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imws

IDENTIFICATION OF FAILURE MODES OF CLT PLATES BY MEANS OF DIC-MEASUREMENTS

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MOTIVATION

Focus of interest:

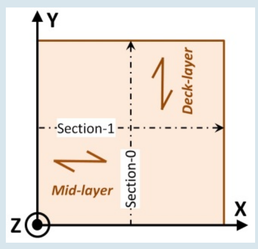
- ❑ Load carrying behavior of CLT plates subjected to concentrated loading
  - ➢ Knowledge about elastic limit, nonlinearities, and collapse load
- ❑ Impact of different strength classes
  - ➢ Database for subsequent probabilistic approach
  - ➢ Check if there is possibility of even higher post elastic collapse loads
- ❑ History of crack formation
  - ➢ Indications for subsequent numerical modeling strategies
  - ➢ Validation of more sophisticated plate theories
- ❑ Background for overcoming of limits within the traditional design of EC5
  - ➢ Visualization of failure mechanisms for sake of convincement

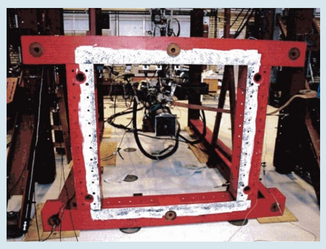
Measurement tasks:

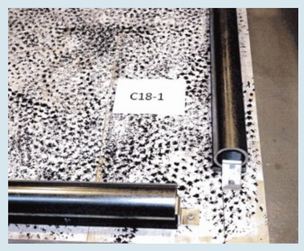
- ❑ Distinction of plate areas highly stressed by shear forces out of plane by displacement fields and multi section plots
- ❑ Visualisation of load redistributions due to crack formations by strain fields
- ❑ A posteriori identification and separation of local irregularities from global homogenised results as expected from numerical modelling for homogeneous material profiles.
- ❑ Scan for software facilities concerning evaluation of data for best illustration of different failure modes
- ❑ Monitoring of crack formation for later linkage to the system response of the structural system.

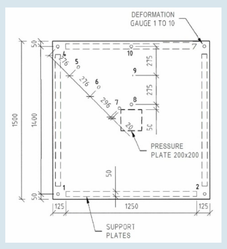
TEST SETUP AND SYSTEM RESPONSE

Test setup



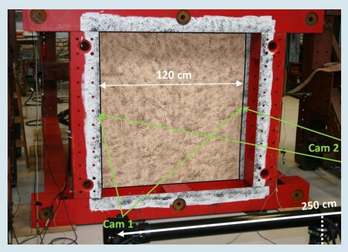


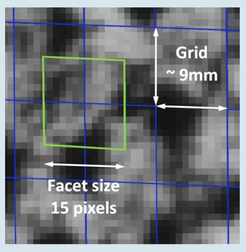




- ❑ 24 tests with quadratic 3-layered CLT plates subjected to concentrated loading
- ❑ Vertical test setup caused by the needs of the planned DIC-measurement system
- ❑ Circumferential support with possibility of free uplift (span 1400x1400 mm)
- ❑ Displacement control for concentrated loading at the plate center
- ❑ Dimensions: Size 1500x1500 mm; thickness 57 mm (=19+19+19)
- ❑ Material profiles: Strength classes C18, C24, C35 (according to EN 338) = 8 specimen per strength class

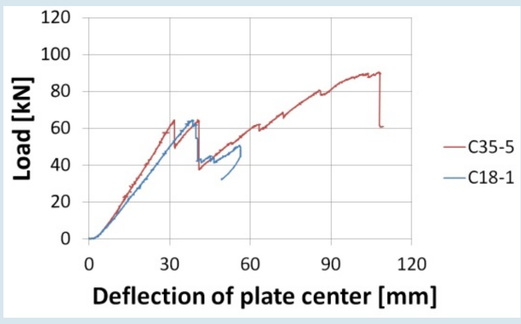
Setup of measurements





- ❑ 3D DIC-measurement system (ARAMIS)
  - ➢ 2-cam system (4 megapixels)
  - ➢ Grid size 9 mm, facet size 15 pixels
  - ➢ Application of the coarse speckle pattern via brush system due to the over size of the specimen
- ❑ Some LVDTs for redundancy purpose

System response



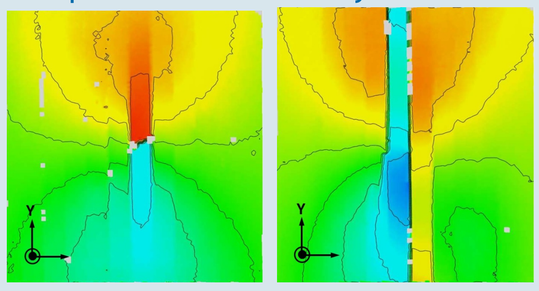
Typical load displacement curves:

- ❑ C35-5: Significant load drop but recovery at a higher collapse load
- ❑ C18-1: Significant load drop, but collapse load < elastic load!

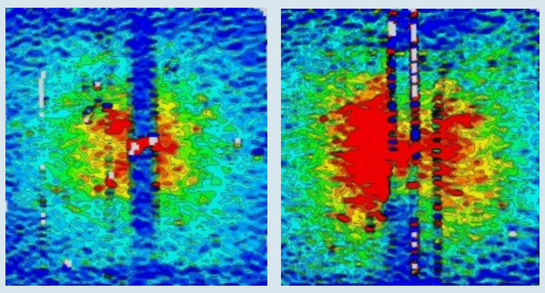
DIC RESULTS

Identification of failure modes

- ❑ Tensile failure: Opposite color at location of rupture
- ❑ Shear failure: Associated color indicating rigid body movement

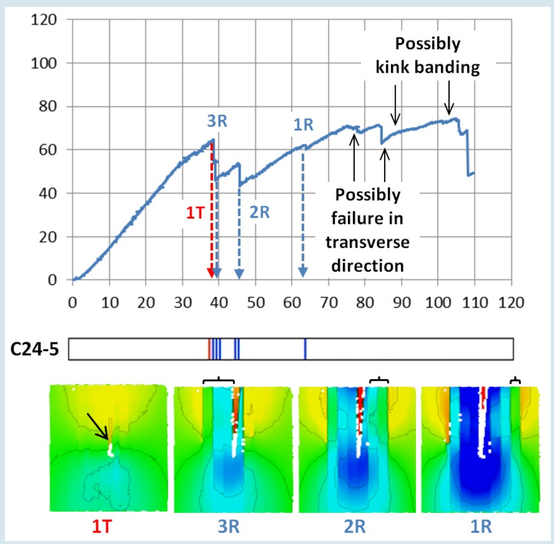


A. Illustration by y-displacements
   - ➢ Extension and type of the failure mode



B. Verification by y-strains
   - ➢ Indication for load-redistribution

Linking with system response

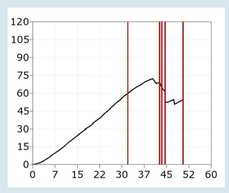


Legend: T=tensile, R=rolling shear-failure

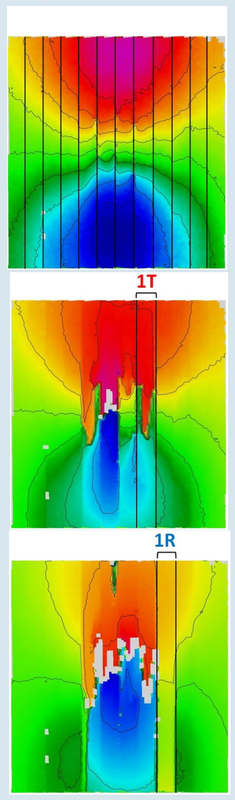
- ❑ Assignment of typical crack formations to significant changes of the load displacement curve
- ❑ Compilation per test sample
- ❑ Illustration of crack formation: Decrease of tensile failure with increasing strength class

Sequence of crack formation (y-displacements)

Dominance of tension failure (T)

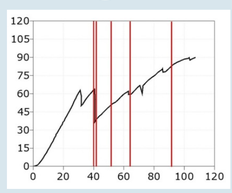


Stages of local failure (a-e)



Note: Change of failure mode at e)

Dominance of rolling shear failure (R)



Stages of local failure (a-e)

Note: No change of failure mode !

LESSONS LEARNED

Structural assessment:

- ❑ DIC measurement systems are a powerful tool for monitoring crack formation
- ❑ Strain fields scaled by stiffness parameters reflect quite well the stress fields and load redistributions predictable from numerical modeling
- ❑ Strength properties of the boards highly affect the characteristics of plate punching failure

Future projects:

- ❑ Identification of kink-banding
- ❑ Compilation of data from concurrent but independent 3D-measurement systems for volumetric assessment e.g. with respect to plate thickness
- ❑ Link of surface data to internal crack formation
- ❑ Prediction of elastic and collapse load by numerical modeling

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