A WEAKEST – LINK ANALYSIS FOR FATIGUE STRENGTH OF COMPONENTS CONTAINING DEFECTS

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ABSTRACT
A weakest – link model of three different strip steel samples has been developed to assess the fatigue limit of the steels on the basis of the steel inclusions content. The analysis is based on a discretization of a component into FE elements whose failure is correlated to the presence of internal inclusions inside the steel that overtake the critical dimension correspondent to the applied stress through the Kitagawa diagram: the failure of an element causes the failure of the entire sample.

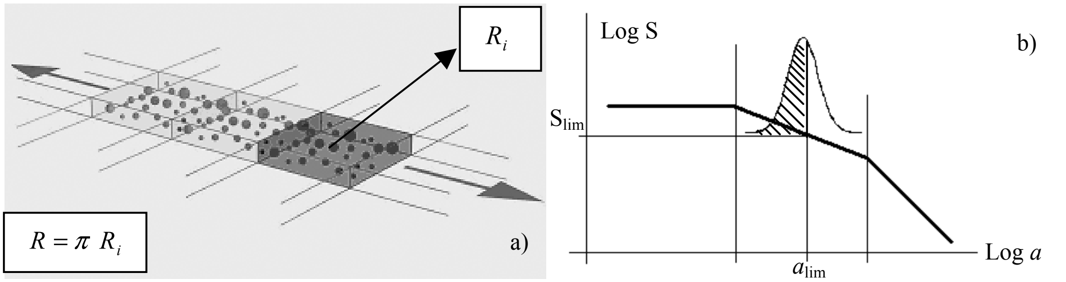

Figure 1: Basic concepts for the analysis: a) weakest link model; b) fatigue strength in presence of defects.

The analysis of the inclusions content is carried out by means of the Statistics of Extremes and in particular with 'Block maxima' method: the three strips are first compared for the cleanliness and after having developed the weakest – link model for the fatigue properties. For each steel the calculated fatigue limits obtained from the model in terms of probability density functions are close to the 'stair-case' fatigue tests. The model is able to well describe the 50% value of the fatigue limit obtained at mechanical tests but a narrower band of uncertainty is estimated as residual stresses and superficial defects are not considered.

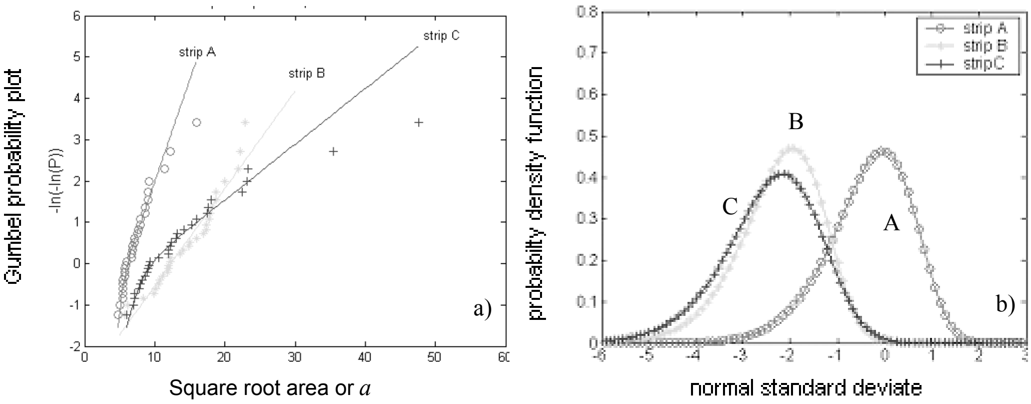

Figure 2: Weakest link analyis: a) extreme inclusion data for the three strips analysed; b) comparison of probability density function for the fatigue limit.

The comparison among the probability density functions of the strips helps understanding how far the effort for a better cleanliness in the strips should go in order to improve the fatigue properties.