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**Mechanistic analysis of fatigue-induced fracture in a AISI 4140 steel conveyor drum shaft**

Rodrigues, M.V.G.(1); Sousa, J.P.(2); Furtado, I.A.(2); Lima, M.N.S.(3); Mendes, L.H.A.(3); Ferreira, J.C.(1); Salas-reyes, A.E.(4); Silva, E.S.(2); De Abreu, H.F.G.(3); Tavares, S.S.M.(5); Rodrigues, S.F.(5);
(1) UFPI; (2) IFMA; (3) UFC; (4) UNAM; (5) ;

The failure of a conveyor drum shaft used in ore transport by a mining company prompted an investigation after it fractured during operation, halting the production line. The shaft and bearing support broke, causing the drum assembly to collapse. Two fractured sections were analyzed, one from the internal fracture zone (IFZ) and the other from the separate end (SEZ). Initial fracture surface observations included misalignment and surface oxidation in IFZ, distinct fibrous and smooth fracture regions, and intense wear with localized plastic deformation in SFZ. Several analyses were conducted to determine the root cause: visual inspection, chemical composition analysis via optical emission spectroscopy (OES), and mechanical tests, including hardness (Rockwell and microhardness Vickers), Charpy impact, and tensile testing. Metallographic studies involved optical microscopy, while scanning electron microscopy (SEM) provided fractographic insights. The chemical composition confirmed the shaft material as AISI 4140 steel, a high-strength alloy suitable for structural applications after applying heat treatments. Hardness values aligned with typical AISI 4140 properties, and Charpy impact tests revealed low energy absorption, indicating brittle fracture susceptibility under impact. Tensile testing highlighted high yield and tensile strengths but limited ductility. Microstructural examination unveiled fatigue striations and crack propagation features, suggesting fatigue as a primary failure mechanism, aggravated by wear and misalignment. This comprehensive analysis identifies potential fatigue failure origins and structural inadequacies, emphasizing preventive maintenance and quality control measures for operational reliability.