## Ramsay Maunder ASSOCIATES Finite Element Specialists and Engineering Consultants

## Fatigue Assessment of a Machine Component

This case study describes a failure analysis project in mechanical engineering undertaken by Ramsay Maunder Associates (RMA) for a component in a machine for pelletising china clay.

The pelletising machine comprises two counter-rotating perforated drums. The moist clay is fed between the drums and is forced through radial holes to form pellets.



Over time, cracks appeared in the drums adjacent to the central hub which eventually led to the drum shearing completely.





RMA conducted a detailed finite element stress analysis of the component and a fatigue assessment of the original design and a modified design where a ring of holes adjacent to the hub were removed. The drums of the palletising machine exhibited three planes of symmetry which were used to reduce the region that needed to be modelled to one-quarter of one drum.



The highly-stressed region of the drum is along the line of contact and adjacent to the hub where the bending moment is a maximum. In order to obtain accurate results in this region a locally refined region was embedded in the mesh.



The stress distribution in the highly-stressed region, whilst showing artificially high stresses under the line contact, provided a realistic picture of how fatigue cracks, similar to those seen in practice, might develop in the component.



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By considering the average stress on the lands lying between adjacent holes it was straightforward to rule out the possibility of shear failure from a single application of the load.



The peak stresses occurring on the land occur at the four corners and are, essentially, in the axial direction, i.e., they are driven by the bending moment. The stress at these points varies as the drum rotates and the finite element results can be used to establish the amplitude and mean stress values to be used in a fatigue assessment.

The fatigue assessment was conducted on the original design and on a modified design where the first ring of holes adjacent to the hub were removed. The bending moment drops rapidly as one moves axially away from the hub, and by removing the first ring of holes the maximum stress in the region drops considerably. The fatigue assessment was based on the conservative Soderberg approach and indicated that with the design modification, the component would have a significantly improved (possibly even infinite) fatigue life.

Thoughtful application of structural mechanics combined with careful use of the finite element analysis enabled the stresses is the drum to be simulated. With these stresses a fatigue life



prediction of the existing design was possible. The understanding of the mechanics developed here led easily to the proposed design modification which showed a significant fatigue life prediction. The client has implemented the suggested design modification and RMA wait with interest to hear how the modified design performs in service.

RMA regularly undertakes such work for clients and can be contacted at <u>http://www.ramsay-maunder.co.uk/</u>