New machine settings for higher strength classes for UK grown Scots pine

Chris Holland

Materials and Engineering

Aims of the project

- **Explore the potential for higher machine settings for the UK as a whole.**
- **Derive machine settings for the GoldenEye X-ray grader and higher strength classes for bending type machines.**
- **Start the repositioning of the UK based timber industry to be more competitive in response to European harmonisation of the structural timber codes**

bre

Why higher machine settings for Scots pine?

- **Higher machine settings can open new markets for the resource – glulam or TR 26.**
- **Help compete against European competition.**
- **Of the four timber that can be machine graded (Sitka spruce, Douglas fir , Larch and Scots pine) Scots pine offers the best technical / commercial possibility of success. Though larch and Douglas fir would both be appropriate, the supply has been limited but is growing.**

bre

The material

- **The material has been drawn from several sites around Scotland, and one site from England.**

- **The sites are:**
  - **Balmoral – Aberdeenshire**
  - **Alvie and Dalraddy – Aberdeenshire**
  - **Moray Estate – Moray**
  - **Seafield – Strathspey**
  - **Strathcarron – FC site 40 miles north of Inverness**
  - **North Strome - FC site 60 miles west of Inverness**
  - **Black Isle – FC site north of Inverness**
  - **Deeside (Supplied by James Jones, large sizes 200 and 225mm)**
  - **Thetford –England still under negotiation**

bre

Conversion and data recording at James Jones

- The majority of the material was converted from log at James Jones Aboyne mill – some was supplied converted by Gordon's.
- Both structural material and falling boards were selected to support both projects.
- Forest Research carried out their data collection for the work they are doing on pine quality before and during conversion
- The sawn material was passed through the X-ray grader and MicroTech collected the X-ray grading data for later derivation of machine setting for that grading machine.
- The material was supplied to BRE.

Data collection at BRE

Nature of the work being carried out at BRE

- Data collection using the BRE Cook-Bolinder strength grading machine – to collect data for new settings and to indicate position of the test centre for determination of strength, stiffness and density.
- Breaking the material to establish strength stiffness at the failure point and whole piece density.
- Carry out the analysis of the results and pass on the results to MicroTech for the derivation of X-ray grader settings, Forest Research for their work on pine quality, and possibly Tony Fewell for new bending settings based on the new data base generated.

Work being carried out at BRE

The work is as follows:

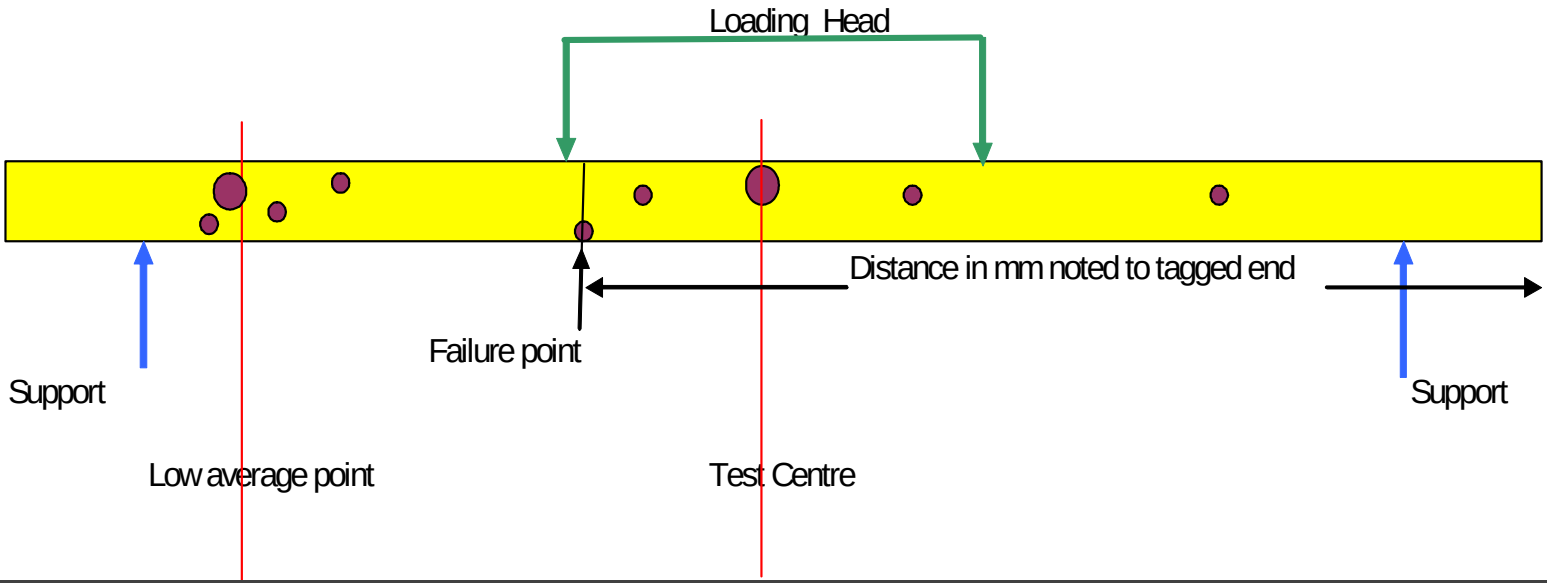
- Over 200 pieces have been tested and all the data has been collected.
- The analysis of the results is underway and the results for just under 200 pieces will be reported as part of this presentation.
- Some initial trial grading has been carried out both theoretical (based on the values for strength, stiffness and density) and grading based on trails settings derived from the old Scots pine data base.

Determination of Test centre

- The results obtained will vary greatly depending on where the timber is tested. So to be as accurate as possible in determining the 5th value for strength and the associated stiffness, testing should be carried out (wherever possible) at the weakest point on the timber.
- However, it is not always possible to test at the weakest point so an alternative point is chosen (second weakest spot where possible).
- But it does not always fail at the test centre so where failure does occurs the position has to be noted and referred back to a known grader value or position on the specimen (from a constant reference end).
- All this data is gathered in case it is needed at some point in the future

bre

Illustration of points on testing



Results

Based on approximately 200 pieces in 3 sizes

- The sizes are:
  - 47mm x 100mm
  - 47mm x 125mm
  - 47mm x 150 mm

Total population: Innate structural quality

Adjustments made:

- Strength at 5th percentile adjusted to 150mm depth
- Stiffness adjusted to 12% moisture content and to E-Cen
- Density to 12% moisture content

• Strength = 19.9N/mm^2	(16.11)	(19.45)
• Stiffness = 15825 N/ mm^2	(8754.12)	(12374)
• Density = 495.8 kg/M^3	(423.25)	(477)

Trail grading based on actual values

STRENGTH CLASS	YEILD (%)	PROPERTIES		
		STRENGTH N/mm^2	STIFFNESSS N/mm^2	DENSITY Kg/m^3
C24				
Actual achieved	87	23.8	10960	435
Target		21.42	10450	420
C27				
Actual achieved	64	25.75	11030	451
Target		24.1	10925	450
C30				
Actual achieved	36	29.35	113850	461
Target		26.78	11400	460
C35				
Actual achieved	10	31.9	12420	481
Target		31.35	12350	480

Grading by new machine based on the old data base

Overall position is not promising

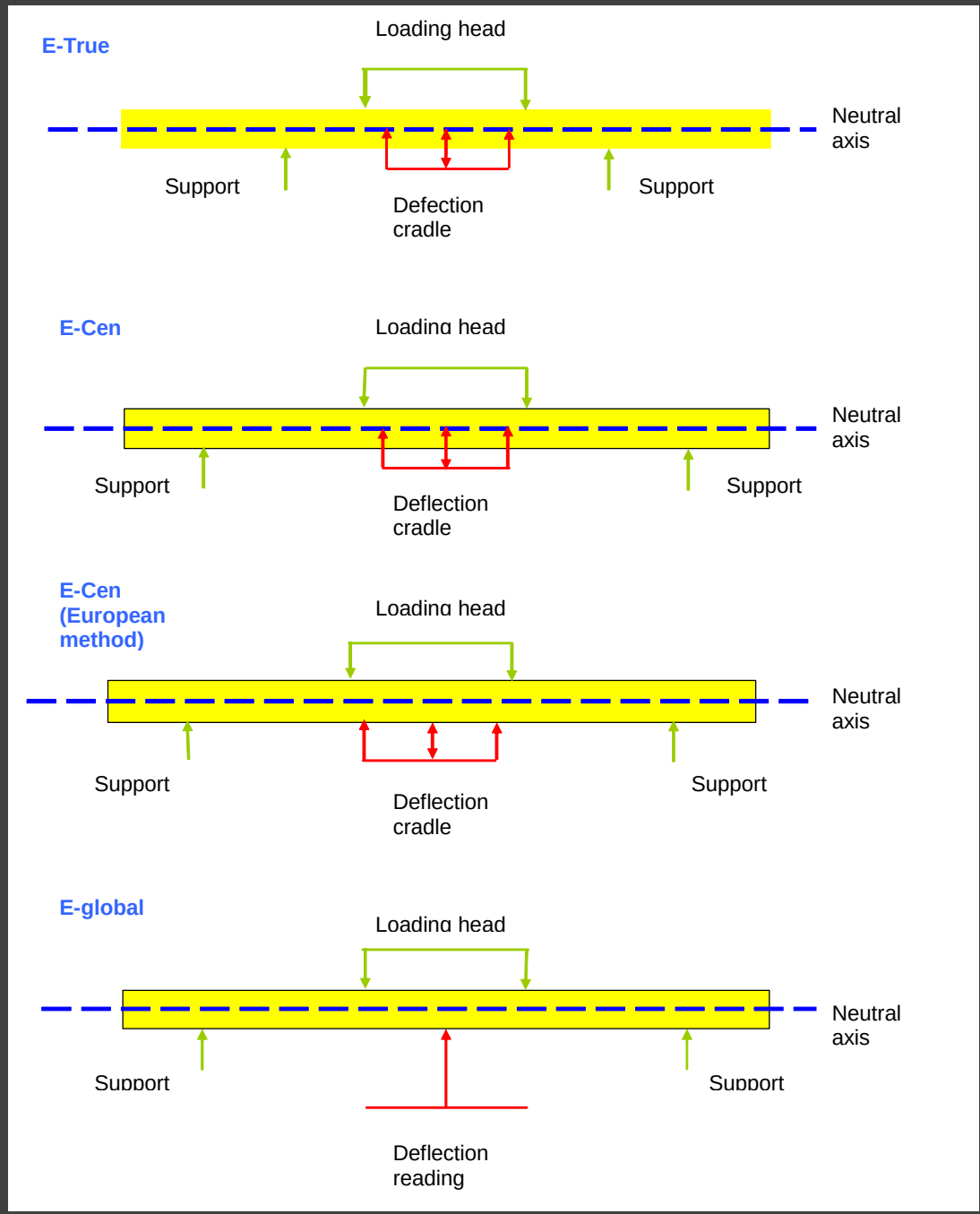
- The yield for C24 was 30%
- The yield for C30 was 4%
- It was not worth checking the rest
- This does not fall inline with the theoretical grading – why?
- Theoretical grading always give slightly better results but not usually that much better. The disparity may lay within the old data base and relates to the measured stiffness associated with the strength / grader values.

bre

Possible explanation

- The old data base results from work carried out at BRE in the late 1980's and early 1990's when all the UK's structural species (Sitka spruce, Scots and Corsican pine, larch and Douglas fir) underwent a major re-evaluation.
- At that time European harmonisation was underway and a new European testing method for stiffness (later to be included in BS EN 408) E-Cen replaced the E-True method used for BS 5268 stresses.
- E-Cen is a shear free method of determining stiffness and should be measured within the shear free zone of the loading head along the neutral axis.
- It was discovered most Europeans did not test at the neutral axis as it was too complicated and time consuming but measured stiffness of the bottom face of the specimen. This gave two completely different sets of results. Subsequent work with SP in Sweden on 150 pieces of Scots pine showed the results for the bottom face was approximately 6% higher than testing at the neutral axis.
- This led to the introduction of the E-global as the standard method of stiffness determination (tested off the bottom face). E-global is related back to shear free E-Cen (EN 338 strength classes) by a formula in BS EN 384.

Possible explanation continued



Possible reason continued

- If the measured stiffness is 6% less than the associated strength this has implications for the machine settings.
- The aim of the machine settings is to ensure that the population that is selected by the grading process for any particular strength class meets the requirements for strength, stiffness and density, say C24:

C24 strength class			
	Strength (N/mm^2)	Stiffness(N/mm^2)	Density (kg/m^3)
EN 338 table values	24	11000	420
Target values	21.42	10450	420

- Therefore if stiffness or any of key properties are lower than the target then the indicating parameter must be increased until all the properties meet or exceed the target requirements.

bre

Conclusions

- **The test results, so far, look promising in that they contain high values for strength and good values for stiffness and density.**
- **The theoretical grading looks promising and this will continue to be reviewed as the work progresses.**
- **The grading to new machine settings based on the old Scots pine data base are highly disappointing. However, at this stage we think we know why this is the case. There was always the possibility that this would be the case so such a result is not such a great drawback.**

bre