MEXT Post-K Priority Issue (8)

Development of Innovative Design and Production Processes that Would Lead the Way for the Manufacturing Industry in the Near Future

GRADUATE SCHOOL OF FRONTIER SCIENCES

Sub-issue E Research and Development of Advanced Press Forming and Welding Simulators for New Materials

- Avanced welding simulation technologies are developed based on an open-source parallel FEM software, "FrontISTR", for increasing accuracy and speed of welding sequence definition and inverse strain estimation.
- Advanced welding simulation technologies will be introduced to manufacturing floors and it leads to advancement of manufacturing such as reduction production time, cost down, independence of trial & error by skilled workers and development welding methods for new materials

Target Problems

- Permanent deformation predictions on the scale of the entire mast assembly for a jib climbing crane
  An welding sequence which can reduce clearances produced by thermal warpage is defined with high accuracy and speed in normal welding
- Permanent deformation predictions on the scale of the entire ladder frame with suspension members
  Estimation time of inverse strain with welding analysis software is reduced from 40 days to 10-20 minutes.

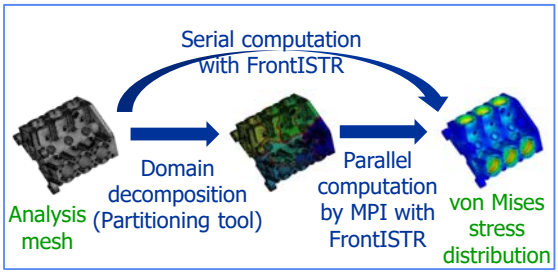
Simulator Developed in Sub-issue E

- The previous "inherent strain method" is not used and elastoplastic analysis is performed for the entire analysis domains.
- High-resolution (mirometer-scale) computation in a melting section for an analysis domain of meter-scale frames of automobiles and heavy machinery
  The total number of elements needed to resolve micrometer-scale sections in a meter-scale analysis domain: some hundreds of billion–some trillions (with mesh density)
- Strongly coupled analysis of temperature and displacement fields (heat conduction/elastoplastic deformation)

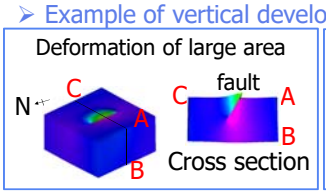
Achievements of "FrontISTR"

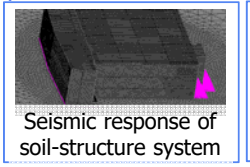
- Example of horizontal development

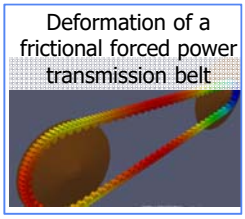
  Users group, "FrontISTR Forum"
  http://www.multi.k.u-tokyo.ac.jp/FrontISTR/index_en.php
  - This forum was inaugurated in April 2013 and the regular meeting was held 30 times until September 16, 2016.
  - The total number of FrontISTR Forum members: 523, The total number of participant companies: 212 (June 19, 2016)

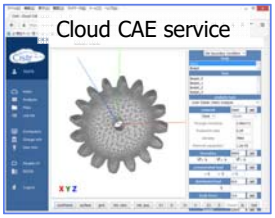


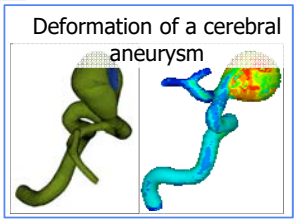
- Example of vertical development

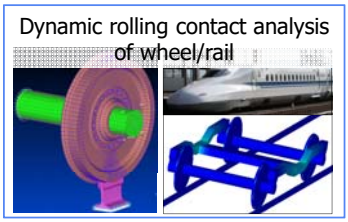


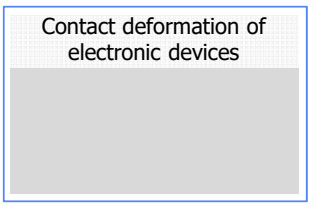


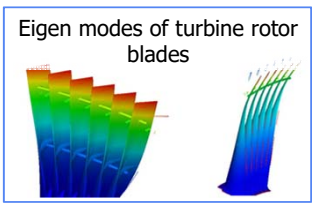


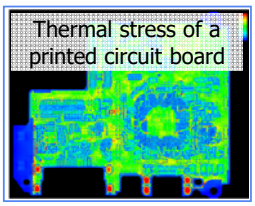


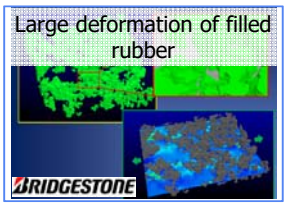












Approach

Ultra-large-scale/high-accuracy strong-coupling solver

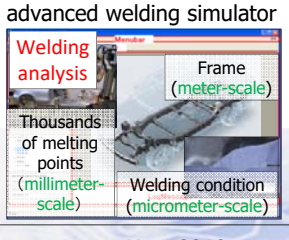
- Parallel iterative method for large-scale analysis of assembly/contact problems
- Large-scale strong coupling method for thermoelastoplastic problems
- Welding analysis method that considers spring-back during press forming

Press forming analysis (auxiliary tool)

Analysis of the series of processes of press forming and welding

Considering spring-back

Pre/post-processor for the advanced welding simulator



Nov. 2016

http://www.ciss.iis.u-tokyo.ac.jp/postK/