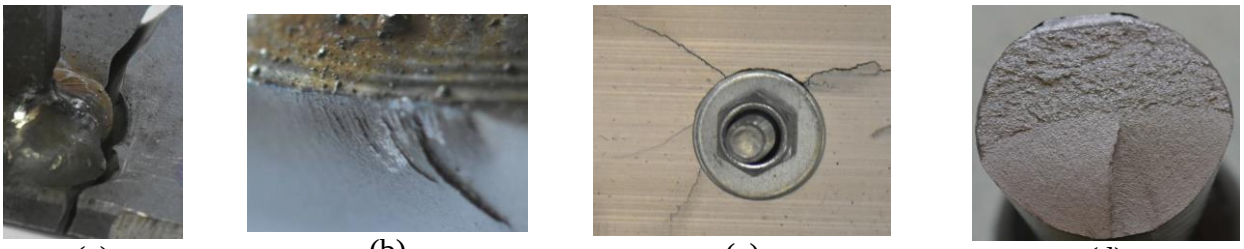
Fatigue of structural components for special vehicles

Tadeusz Szymczak[1, a], Adam Brodecki[2, b], Zbigniew L. Kowalewski[2, c]

[1] Motor Transport Institute, ul. Jagiellonska 80, 03-301 Warsaw, Poland
+48 22 43 85 474, [a] tadeusz.szymczak@its.waw.pl, +48 22 826 12 81, [b] abrodec@ippt.pan.pl,
[2] Institute of Fundamental Technological Research, ul. Pawinskiego 5B, 02-106 Warsaw, Poland
+48 22 826 12 81, [c] zkowalew@ippt.pan.pl

Contemporary progress of technologies applied in the automotive industry enables production of vehicles of various types. Among of them one can distinguish special cars such as: articulated lorries, trolleys, truck tractors, towing cars, etc. Their usage and safe exploitation are strongly dependent on the mechanical properties of the components applied. Therefore, many efforts of producers are focused on elaboration of new vehicle projects reflecting mechanical parameters of such modern materials as aluminium alloys (6005) and high-strength steels (S700 MC) for example. For quality assessments of working components especially the fatigue tests play important role. This type of experiments is usually executing under force control [1]. According to standards, the fatigue tests for steel should be carrying out at least up to 2×10^6 cycles, while for the light alloys this number should be greater than 3×10^6. In our experimental programme the servo-hydraulic actuator, IST multi-channel digital controller and anti-vibration platform with T slots were used to conduct cyclic loading. Various types of components were tested i.e.: working frame of breakdown trucks, rear beam of roadside assistance platform having mechanical coupling devices A50-X type [2]. The results of tests exhibited various phenomena of components in question. In the case of welding elements the cracks appeared in the HAZ along the regular path, indicating high concentration of the residual stresses as a direct reason of failure (Fig. 1a). For the parent material, besides of the crack the fatigue fringes can be observed indicating the fatigue limit being exceeded, Fig. 1b. Failures observed near the artificial notches in the form of holes were characterized by the radially distributed multi-cracks. Such effect can be assigned too low stiffness, Fig. 1c. The research programme also included examination of the mechanical coupling device. The representative result is shown in Fig. 1d.



(a) (b) (c) (d)

Fig. 1. Illustration of the fracture zones due to fatigue: (a) and (b) crack in HAZ section and fatigue fringes in parent material, respectively, for component made of the S700 MC steel; (c) distribution of multi-cracks in the rear beam made of the 6005 aluminium alloy; (d) A50-X coupling device

[1] Regulation No. 55 UN/ECE, Uniform provisions concerning the approval of mechanical coupling components of combinations of vehicles, 2010.

[2] A. Brodecki, T. Szymczak, Z.L. Kowalewski, Digital image correlation technique as a tool for kinematics assessments of structural components, Acta Mechanica at Automatica, 12, 2, 2018, 101-104.