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PROBLEMS AND SOLUTIONS REGARDING THE CENTRIFUGAL CASTING OF WIRE SHEAVE FOR HEAVY CRANES

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ABSTRACT

The centrifugal casting of wire sheave is a technological method that ensures the important quality requirement, the continuity of the material in the active rolling zone of the sheave. However the centrifugal casting has some difficulties: the stability of the casting system, small productivity, gas permeability of the cast mould. The paper shows the problems induced by the centrifugal casting of these parts and the solutions for their solving.

KEYWORDS: centrifugal casting, wire sheave, productivity

1. Introduction

The wire sheaves for heavy cranes have, as characteristic, the relatively great diameter, compared to their thickness (Figure 1).

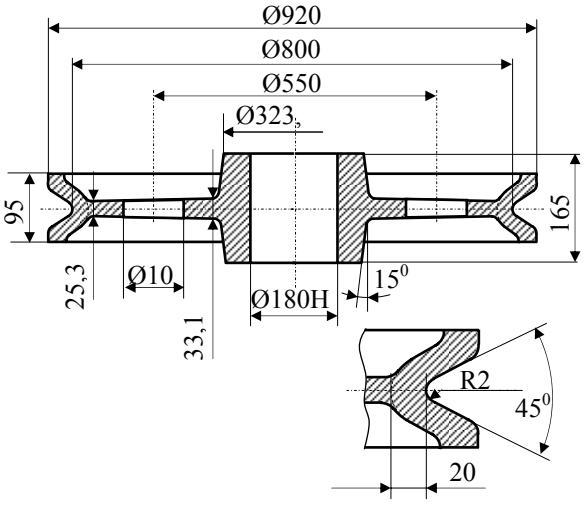

Fig. 1. *Form and dimensions of the wire sheave*

The wire sheave is obtained by casting from the alloyed steel according to the standard DIN 1683 GTB 18.5. The chemical composition of the steel for wire sheave is rendered in Table 1.

Table 1. *Chemical composition of the steel, [%]*

C	Mn	Si	P	S	Cr	Ni	Mo
0.25-0.35	0.4-0.9	0.2-0.45	max 0.03	max 0.03	1.3 1.6	1.3 1.6	0.2 0.3

The characteristics of the cast steel, after the heat treatment are rendered in Table 2.

The gravitational casting of these sheaves in the temporary casting mould presents some difficulties.

A quality requirement, which must be strictly met, is ensures of the material continuity in the rolling way zone of the wire sheave.

The presence of the gas gaps in this zone is strictly forbidden.

Table 2. *Characteristics of the steel*

Heat treat-ment	$R_{p0,2}$	R_m	A	Z	KCU	HB
u.m.	$\frac{N}{mm^2}$		%		$\frac{J}{cm^2}$	$\frac{daN}{mm^2}$
Q+T	640	780-980	10	20	39	232

To meet this requirement, the increasing of the mechanical work addition material practically is necessary.

This fact leads to the increasing of the material consumption and the greater costs of the mechanical working process, respectively, the greater general cost of the production process.

In the aim of the decreasing the work addition material and, at the same time, the ensure of the material continuity in the rolling way zone, taking into consideration that the dimensions of the wire sheave are adequate, the centrifugal casting, with

vertical rotation axe, is a possible technological process for making these parts.

The centrifugal casting presents some advantages:

- ensures of the continuity and a compact structure of the part in the important zone of the rolling way,
- the work addition material may be established at the minimum level,
- the dimensional precision, in the active zone, is better than at the gravitational casting.

2. Establishment of the revolution

The revolution of the casting mould at the centrifugal casting may by calculated with different calculus relations, recommended in the specialty literature. Thus, according to:

– [1] the revolution will be:

$$n = 300\sqrt{\frac{k}{r}} \qquad (1)$$

n is the revolution, in revolution per minute, r – the radius of the interior surface of continuous cast part, in cm, k – coefficient in function of the part material,

For the alloyed steel the values of the coefficient k is of 20 – 30, and for the radius r of 8 – 10 cm, the value of the revolution is

$$n = 474 - 581 \text{ rpm}$$

– [2] the revolution will be:

$$n = \sqrt{\frac{1800}{D_{\text{int}.f}} \cdot k_g}$$

$D_{int.f}$ is the interior diameter of the mould cavity, in meters, k_g – the coefficient which, for the centrifugal casting machine with the vertical turning axe has the value of 90 … 100.

In case of the casting of part with 0.8 m, in diameter, we obtain:

$$n = 450 - 474 \text{ rpm}$$

3. Installation and structure of centrifugal casting mould

A new installation of centrifugal casting can require great initial expenses, which can't be supported, unlike the case of a high number of identical cast parts. Because the number of the wire sheaves is not great the investment for production of the centrifugal installation is not justified.

Therefore at the PROMEX Society in Braila for the organization of the experimental equipment was used a carrousel lathe of 1100 mm of the revolution plate in diameter and the maximum revolution of 1000 rpm. The lathe was placed on a foundation, necessary for an adequate dynamic stability. Also it was ensured an adequate protection system because the centrifugal casting installation may be dangerous.

The casting mould (Figure 2) consists of a metallic case, which ensures the setting of the segments from the mould compound.

The metallic case is consists of the base plate 1, out of which is welded the cylindrical form 2. Inside the metallic case is placed the inferior casting mould 5 and the superior casting mould 6 pre-assembled with the hole form 8.

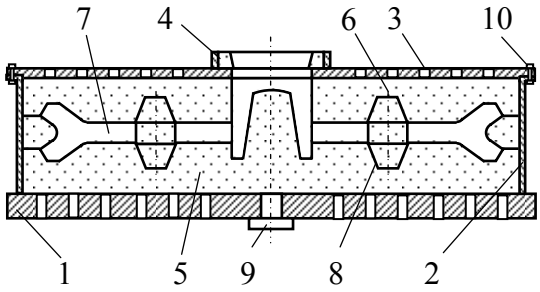

Fig. 2. Structure of casting mould:
1-base plate, 2-cylindrical form, 3-lid, 4-cast span, 5-inferior mould, 6-superior mould 7-mould cavity, 8-hole form, 9-centering shaft, 10-assembly elements.

The casting form is closed with the lid 3 through the assembly elements 10. In the center of the case on the plate of the carousel lathe is placed a centering shaft 9.

4. Conditions for parts casting

The Society PROMEX from Braila, Romania has electrical arch ovens of 3 and 5 tons and electrical induction ovens of 250 kg, for melting the carbon and alloyed steels. Thus, the melting capacity is better than the necessary material quantity for casting one part. Because of this more cast moulds are necessary for a charge of melted steel. This entails preparation of two, three cast moulds or small values for the time necessary for assembly of centrifugal casting mould, casting and exhausting of the mould with cast part.

The transport of the melted steel from the melting oven to the casting moulds is made with the crane and casting the ladle. The transport distance is of 35-40 meters. The casting ladle must have the adequate capacity, according to the necessary quantity for casting of the parts prepared in this aim. At the casting bay there are casting ladles, meant for casting of steel, of three and five tons. In the aim of security ensure of the worker at the time of the casting process was designed and worked a casting platform and protection screens in the proximity of the centrifugal casting machine (Figure3).

5. Results and discussions

In Figure 4 is shown an image of the centrifugal casting case, fixed and centered on the plate of the carrousel lathe. In Figure 5 is shown a view of the cast part.

Fig. 3. *Image of the casting platform.*

Fig. 4. *Image of the casting equipment.*

The cast part presents a great quantity of iron oxides. The aspect of material leakage is caused, also, by the iron oxides, which are easily removed in the cleaning process.

The principal problems ascertained in the time of the casting process and in the view of quality of cast part are:

1. The relatively small productivity of the casting process,
2. Instability of the casting form in the time of the casting and solidification processes,
3. The presence of the open ducts at the superior surface of the part.

The reduced productivity is caused by the great duration of the preparing of the casting technological system: the assembly and centering of the metallic case on the turning plate of the carrousel plate and of the mould inside of case.

Fig. 5. *Image of the cast part.*

This problem may be solved by the rigid fixation of the metallic case and very good centering on the carrousel plate. The assembly of the form by mould compound with the lid of the metallic case. In this aim there may work two or three lids prepared for assembly with the immediate case, when the cast part and the respective mould were extracted and the metallic case was cleaned with compressed air spurt. Thus, in a new mould will be shortly assembled in the metallic case.

The second problem imposes a very strong fastening and good centering of the metallic case on the plate of the carrousel lathe and of the lid with the metallic case.

Well centering the mould into the metallic case, and the maintaining of centered position during the casting are very important.

If the axe of mould is, even very little, displaced in comparison with the revolution axe, in the casting process, the material, in the casting mould, leads to the increasing of the eccentric mass and, the great revolution can produce the vibration with the instability of the dynamic process.

That is why the maintaining of dynamic stability in time of casting and solidification is strictly imposed. In this aim supplementary centering elements are necessary.

The elements can be constituted by a system of centered columns, fixed in the base plate of the metallic case (three are sufficient). The mould has comprised corresponding guiding jacks. Eventually the lid may be provided with guiding holes. These systems will be made in the holes of the casting form (Figure 6).

At the circumferential surface of the cast part the continuity of the material was observed.

The cast part presents at the superior surface open ducts with the depth of 3 to 16 mm and 3 – 5 mm in diameter.

The cause of these holes is the small gas permeability of the casting mould.

The solution for solving this problem is ensure of the easy and extended capacity of the casting mould for evacuation of the gases form the cavity of the casting form.

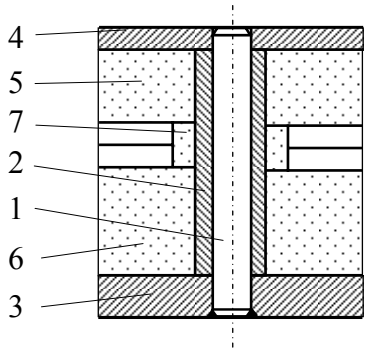

Fig. 6. *System of complex centering: 1-guiding column, 2-guidning jack, 3-base plate of metallic case, 4-lid, 5-superior cast form, 6-inferior cast form, 7-form for holes.*

In this aim canals must work at the contact surface of base plate and lid with the mould. Because the centrifugal casting process males at great revolution, circular and symmetrical canals are recommended. At the same time the canals system must communicate with the exterior through holes, sufficient many enough and with a symmetrical distribution.

6. Conclusions

The centrifugal casting is a good method for obtaining the parts with revolution form. In the case of the wire sheaves for heavy cranes, characterized with the diameter much greater than the thickness in the active zone, there are some special requirements.

These requirements refer to the dynamic stability in the technological process and to the quality of the cast part.

The experiment shows that the centrifugal casting process, of a wire sheave with the 800 mm in diameter, ensures the obtaining of the part, but some improvements are necessary, concerning the dynamic stability, productivity and gas permeability of the casting form.

The solutions proposed for improvement of this centrifugal casting system are:

- supplementary centering of the mould using the systems with guiding column and jacks,
- the use of two or three lids assembling the mould at the lid a priory of assembly with the base plate,
- working of net canals and holes for easy evacuation of the gases.

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