Solvage of Car Lifter Breakage on Chrysler Line

An inner liner within a car lifting mechanism broke at a *Chrysler* assembly plant. *Valiant Machine and Tool* (the designer, programmer, and maker of the assembly line) requested WIDL's assistance to resolve the issue, remotely, without interfering with production.

In order to build meshes and reproduce failure conditions, parts and the assembly drawings were provided to WIDL. Mentat™ pre-processor to MARC™ was used (cf: http://www.mscsoftware.com) in the investigation. Hand meshing used linear "brick" elements. Because of symmetry, only a quarter of the car lifter was built for Finite Element Analysis, or FEA.

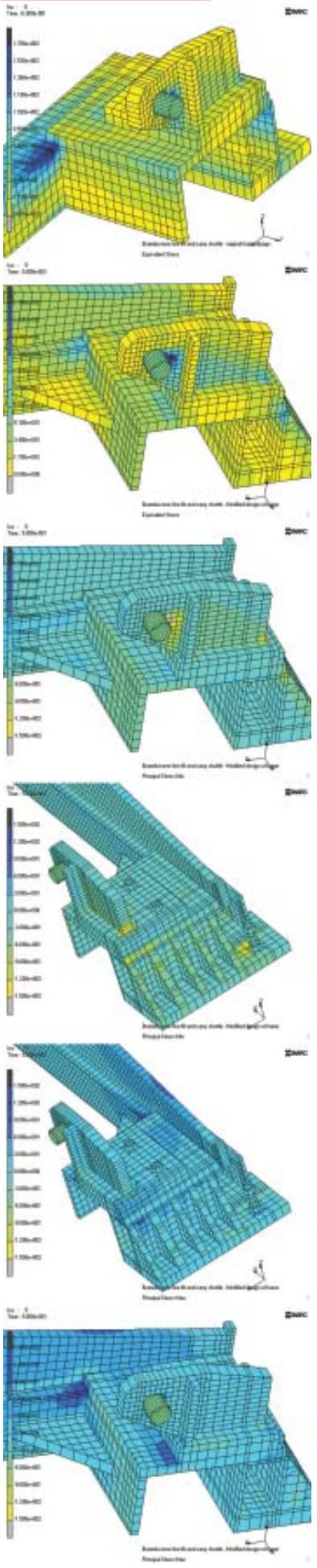
Failing Line at Chrysler; Zoom on Crack

Initial calculations in MARC™ were static. Plates and gussets were made of steel SAE 1008 (elasticity modulus of 199 GPa and Poisson's ratio of 0.3). Stress levels were used to test pre-cracked Compact Tension (CT) samples, and monitor the Crack Opening Displacement (COD) with cyclic loads, as per ASTM standards (Designations E399, E813 and E647). To ensure both central location, and correct engagement in the specimen, the gauge had knife edges for a special jig. A servo-hydraulic unit by *INSTRON* (cf: http://www.instron.com) was used at WIDL, to condition the signal output locating the knife edges, as any crack would potentially advance. Post-processing "load versus crack propagation", resulted in K_{IC} (or fracture toughness of the liner' steel).

COD Gauging at WIDL

Moreover, computer analyses of fatigue data generated at WIDL drew S-N (stress versus number of cycles) curves. Of importance to ensure safety under cyclic loading, the "fatigue limit" of steel making the liner was post-processed. This refers to the stress magnitude under which a crack does not propagate, even after "infinite" load cycles.

Initial modeling at WIDL, of the failing liner at *Chrysler*, was linear. Some analyses accounted for non-linear effects: plasticity and contact conditions at the loaded pin. In defining elastic-plastic behavior of the liner's material, a von Mises yield criterion was used, along with the associated Prandlt-Reuss flow rule. Fatigue analyses drew minimum and maximum principal stresses in Mohr circles. A Goodman Failure Index (G.F.I) assessed fatigue safety limits. Profiles of accelerations were drawn, as dynamic loads were included in transient FEA models. Measurements at *Chrysler* confirmed accelerations post-processed at several locations.



Stresses in Lifter in Operation

Following the localization of cracking, and translating numerical predictions to the assembly plant, several optimization analyses were completed at WIDL. The goal was to weld reinforcing plates and gussets at strategic locations, and attenuate inertial forces. In the end, FEA and the regulation of movement of the lifter increased strength, under both static and dynamic loads.