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IMPROVEMENT OF TECHNOLOGY FOR PRODUCING CAST PARTS OF ROLLING STOCK BY REDUCING THE FRACTURE OF LARGE STEEL CASTINGS

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ABSTRACT

One of the problems of the side frames is a fracture. During operation, the fracture of the side frame leads to economic losses and human casualties. In this paper, a new concept is proposed to reduce the defectiveness of frames by cracks due to the implementation of powerful reinforcing ribs. The results show that after using the thickened rib, hot cracks in the R55 zone were eliminated.

Keywords: *freight railcars, shrinkage shells, fracture, superstructure beam, hot cracks, fatigue cracks, strengthening effect, side frame.*

УСОВЕРШЕНСТВОВАНИЕ ТЕХНОЛОГИИ ПОЛУЧЕНИЯ ЛИТЫХ ДЕТАЛЕЙ ПОДВИЖНОГО СОСТАВА ПУТЁМ СНИЖЕНИЯ ИЗЛОМА КРУПНЫХ СТАЛЬНЫХ ОТЛИВОК

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АННОТАЦИЯ

В настоящей работе предложена новая концепция по снижению дефектности рам по трещинам за счет выполнения мощных упрочняющих ребер. Утолщенные угловые упрочняющие ребра выполнялись на внутренней стенке отливки. Для этого на центральном стержне в зоне R55 имеющиеся выточки толщиной 4 мм увеличили до 8-9 мм.

Ключевые слова: *грузовые железнодорожные вагоны, усадочные оболочки, разрушение, балка пролетного строения, горячие трещины, усталостные трещины, эффект усиления, боковая рама.*

INTRODUCTION

Improving the operational and technological properties of industrial products, rising the technical level and products quality 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 tools, 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.

The main parts of freight railcars produced by steel casting methods are the side frame and the superstructure beam of the trolley, as well as 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 railcar, from impacts when the railcar passes the irregularities of the track.

Besides that, they experience longitudinal loads from traction forces during uneven movement of the train, forces when railcars collide, and also experience the effect of torque when railcars fit into curves. At the same time, the main part of dynamic vertical loads is cyclical 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.

METHODOLOGY

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

During the products operation, 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 casting of steel, leading to the formation of bulk structural defects and an increased number of non-metallic inclusions in steel.

The reasons for the fracture of the side frames may be different. For example: due to the formation and development of fatigue cracks, internal casting defects (shrinkage shells, hot cracks), thermal stresses, underflows, undulation.

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

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

The causes of hot cracks in castings arise from:

- incorrect design of castings; uneven cooling of individual parts of the casting;
- wrong choice of metal supply;
- insufficient power supply of places of transition from one section to another (massive nodes);
- insufficient malleability of forms and rods; increased temperature of the poured metal;
- increased content of sulfur, phosphorus, hydrogen and impurities that contribute to the appearance of fusible compounds.

RESULTS AND DISCUSSION

The analysis of the defect factors formation showed that hot cracks are formed due to the insufficient strengthening effect of shrinkage ribs on the internal angular sections in the R55 zone, and defects in the form of underflow, non-spillage and junction are formed due to the unsuccessful design of the gate system with a large length of channels and suboptimal supply of liquid metal to the casting.

In this paper, a new concept is proposed to reduce the defectiveness of frames by cracks due to the implementation of powerful reinforcing ribs. Thickened angular reinforcing ribs were made on the inner wall of the casting. To do this, the existing recesses with a thickness of 4 mm were increased to 8-9 mm on the central rod in the R55 zone. The results show that after using the thickened rib, hot cracks in the R55 zone were eliminated. In this regard, three proposals of innovative technological solutions were proposed for additional rib hardening in the corner zones (R55) of the axle opening and a change in the design of the gate system with the installation of filters on all feeders.

Proposal 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).

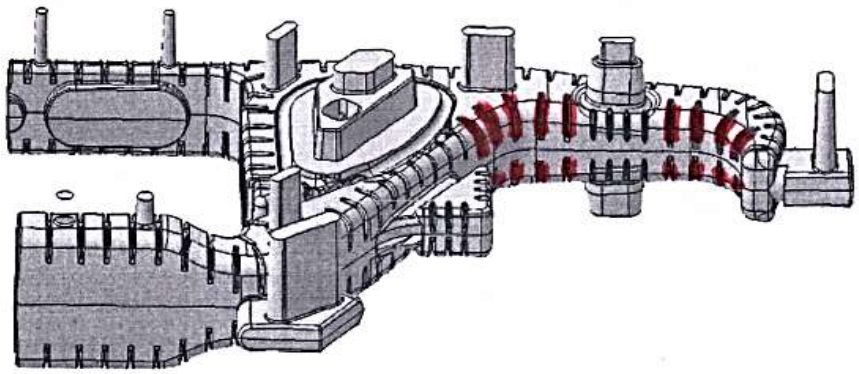

Figure 1 - Scheme of reinforcement of rib hardening by increasing the number of angular ribs

Proposal 2. Extend the mentioned edges according to option 1 until the upper and lower edges merge and form bracket-shaped edges (Figure 2).

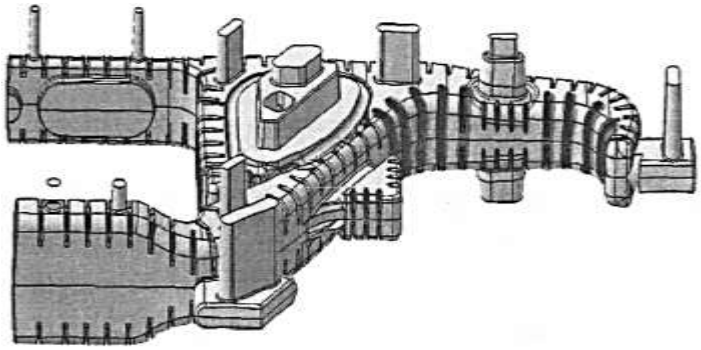

Figure 2 - Scheme of reinforcement of rib hardening due to the implementation of bracket-shaped angular ribs

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

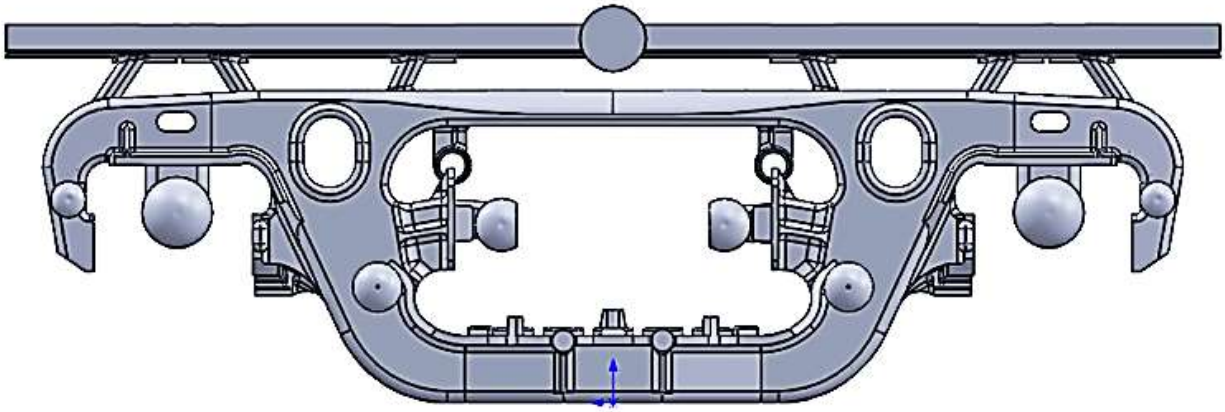

Figure 3 – Changed design of the gate system with the installation of filters on all feeders

CONCLUSION

An innovative technology is proposed to reduce the fracture of large steel castings of a particularly responsible purpose used for cast parts of railway rolling

stock, which allows to produce suitable casting products due to additional rib hardening in the corner zones (R55) of the axle opening and changing the design of the side frame gate system 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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