pieces	3 + 3
Dimensions of the rolls, mm:	
diameter	123 - 150
thickness	15 - 20
The number of drives with low velocity for displacement of rolls in the working position during rolling, pieces	2
Installed capacity, kW	2
Rotational speed of the drives, rpm	1350/1680
Rotational speed of the rolls, rpm	275
Volumetric flow rate of water for rolls cooling, l/minute	15
Voltage, V	380 - 460
Current frequency, Hz	50 - 60
Mass, kg	1400
Dimensions, mm	1600 x 650 x 1600

The block of "rolling" contains two groups of rolls. Each group consists of three rolls located at an angle 120° respectively to each other (see fig. 3, a, where indexes "PR", "FO", "RT", "RO" denote profiles of the rolls for deformation during each pass).

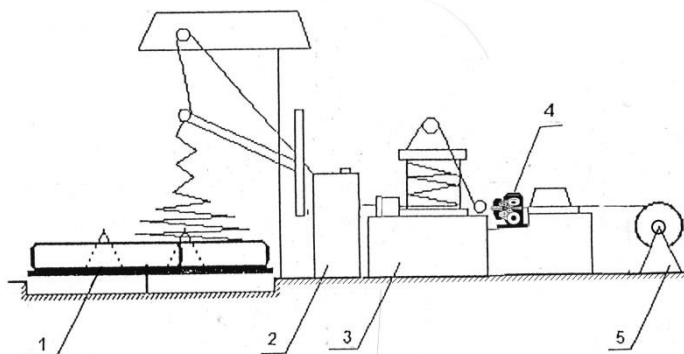


a – scheme of shapes of “rolling mills” rolls; *b* – assembled “rolling mills” roll; *c* – the influence of normal strain on the force of deformation during cold “rolling” (*cr*) and drawing in the monolithic die (*dr*) of the wires with diameters: 12 mm (*a*), 8 mm (*b*) and 5,5 mm (*c*) [7]

Fig. 3. Production of the wire for the reinforcement in the line of the mill of cold “rolling”, model of mill is LTP [7]

Rolls are located sequentially one after the other in the direction of the drawing and these rolls provide value of normal strain up to 22 % during one pass in the two groups of rolls. At the same time in the line of the mill of cold “rolling” the huge blocks of rolling draw plates (table 2) defining the narrow specialization of the mill are used. Consequently, the application of these technological lines of production of cold-deformed wire for the reinforcement (fig. 4) may be affective only in the conditions of mass certified production and stable sales markets. Both the first and second conditions of the usage of lines of cold “rolling” require significant investments at metalwork enterprises of Ukraine. At the same time the standard ISO 10544 provides the possibility of acceptance of products supplied by lots with normalized methods of testing depending on the volume of supplied products [9-11], which expands the technological possibilities of organizing of production of the cold-deformed wire for the reinforcement in small lots and with wide range of dimensions in a small-scale production using universal designs of cages of rolling draw plates.

The design of rolling cage with small rolls of the «DIV» series [12,13] was developed due to the implementation of the supporting rolls of the different sizes (table 3) taking into account the worldwide trend in the usage of rolling cages with supporting rolls that provide the reduction of diameter of the working tools. The small dimensions of the cage and the advantages of the rolls of the small diameter provide reduction of the normal strain along the width of the stock in the working rolls.



1 – uncoiler, 2 – discaler, 3 – section of drawing, 4 – cage for the shaping, 5 – coiler of the finished product

Fig. 4. Scheme of the process of drawing of ribbed wire with diameter of 5 mm and with three rows in the cage with rolling die «DIV-9v-31/115»¹

Conclusions

Technology of production of the wire for the reinforcement produced in accordance with the requirements of ISO 10544 using the new rolling draw plates with the supporting rolls of the small size considerably does not differ from the technology of the production of the wire for the reinforcement of the Vr-1 class and it does not require additional investments for the production in the accordance with the requirements of the standards of the countries that determine the price policy in the World Market of the cold-deformed wire for the reinforcement.

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¹ During production of the wire for reinforcement in the accordance with ISO 10544 with two rows it is applied cages «DIV-6v».

Table 4

Comparison of physical and mechanical properties of the wire from experimental lots and parameters in the accordance with different standards [14]

Name\ Properties	Samples made in the cage DIV-6v- 40/130	USA standard ASTM A 496-78	British standard BS 4482:1985	ISO 10544	Samples made in the cage DIV -9v- 31/118	Standard of Germany DIN 488	Standard of France NF A35- 019-1984
Number of rows	2	2	2	2,3	3	3	3
Nominal diameter d_n , mm	6,0	2,87-15,95	5-12	4,0-16,0	5.0	4,0-12,0	4,0-16,0
Proof strength R_{po} , N/mm ²	510	>485	>460	>500	580	>500	>500
Tensile strength R_m , N/mm ²	555	>552	>510	>550	645	>550	>550
Elongation, %	$A_5 = 13,3$			$A_5 > 12,0$	$A_{100} = 3,3$ $A_5 = 12,0$	$A_{10} > 8.0$	$(A_5 > 12)$ $A_{10} > 8.0$

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