

FAIR-CT96-1638

**EXTENDING MARKETS FOR WOOD-BASED PANELS BY
DEVELOPING A BETTER UNDERSTANDING OF SHEAR TEST
METHODS AND BOARD SHEAR PROPERTIES**

Abstract of the Final Report

- Type of contract** : Shared-cost research project
- Total cost** : 1048 kECU **EC contribution** : 524 kECU (50%)
- Commencement date:** 1 December 1996 **Duration** : 36 months
Completion date : 30 November 1999
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1. OBJECTIVES

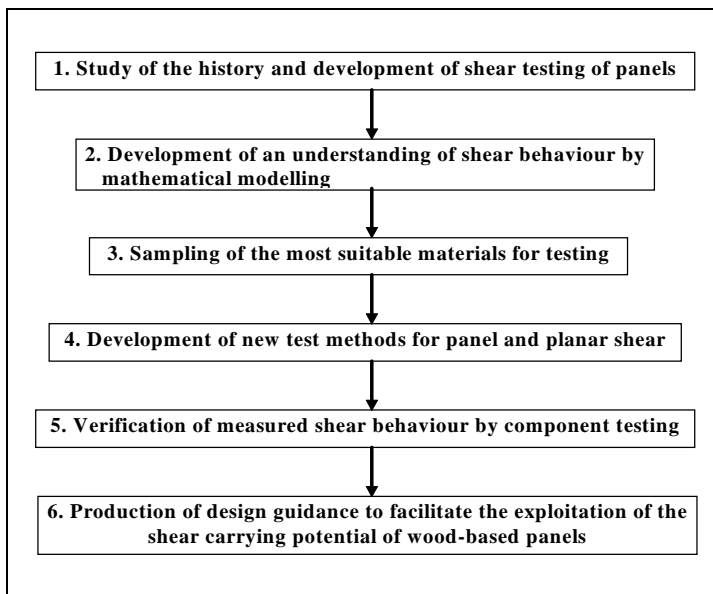
The work summarised in this report was supported under the EC FAIR programme under Contract No. FAIR-CT96-1638. The contract ran from 1 December 1996 to 30 November 1999. The principal objective of the project was to facilitate the increased use of wood-based panels in applications where they are required to carry high shear forces, by developing a better understanding of shear test methods and board shear properties and how these relate to the design and behaviour of components and structures. Within this principal objective were a number of specific sub-objectives, as follows:

1. To develop an understanding of the EN789 test method for Panel Shear and its interrelationship with panel structure and properties.
2. To develop and validate a test method for Panel Shear meeting agreed criteria:
3. To develop an understanding of the EN789 test method for Planar Shear and its interrelationship with panel structure and properties.
4. To develop and validate a test method for Planar Shear meeting agreed criteria:
5. To consider the potential application of the more reliable panel and planar shear values in structural use and to identify ways of exploiting this potential. This will involve safer and more efficient use of panels in existing structure types and possibilities for new forms of structure/component which are not currently practical or economic

2. METHODOLOGY

The project was broken down into four main tasks and a series of sub-tasks. Some of the sub-tasks related to improving the European standards for the testing of panels and components with the aim of improving the efficiency of utilisation. One task related specifically to the development and promotion of new markets, and new forms of components and structures. The main flow of the project can be summarised in Figure 1.

Figure 1. Main stages of the project



3. RESULTS AND DISCUSSION

3.1 Materials selection and sampling

The materials chosen for the test programme are listed in Table 1. The data derived from the materials testing tasks would also be used in the component tests so common materials were required for all tasks. Some of the materials were selected as being representative of those commonly used in practice, others were selected as being particularly difficult to test in shear.

Table 1: Materials used for the test programme

CBPB	18mm cement bonded particleboard to EN634
MDF	28mm MDF.LA to EN622-5
PW	15mm thick veneer conifer plywood to EN636-3
OSB	16mm OSB/3 to EN300
PB	22mm particleboard to EN312-7
HB	8mm hardboard to EN622-2

3.2 Development of panel shear test methods

An initial study of shear test methods formed the basis for the testing and modelling work. Information was gathered using keyword literature searches and by sending questionnaires to relevant standardisation committees and research institutes. This gave an insight into the history of panel shear testing and concentrated in particular on experiences with the EN789 panel shear test method. Modifications to the EN789 test method were discussed and were investigated by mathematical modelling. Selected EN789 variants and alternative methods were investigated experimentally.

The mathematical modelling of the EN789 method showed very high stresses in the corners of the panel, which increase rapidly close to the corners. In reality, there will be a re-distribution of the stresses due to the plasticity of the panel material. The modelling predicted failure in tension or compression with crack propagation starting in the corners of the test specimen, which is in accordance with experimental findings.

The orientation of the supports in the original model induced tension stresses in the specimen. To reduce the tension stresses the supports and the loading point were reoriented so that the test piece rails were vertical. The new configuration of the supports resulted in significantly lower tensile stresses in the corners. The compression stresses were still high which meant that problems were expected with brittle materials. Further modifications were made to reduce the compression stresses in the specimen. In order to remove the sharp section change between the panel and the rail, a specimen with a radiused outline between the panel and the rail was used. The radius reduced the calculated compression stresses and the tension stresses were almost eliminated.

The finite element analysis resulted in a series of test set-ups that were considered to be worthy of further investigation. The four basic geometries used were as follows, shown in Figure 2 (from left to right):

- Standard EN789 (EN789)
- EN789 with test piece cut at an angle (EN789T)
- NORDTEST 0° method (NT)
- Radiused NORDTEST 0° method (NTR)

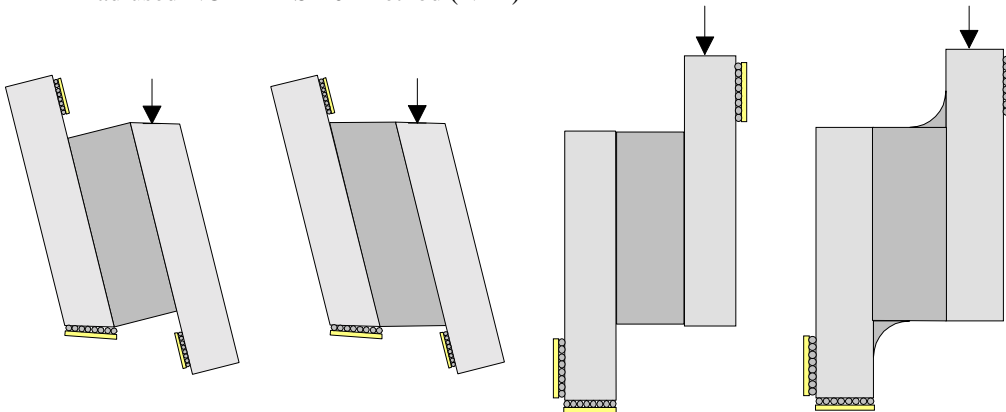


Figure 2 Specimen geometry and test set-up for four models chosen to be used in Task 2.1.3.

The test rigs used for the EN789 and NORDTEST procedures are shown in Figures 3 and 4. A programme of testing was carried out and the NTR method appeared to give higher strength and modulus. The strength values were higher than with the standard EN789 method. The percentage of shear failure was higher for the materials tested by using NT and NTR than by EN789 and EN789T. As a result, the NTR method was selected as being the “optimum” method. A test based on NT Build 315 was developed as a means of quality control.

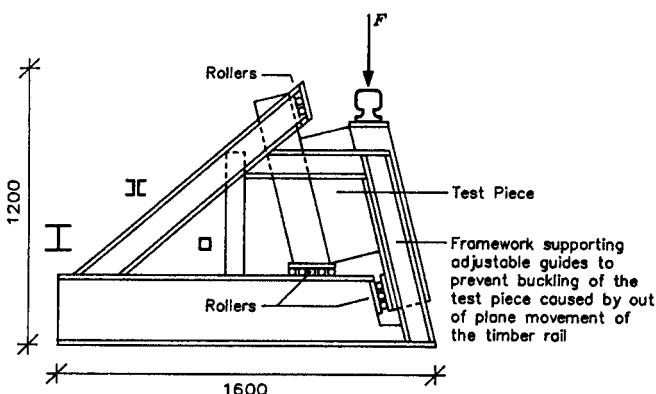


Figure 3: Test set-up for test types EN789 and EN789T

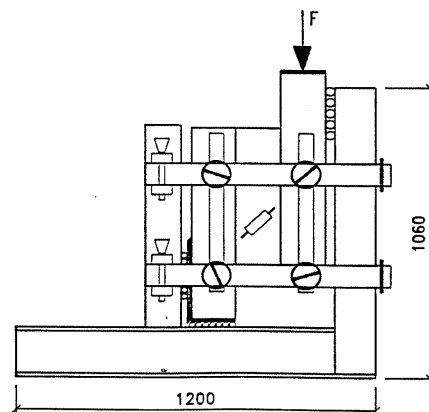


Figure 4: Test set-up for test types NT and NTR

3.3 Development of planar shear methods

The initial study of planar shear formed the basis for the test programme and the mathematical modelling. Information was gathered and utilised in the same way as for panel shear. Potential modifications to the EN789 test method were discussed and were investigated by mathematical modelling. Tests were then carried out with selected EN789 variants and alternative methods.

The planar shear test specimen given in EN 789 was modelled using finite element methods which highlighted two serious problems:

- shear stress is not evenly distributed along the specimen length. Two distinct peak values occur near the ends
- A high transverse tension stress arises at the unloaded end of the panel-steel boundary

In order to obtain a more evenly distributed shear stress and to minimise the transverse tension stress the effects of several modifications to the planar shear specimen given in EN 789 were modelled. As a result, four variants of the EN789 procedure were agreed for experimental investigation, as shown in Figure 5

- standard EN789 method (extreme left in Figure 5)
- 45° angle plates (second left in Figure 5)
- VTT 0° method with roller supports (third left in Figure 5)
- DTI disposable plate system (extreme right in Figure)

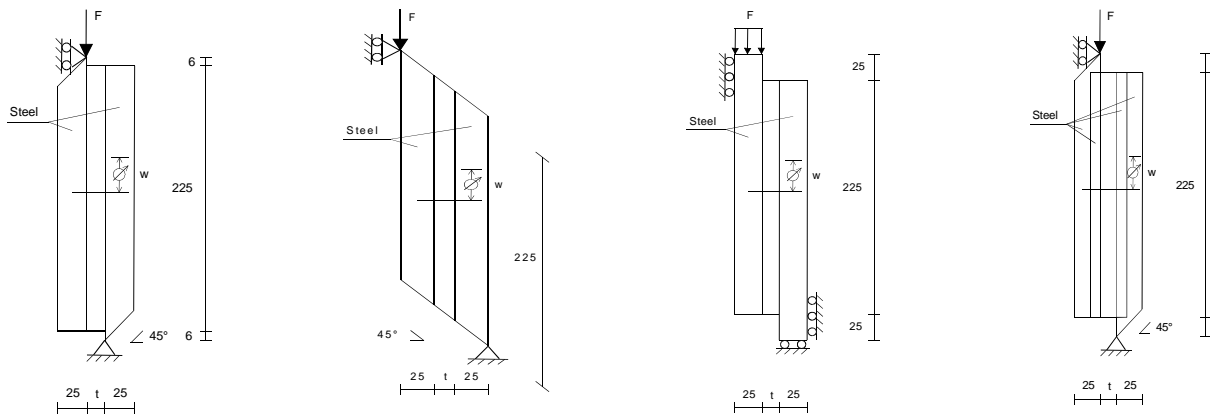


Figure 5. EN789 planar shear variants

A programme of testing was carried out and the 0-degree samples were found to be the easiest to produce and the safest to handle. Generally, based on both strength and modulus, 0-degree appeared to give the optimum performance and was therefore selected as the preferred method.. The strength values were higher than with the standard EN789 method. A block shear test based on DIN 52 367 was also developed as a means of quality control.

3.4 Exploitation of shear properties

Tests were undertaken to verify that the behaviour of the panels in components was in line with that predicted by the measured shear properties. The applications considered were:

- ◆ timber flanged I-beams
- ◆ timber frame wall panels
- ◆ concrete formwork

Tests were carried out on a range of materials selected from those tested earlier in the project. In general, the behaviour of the components was in line with that predicted by the material properties, but it was found to be very difficult to obtain true shear failures in the components.

Design studies were also undertaken in order to identify forms of component or structure that could be made more commercially viable by the availability of improved shear values. These included principal thin-webbed box and I-beams, timber framed walls, concrete formwork and stressed skin floor panels. These studies concluded that the greatest scope for exploiting better shear properties is in thin webbed beams, portal frames and stressed skin panels. In most other applications deflection or other strength properties were nearly always the limiting parameter.

4. CONCLUSIONS

This abstract summarises the research carried out to develop improved test methods for measuring the panel and planar shear properties of wood-based panels. Drafts of the recommended new methods have been sent to CEN TC112 WG4, together with suggested quality control procedures. It is believed that the new methods will provide more reliable design data for shear properties and this in turn should lead to more exploitation of the shear properties of wood-based panels. The design studies carried out indicate that shear is only a critical parameter in a small number of situations and improved shear design values alone do not generally have a major impact on a design. There is also therefore a need for better design guidance and information for specifiers/designers.