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ARLEQUIN METHOD – APPLCATION TO WELDED STRUCTURE CALCULATIONS

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ABSTRACT

The fatigue strength assessment of most of welded structures is based on the concept associated with S-N approach, where S is the structural stress and N is the number of cycles to failure. This concept requires an efficient determination of the stress at the most dangerous region, for welded structures, it's around the weld (structural hot spot stress SHS). It is generally the most difficult point of the finite element modeling as the stress depends on the weld form, joint geometry, mesh size and also loading mode.

J.L Fayard and al. [2], [3] developed an efficient numerical tool which defines precisely the design stress state and allows the prediction of the fatigue strength of arc - welded structures. Based on the thin plate theory, Fayard modeled the sheets using a regular mesh of four nodes shell elements and rigid beams for the sheet links. This procedure has been tested with success for the MAG weld with the different loading modes. Nevertheless, modeling exactly Fayard mesh methodology is not always easy for complex structures, because this methodology requires compatible nodes and regular elements at the weld positions while in automobile modeling, each structure to weld is modeled by a different person, and moreover, the weld position is unknown at this step.

Therefore, our idea is to find a solution which allows to apply this mesh methodology on the initial structure meshes (where the nodes are incompatible, and the meshes are irregular) without any complex mesh modification. The solution chosen is the Arlequin method. This method was first proposed by Ben Dhia [1]. It is based on the principles of energy partition and displacement kinematical link. It aims to propose a model which allows the modeling of structures by different superimposed meshes ? $_1$ and ? $_2$. These two models are glued using a coupling term in the overlapping zone ? $_c$ (Fig. 1).

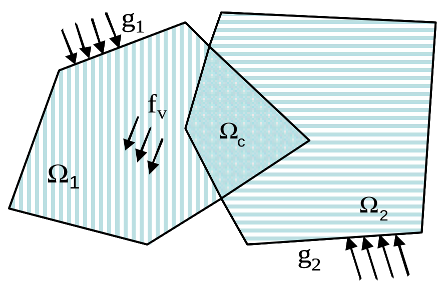

Fig. 1: Arlequín Model

We have implemented the Arlequin method in the Abaqus finite elements software by creating Alequin User Elements (UEL). This element is composed of two superimposed elements of two models in the glued area. So, the number of Arlequin Elements is the number of couples of superimposed elements in glued zone.

We present in following numerical example (Fig. 2) one pipe welded with a plate sheet computed using the Arlequin method. The welded area is modeled in order to respect the Fayard methodology and then glued with the plate model (which is meshed separately and freely) at its two boundary element layers. Its hot spot stress is compared with a referent model which does not use the Arlequin calculation. This result illustrates the method accuracy.

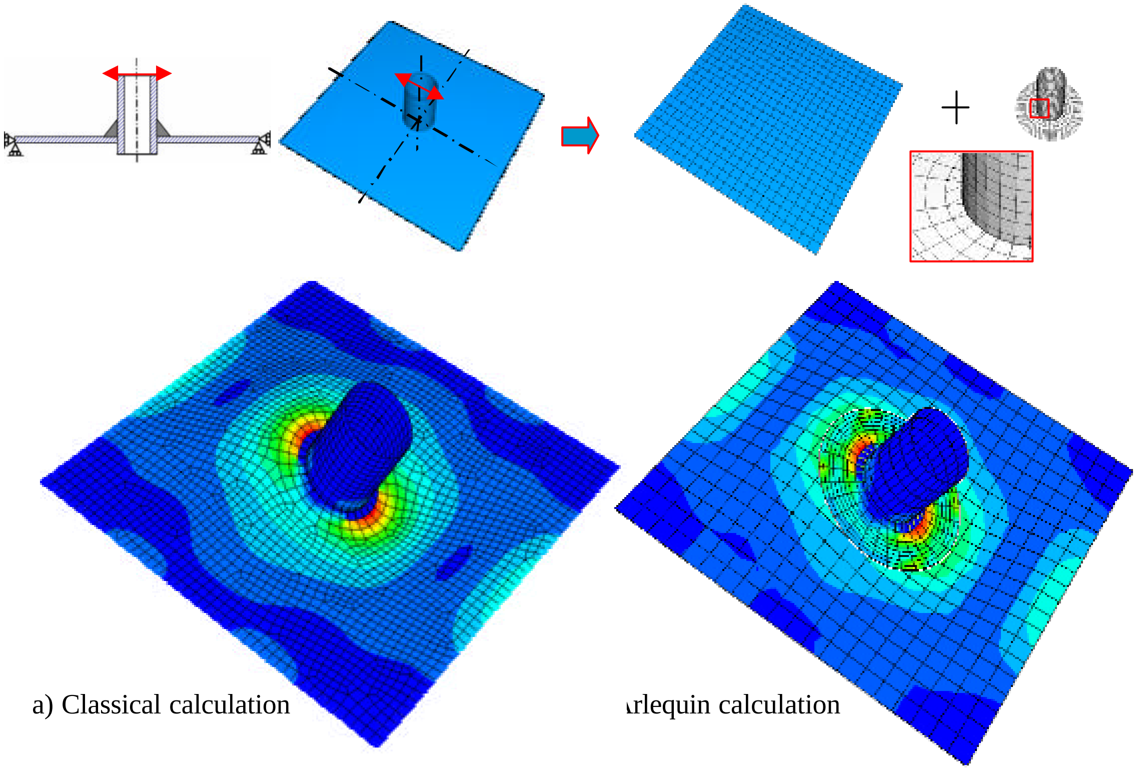

Fig. 2: Comparison of Arlequin calculation and classical calculation

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