Finite Element Models for Multipass Rolling, Cooling and Distortion

Product Modelling & Control Group

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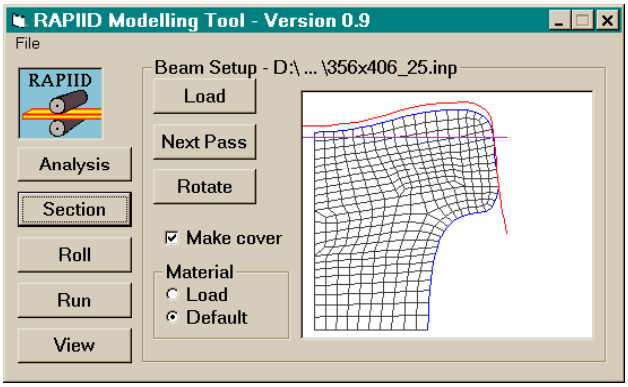
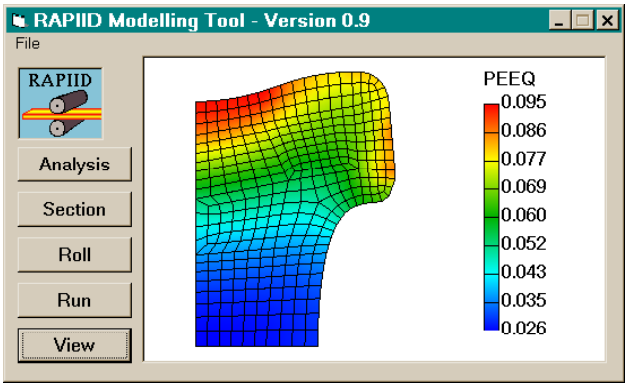
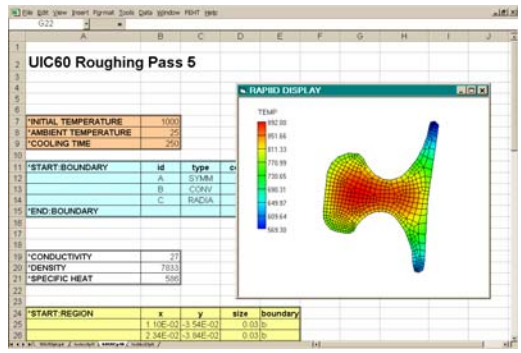
The Product Modelling & Control Group within the Long Product Rolling Department has developed a range of numerical tools and techniques for predicting the evolution of process and product properties during multipass rolling, cooling and straightening. The group, which has a wide technical skill base covering computational mechanics, IT, metal forming, constitutive material modelling, tribology and process control has successfully developed a suite of Finite Element, Finite Difference, Finite Prism and post processing tools for predicting and tracking metal deformation during multipass hot rolling and roll pass design, temperature during cooling of any arbitrary shapes (taking into account phase transformation) and subsequent distortion to address both off-line and semi-production environment and computing platforms (UNIX, Wintel systems). These tools have been developed to address key drivers such as rapid prototyping, data encapsulation, process/product optimisation and computing time.





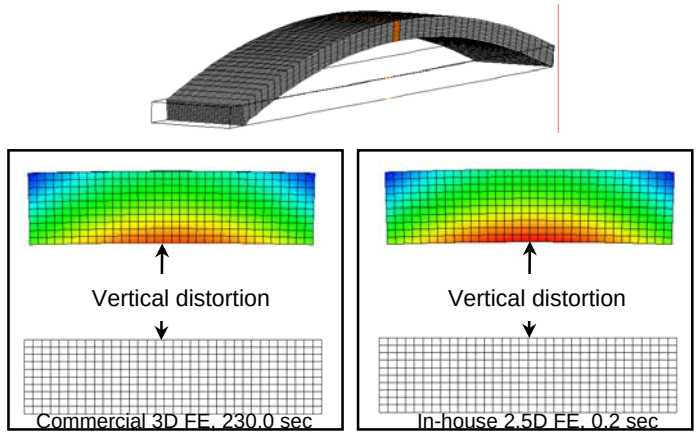
RAPID PROTOTYPING RAPID 2.5D FEM CODE

Amongst these numerical tools, RAPIID is a customised 2.5D FEM code based on ABAQUS which predicts shape, roll force, torque and elongation of any flat and long product sections. Predictions which are within one minute per pass have been validated against 'standard' 3D FEM simulations. The code is available on NT and Windows 2000 platforms.



RAPID 2D FEM HEAT TRANSFER FEHT

Understanding of cooling of sections is key to the achievement of minimum distortion prior straightening, together with the required structure-property and residual stress level following solid state transformation. Recently, a suite of in-house FEM/Finite Prism codes, written in Fortran 90 has been developed to predict temperature evolution during cooling (FEHT) and subsequent distortion (FEDIST), making them suitable to be run in advisory mode in Works-based-environment. These techniques are uncoupled (thermal/stress analysis), and are applied sequentially to model specific sections under given processing conditions. These codes are modular, run at least 300 times faster than conventional commercial 3D packages and can be coupled to Excel or encapsulated within a GUI environment such as Visual Basic or Delphi.



Benefits to be gained using these tools are:-

- **rapid property and process predictions**
- **what-if scenarios for process and product improvements (scheduling, cooling, distortion)**
- **reduction in mill trials**
- **ability to perform optimisation**