

Failure analysis of a broken diesel engine

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A failure analysis of a broken diesel engine was conducted to determine the cause of the failure. The analysis included visual inspections of broken parts and electron microscopy examinations of the fracture surface. The visual inspections showed that two bolts of the engine had initially fractured. The results of the electron microscopy examinations revealed that the broken bolts failed by fatigue damage. In addition, a mathematical model corresponding to the failure mechanism was derived for failure analysis. The model comprises design philosophy and fracture mechanics approaches.

(Keywords: brittle fracture; plastic deformation; high-strength low-alloying steel; stress intensity factor)

A broken diesel engine was submitted to the authors by Kuwait Oil Tanker Company for determination of the cause of failure. The broken engine was a vertical, water-cooled, four-cycle diesel engine with a rotational speed rating from 720 to 750 rev min⁻¹ during operation. The overall engine dimensions were 3544 mm in length, 1621 mm in width, and 2527 mm in height. The engine had 6 cylinders and weighed 9.2 t. It had been in operation for 15 years on a cargo oil tanker before the failure occurred. A cross-sectional view of the engine is shown in Figure 1, indicating the broken bolts (items 14 and 15).

EXPERIMENTAL DETAILS

Visual inspection

A visual inspection of the broken parts indicated that the bolts had initially suffered from a brittle fracture, followed by an overloading plastic deformation. These findings were based on the particular features of the fracture surface of the bolts. The fracture surface had two distinct regions: a smooth, flat region, indicating that a crack had initiated and propagated with limited deformation (brittle fracture); and a 45° inclined region, indicating that the final rupture was due to plastic deformation. In other

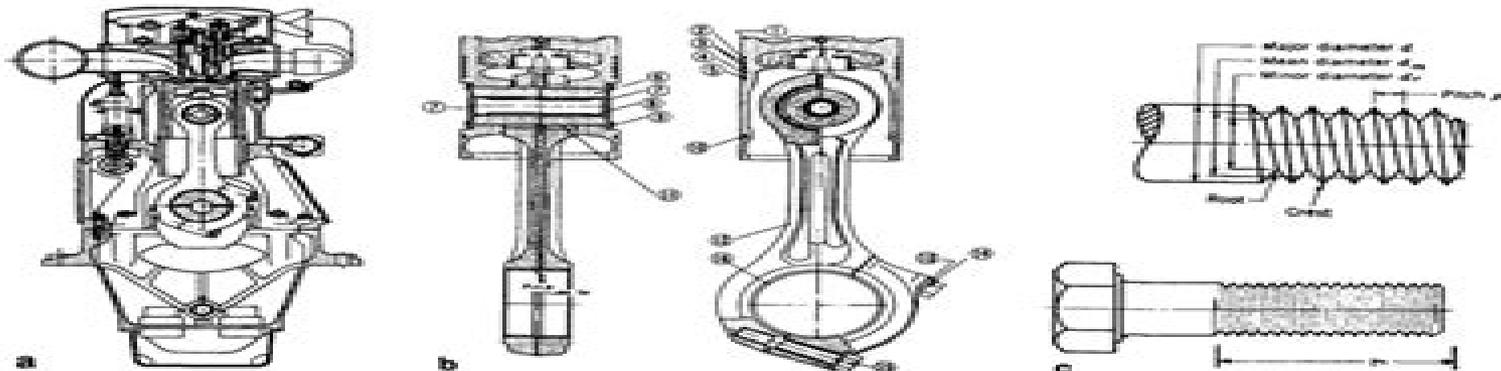


Figure 1. (a) Cross-sectional view of the diesel engine. (b) Cooling-type piston and connecting rod. (c) Specifications of connecting rod bolt: 1, piston; 2, first piston ring; 3, second and third piston rings; 4, fourth piston ring; 5, first oil ring; 6, piston pin; 7, piston pin holding plate; 8, oil-sterilizing pipe; 9, bolt for holding plate; 10, second oil ring; 11, piston pin metal; 12, connecting rod; 13, locking metal; 14, lock bolt; 15, connecting rod bolt; 16, crank pin metal.

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