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DEFECTS REDUCTION IN LARGE CAST PARTS OF RAILWAY ROLLING STOCK DUE TO THE POWERFUL REINFORCING RIBS IMPLEMENTATION

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Abstract
Improving the operational and technological properties of industrial products, improving the technical level and quality of products is one of the main tasks of science and technology. The continuous tightening of requirements for the reliability of structural elements makes it necessary to analyze in more detail the specific conditions of their work. Most machine parts, machines and parts are subjected to cyclic loads during operation. Therefore, the problem of endurance of materials is relevant for railway, automotive, aviation, shipbuilding, machine tool, energy and other industries. In the present work, a new concept has been proposed to reduce the defective crack frames by making powerful reinforcing ribs. Thickened corner reinforcing ribs were made on the inner wall of the casting.

Keywords: side frame, steel smelting, deoxidation technology, casting technology, structural defects, fatigue crack, bracket-shaped ribs, cast parts.

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1. Introduction

The main parts of freight cars obtained by steel casting methods are the side frame and overspring beam of the trolley, as well as the elements of the traction device. The side frame of the trolley is subjected to the greatest loads during operation. During operation, the side frames perceive static and dynamic vertical loads - from the weight of the car, from impacts when the car passes path irregularities.

In addition, longitudinal loads are tested due to traction force with uneven movement of the train, forces when cars collide, and also they are subjected to torque when cars fit into curves. At the same time, the main part of dynamic vertical loads is cyclic in nature, and the fatigue strength of the side frames (the ability to withstand the effects of cyclic loads for a long time) is the main characteristic of their operational reliability, i.e. directly affects traffic safety.

One of the problems of the side frames is the fracture. During operation, breaking the side frame leads to economic losses and human casualties.

During the operation of products, including frames, there are mainly two types of fracture - brittle and fatigue. The main factors contributing to these fractures are: reduced mechanical properties of steel; disadvantages of steel smelting and deoxidation technology; imperfection of casting technology and steel casting resulting in formation of volumetric structural defects and increased number of non-metallic inclusions in steel.

2. Methods

The reasons for the breakage of the side frames may vary. For example: due to the formation and development of a fatigue crack, internal foundry defects (shrinkage shells, hot cracks), thermal stresses, underfilling, and waviness.

The main prevention of the occurrence of fracture is the reduction of hot cracks in steel castings, regulation of the content of harmful impurities in metal and compliance with the temperature interval of casting.

A hot crack is a defect in the form of a rupture or tear of the casting body of shrinkage origin arising in the hardening interval. It has a strong oxidized surface (dark).

The causes of hot cracks in castings are due to:

- Incorrect design of castings; uneven cooling of individual parts of casting;
- Incorrect selection of metal supply;
- Insufficient power supply of transition places from one section to another (massive units);
- Insufficient compliance of molds and rods; increased temperature of cast metal;

- Increased content of sulfur, phosphorus, hydrogen and impurities contributing to the appearance of low-melting compounds.

Analysis of the factors of defects formation showed that hot cracks are formed due to insufficient strengthening effect of shrinkage ribs on internal angular sections in the R55 zone, and defects in the form of underfilling, nestitines and soldering are formed due to unsuccessful design of the sprue system with a large channel length and suboptimal supply of liquid metal to the casting.

3. Results and Discussion

In this work, a new concept has been proposed to reduce the defective crack frames by making powerful reinforcing ribs. Thickened corner reinforcing ribs were made on the inner wall of the casting. For this, on the central rod in the R55 zone, the existing recesses with a thickness of 4 mm were increased to 8-9 mm. The results show that after using the thickened ribs, they got rid of hot cracks in the R55 zone. In this regard, three proposals were proposed for innovative technological solutions for additional edge strengthening in the corner zones (R55) of the axle box opening and changing the design of the gate system with the installation of filters on all feeders.

Proposition 1. Increase the number of thickened ribs on the first and fourth R55 from 3 to 4 pieces, and on the second and third R55 from 4 to 5 pieces with an increase in the thickness of the mentioned ribs to 8 mm (Figure 1).

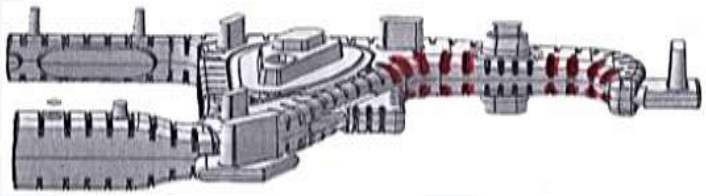

Figure 1 - Diagram of reinforcement of edge reinforcement by increasing the number of corner edges

Proposition 2. Extend the said ribs according to option 1 until the upper and lower ribs merge and form bracket-shaped ribs (figure 2).

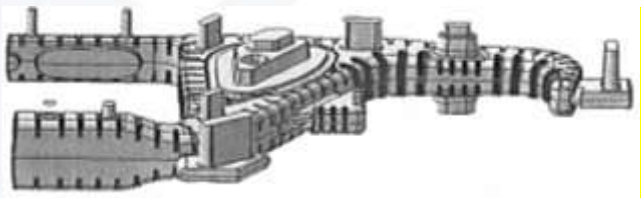

Figure 2 - Diagram of reinforcement of edge reinforcement due to execution of bracket-shaped corner ribs

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Proposition 3. Change the design of the gate system and install filters on all feeders (Figure 3).

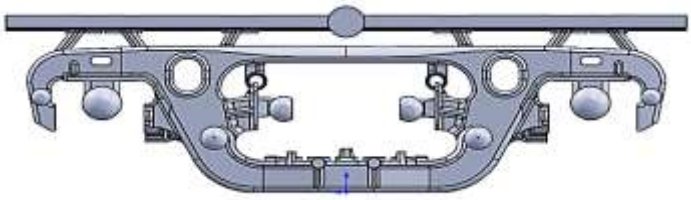

Figure 3 - Modified design of the sprue system with filters installed on all feeders

4. Conclusion

An innovative technology has been proposed to reduce the fracture of large critical steel castings used for cast parts of railway rolling stock, which allows producing suitable foundry products due to additional edge strengthening in corner zones (R55) the axle box opening and changing the design of the sprue system of the side frame with the installation of filters on all feeders, which leads to uniform cooling of individual parts, and also reduces internal defects and hot cracks.

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