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XRK 2-180 STRAIGHTENING MACHINE MODERNIZATION

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Abstract: *The manufacturing program of ZDAS, a.s. includes the straightening machine of XRK type. The XRK 2-180 straightening machine is an energy-intensive one. Within the framework of the innovation of this type of the straightening machine we have made its new design so as to improve the machine parameters, to reduce the prices and the energy-demand factor. The designed straightening machine XRK 2-180 was computer-simulated and checked for strength using the program MSC.MARC. The features of the innovated straightening machine are as follows: increase of speed by 20%, reduction of the energy-demand factor by 27.3%, reduction of weight by 7,4%, decrease in cost by 8.6%, and the average improvement by 11.2% as to the parameters of the range of products to be straightened.*

Keywords: ***Straightening machines, two-roll oblique straightening machine, production costs.***

1. Introduction

Straightening machines produced at ŽĎAS a.s. are of roller, section and oblique type. Roll straightening machine are designed for cold or hot straightening of sheets. Section straightening machines are designed to straighten sections. Oblique straightening machines are intended for straightening of circular rods and pipes and are divided according to the number of straightening rolls, as follows: XRK 6 with two rolls, XRK 9 with nine rolls, XRK 10 having ten rolls and special-purpose ones.

The task was to create a new design of the XRK 2-180 straightening machine to meet the set parameters:

– for rounds to be straightened - maximum diameter 180 mm at yield strength of Re 1000 MPa,
– maximum straightening speed 18 m/min,
– maximum decrease in weight,
– maximum price reduction.

2. Machine description

The straightening machine (Fig. 1) is an oblique two-roll one with straightening rolls mounted one over the other; both rolls are driven. In the pre-stressed frame consisting of the upper and lower crossbeams and four columns there are the other mechanisms. Fastened in the upper crossbeam is the guide for the upper work roll being adjustable in height and at an angle. Vertical adjustment is done by means of the nut and the screw which is rotated by the gearbox with electromotor. Setting at an angle is done by means of the hydraulic cylinder. The lower crossbeam comprises the guide-way for the lower work roll which is hydraulically spring-loaded and set to an angle by means of hydraulic cylinder. To guide bars between the work rolls, the guide-gibs are provided there. Each work roll has its own drive fastened to the foundation frame into concrete. The drive consists of the electric motor, coupling, gearbox and propeller shaft.

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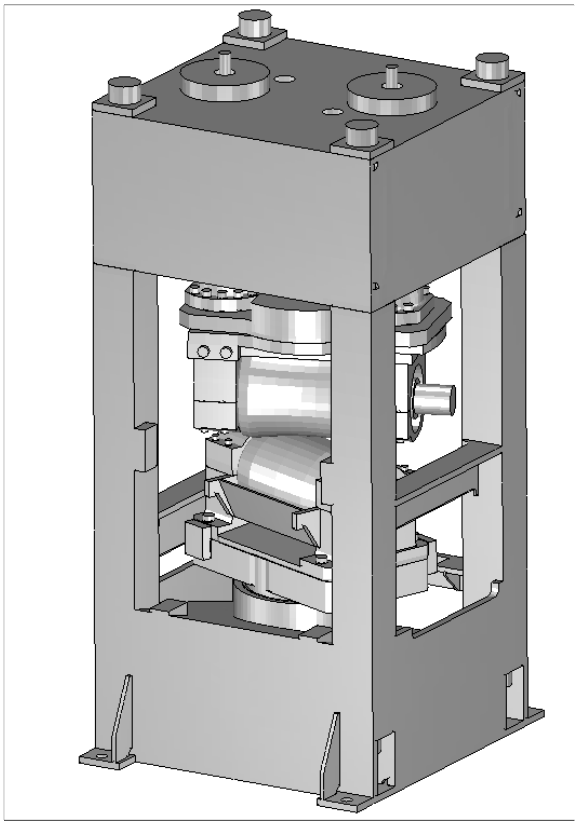

Fig. 1: Machine description.

2.1. New straightening machine design

When designing the construction of the XRK 2-180 straightening machine we came out mainly from the construction of series of newer straightening machines (Fig. 2) ranging from the size XRK 2-80 up to XRK 2-150, and from energy-force calculations acc. to the required parameters. We also solved the production technology with respect to the cost.

The work roll diameter was determined, according to the calculation, to be 680 mm for the lower roll and 630 mm for the upper roll. The work-roll diameters of the XRK 2-180 straightening machine from the year 1979 were 730 mm for the lower roll and 670 mm for the upper roll. According to the calculation, the work-roll body length has been determined to be 960 mm. The work roll body length of the XRK 2-180 from the year 1979 was 1350 mm. A shorter length of the work roll body will positively affect the width and weight of the straightening machine; the disadvantage, however, is a greater straightening force, which will result in greater stress of the straightening machine and increase of height of the cross-beams. The lower work roll mounting was designed for the roll diameter of 670 mm, body length of 960 mm and for double-row spherical-roller bearings 24164 determined by calculation. The upper work roll mounting was designed for the roll diameter of 630 mm, body length of 960 mm and double-row spherical-roller bearings determined by the calculation.

When designing of the lower part of the straightening machine we came out from the XRK 2-150 straightening machine frame drawing. The roll holder, which serves to hold the chock and rotates in the slide bearings mounted in the lower crossbeam, was designed as a casting and also as a weldment. When designing the lower crossbeam we came out from the XKR 2-150 straightening machine lower crossbeam drawing; the lower crossbeam was designed as a casting and also as a weldment.

When designing the upper part of the straightening machine we came out from the XKR 2-150 straightening machine upper adjustment drawing. The upper crossbeam was designed as a casting and as a weldment, too. Further, we also designed columns, anchors and nuts.

Critical parts were designed as castings and weldments. We compared both variants and chosen the preferable one.

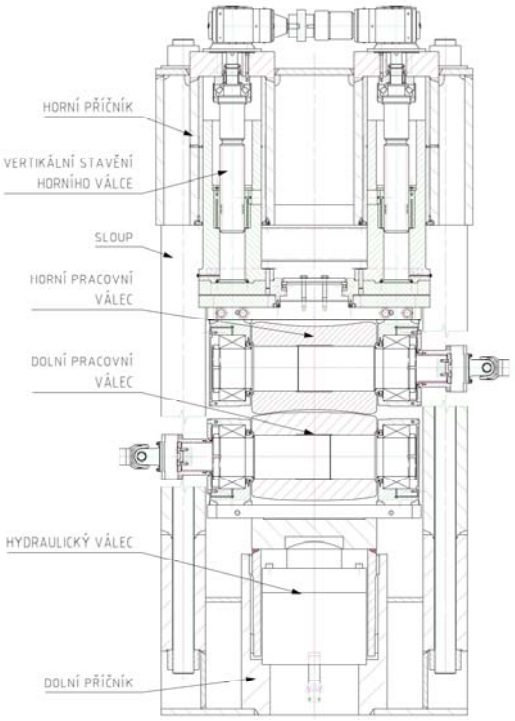

Fig. 2: New straightening machine design.

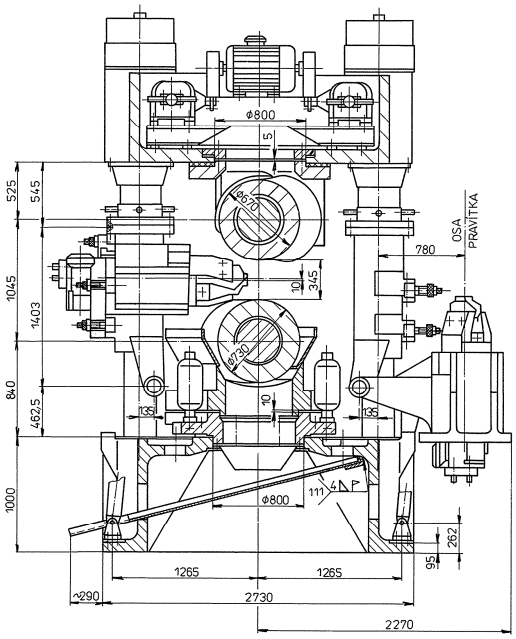

Fig. 3: Old straightening machine design.

2.2. Old straightening machine design

This is an oblique two-roll straightening machine having rolls mounted one over the other (Fig. 3). Both rolls are driven. The frame is the structural part of the machine. The main part is the lower crossbeam in which four columns are mounted and secured by nuts. Swing-mounted in the centre of the lower crossbeam is the support plate on which the lower-roll chock is fit. This chock is supported on four hydraulic jacks. The upper crossbeam transmits the straightening force onto columns with lower crossbeam and it moves using a nut and a worm gear along columns of the frame. The upper-roll chock is centered on the upper crossbeam, mounted via the carrier ring using four bolts and balanced by Belleville springs. To guide the rods between the work rolls, the guide-gib mechanism is used. Each work roll has its self-contained drive attached to a foundation frame embedded in concrete. The drive consists of the electric motor, coupling, gearbox and propeller shaft.

2.3. Straightening machine load

This design model was created by František Ficek using the program MSC. MARC. To load the work rolls of the model, the straightening force Fr = 7301.1 kN was applied (Fig. 3). To load the frame, the straightening forces were applied, which act on the guide gibs while the bar passes through the straightening machine. The mechanism of the guide gibs was not designed for the time being. The frame of the straightening machine was loaded at the expected point of clamping of the guide-gib mechanism.

The comparison of parameters of XRK 2-180 straightening machines is shown in Tab. 1.

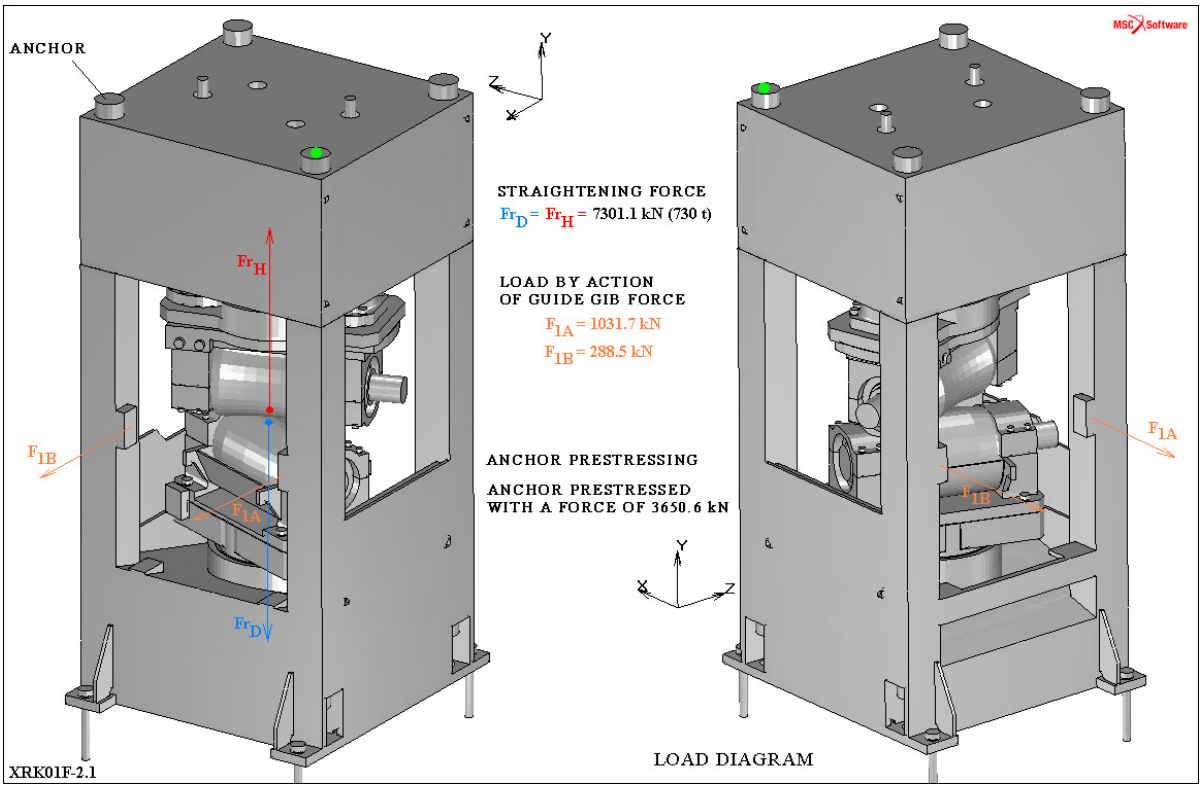

Fig. 4: Straightening machine load.

Tab. 1: Comparison of straightening machine parameters.

	Straightening speed [m/min]	***Maximal diameter [mm] up to Re***				***Drive motor input [kW]***	***Straight. machine weight [kg]***	***Prod. costs [mil. CZK]***
		Re=1000 MPa	***Re=900 MPa***	***Re=800 MPa***	***Re=600 MPa***			
Old straightening machine	***7.5 and 15***	***165***	***175***	***180***	***190***	***220***	***95109.1***	***19.637***
New straightening machine	***5÷18***	***180***	***190***	***200***	***220***	***160***	***88063.6***	***17.941***
Difference [%]	***+20***	***+9.1***	***+8.6***	***+11.1***	***+15.8***	***-27.3***	***-7.4***	***-8.6***

3. Conclusion

As regards the XRK 2-180 straightening machine designed in this way, we have managed to achieve a decrease in cost by 8.6% and a reduction of weight by 7.4% compared to the straightening machine from the year 1979.

Main features of the designed straightening machine:

- decrease in speed by 20%,
- for rounds to be straightened, increase of maximum diameter by 11.2%,
- reduction of energy demands by 27.3%.

Reference

Ficek, F. (2009) Supplement 1., ŽĎAS a.s.