INCREASE IN THE STRENGTH OF REAR AXLES
DUE TO ELECTROTHERMAL TREATMENT


One of the most important parts of trucks, ensuring operational reliability, is the rear axle (Fig. 1). The welded rear axles used at the Moscow Automobile Factory and the Kutaisi Automobile Factory consist of beams and two outer axles or two terminal flanges welded to the beam with a transverse weld seam.

The operating conditions of rear axles require that they have high resistance to static and cyclic loads. It is of practical interest to increase the strength of rear axles while simplifying and reducing the cost of the heat treatment. The rear axles of ZIL trucks (Moscow Automobile Factory) are strengthened by bulk quenching and tempering.

The outer axles and beams are manufactured from medium-carbon steel (Table 1). The units are oil quenched from 930°C and tempered at 540°C. The weld seams are normalized, with local induction heating of the weld zone to 900°C.

Due to the uneven stresses on the axles, local heat treatment can be used to harden the most heavily stressed sections. In this case the outer axles and beams should be treated separately. Steel 35 is proposed instead of steel 40Kh for the outer axles (Table 1), while the threaded ends, journals, and fillets in highly stressed sections are subjected to induction hardening (Fig. 1). Comparative fatigue tests (Fig. 1) showed that this treatment ensures a strength no lower than that resulting from the standard treatment.

The beams are subjected to a different heat treatment, since standard surface hardening cannot be used. The beam has a thin-walled boxlike section, and the operating stress differs little on the inside and outside of the beam. It has been proposed that beams be prepared from steel 17GS, the properties of which after normalization are close to those of medium-carbon steel after quenching and tempering to a hardness HB 187-269, and that hot stamping and local heat treatment be used in sections where fracture occurs. Production tests showed that failure generally occurs near the transverse weld seam and along the legs of the beam at a distance of 200 mm from the weld seam. Fracture has also been observed at defects in weld seams. The use of steel 17GS should make it possible to eliminate dangerous defects that occur during welding, which is due to its superior weldability as compared with medium-carbon steels.

Two local heat treatments were tested. Treatment 1 consisted of normalization of the zone near the transverse weld seam at 1050°C, with heating for 3 min. Rear axles of ZIL-130, ZIL-131, ZIL-133, and KamAZ-5320 trucks were subjected to this treatment.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of truck</td>
<td>outer axle</td>
</tr>
<tr>
<td>ZIL-130</td>
<td>40Kh</td>
</tr>
<tr>
<td>ZIL-131</td>
<td>40Kh</td>
</tr>
<tr>
<td>KamAZ-5320</td>
<td>40Kh</td>
</tr>
</tbody>
</table>


This material is protected by copyright registered in the name of Plenum Publishing Corporation, 227 West 17th Street, New York, N.Y. 10011. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission of the publisher. A copy of this article is available from the publisher for $7.50.
Fig. 1. Rear axle of ZIL-130 truck subjected to fatigue tests (a) and fatigue curves (b) of standard (O) and experimental (●) axles. 1) Outer axle; 2) beam. The zones of local heat treatment are shown on the outer axle.

Fig. 2. Results of bending tests of the rear axle of the ZIL-131 truck after the experimental (1) and standard (2) treatments.

After treatment 1 the weld seam of the rear axle of the ZIL-130 truck was quenched along the entire perimeter and leg to a distance of 400 mm and tempered at 450–550 °C (treatment 2). Heating to 950–1100 °C was conducted in 2.5 min in a multiturn inductor with the shape of the axle; cooling was conducted with water in a shell repeating the contour of the axle. Water was also supplied on the inner surface. Tempering was conducted in the same inductor used for quenching.

Metallographic analysis showed that treatment 1 results in the completely recrystallized Widmanstatten structure characteristic of the transverse seam after welding. Treatment 2 leads to formation of sorbite with a hardness HB 220 in the area of weld seam and in the legs of the beam. A decarburized layer as deep as 0.3 mm was observed on the surface. Rear axles with heat treated beams and outer axles were subjected to static and cyclic bending tests.

The results of comparative static bending tests in the Link machine (Fig. 2) indicate that the experimental rear axle has greater rigidity than standard axles up to the appearance of substantial deflection. The experimental axles have a higher proportionality limit. Under high loads the standard axle has higher resistance to plastic deformation. Due to the fact that the mechanisms inside the axle can operate only in the absence of deflection (in the elastic area of the strain—load curve), the experimental axles meet the requirements for rigidity and resistance to plastic deformation.

<table>
<thead>
<tr>
<th>Type of axle</th>
<th>Heat treatment</th>
<th>Load range of pulsating cycle, tons</th>
<th>Cycles to failure, 10⁶</th>
<th>least</th>
<th>most</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZIL-130 rear axle</td>
<td>Standard Treatment No. 1</td>
<td>0–17</td>
<td>0.3</td>
<td>&gt;5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment No. 2</td>
<td>0–17</td>
<td>0.7</td>
<td>&gt;2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expt. + real. compress. stresses</td>
<td>0–17</td>
<td>1.67</td>
<td>&gt;2.66</td>
<td></td>
</tr>
<tr>
<td>ZIL-131 front axle</td>
<td>Standard Treatment No. 1</td>
<td>0–8.3</td>
<td>0.34</td>
<td>&gt;1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–8.3</td>
<td>1.56</td>
<td>2.52</td>
<td></td>
</tr>
<tr>
<td>ZIL-131 rear axle</td>
<td>Standard Treatment No. 1</td>
<td>0–10.5</td>
<td>1.43</td>
<td>&gt;1.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–10.5</td>
<td>1.67</td>
<td>&gt;2</td>
<td></td>
</tr>
<tr>
<td>ZIL-133 middle axle</td>
<td>Experimental</td>
<td>0–15</td>
<td>1.67</td>
<td>4.47</td>
<td></td>
</tr>
<tr>
<td>KamAZ-5320 middle axle</td>
<td>Standard Treatment No. 1</td>
<td>0–15</td>
<td>0.48</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–15</td>
<td>1.9</td>
<td>4.1</td>
<td></td>
</tr>
</tbody>
</table>