Machine Stress Grading & Quality Assurance

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Wood Processing and Products

Machine Stress Grading

Relies on a relationship between the stiffness of the timber as measured by the machine stress grader (MSG) and the stiffness and strength properties determined by the Quality Assurance testing.

Timber has to be broken to measure its characteristic strength, so only a small (but representative) sample of timber produced is tested.

Proof load testing for strength can be used.

There is a trade off between the number of samples tested and the accuracy of the estimate of the characteristic strength of the entire production.

The verification standard used is NZS3622:2004.
Machine Stress Grading

There are two important stages in an MSG operation.

1a). Monitoring the performance of the machine stress grader in terms of:
- Setup, Calibration, Accuracy, Repeatability, Consistency

1b). Application of the visual override. (The visual override is applied to help achieve the strength properties and satisfy customer acceptance criteria)

2. Quality Assurance – what are the actual properties and are the characteristic properties being achieved.

Thresholds are set for the upper and lower limits of the MSG Grading Parameter (ie. \( \text{MoE}_{\text{pmin}} \)).
- The upper limit is equal the lower limit of the next highest grade etc..
- In service, if the quality assurance results show the timber properties to be below that specified for the grade, then usually the lower grade threshold is adjusted upwards.
- This adjustment should remove some of the poorer timber from that grade and put it into the grade below.
- Thus two grades are affected.
- Ideally the on-going quality assurance testing is used to check the effectiveness of this adjustment.
Machine Stress Grading

MSG in NZ & Australia is:
• Normally limited to a 50mm thick board, however it is practical to MSG a board up to 75mm thick.
• Timber for MSG is almost always gauged prior to grading.
• The timber is almost always graded in the dry state, however it possible to grade green gauged timber.
• Mechanical stress grades are based on dry timber ie.. if the timber is graded when green the machine is set up to spray the appropriate dry mechanical stress grade.
• The new sonic graders (A-Grader) can grade green/dry rough-sawn/gauged timber.

MSG Machines

There are several different types of machine graders in use and under development:
• Constant load machines
• Constant deflection machines
• Joist grading machines
• Sonic grading machines.
• Others, X-ray, Microwave, vibration etc..

Dependent on the machine type, different grading parameters are used. However the best way to judge a machine is by the quality of the timber produced and the effect on grade recovery.
**Constant Load Plank Graders**

**Mode of Operation**
Applies a constant load and measures the resultant deflection.
Can calculate both $\text{MoE}_{\text{average}}$ & $\text{MoE}_{\text{minimum}}$

**Computermatic (150m/min)**
**Eldeco Dart (250m/min)**
**Cook Bolinder (150m/min)**

The stiffness measurement is repeated at intervals along the length. 700mm each end is not graded.

**Constant Deflection Plank Graders**

**Mode of Operation**
Applies a constant deflection and measures the resultant load. Bends timber in both directions.
Can calculate both $\text{MoE}_{\text{average}}$ & $\text{MoE}_{\text{minimum}}$

**Metriguard CLT (450m/min)**
**Metriguard HCLT (600m/min)**
**Lakeland MSG (300m/min)**
Joist Grader

Mode of Operation
Applies a load and measures the resultant deflection hence determines the Long span stiffness as a joist (LMoE_j)

One stiffness reading per piece is taken

E-Grader™ (35 pieces/min)

Acoustic Graders

MoE = (speed of sound)^2 x density

Mode of Operation
Uses acoustic wave technology

One stiffness reading per piece is taken

A-grader (140 pieces/min) grades green and dry timber

Dynagrade (100 pieces/min) grades dry timber only
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**Value & CoV% differences**

- **Joist Grade**
  - Acoustic 1
  - Acoustic 2
  - Plank 3 slow
  - Plank 1 slow
  - Plank 1 fast
  - Plank 2 fast
  - Visual

- **Value Recovery $/m³**
  - $579
  - $382
  - $380
  - $377
  - $374
  - $373
  - $374
  - $370
  - $360

- **Average Grade CoV%**
  - 0%
  - 5%
  - 10%
  - 15%
  - 20%
  - 25%
  - 30%

**90x45 Recovery**

- **90x45 Grade Recovery %**
  - Visual grading
  - MoEpmin
  - MoEpaver
  - LMolEj
  - Theoretical Best

- **Financial Basis:** (green, off the saw)
  - Box/Reject - $150/m³
  - No 2F/MSG6 - $225/m³
  - No 1F/MSG8 - $300/m³
  - MSG10 - $330/m³

- **Reject/Box**
  - MSG6/No 1F
  - MSG8/VSG8
  - MSG10/VSG10
Mill QA Requirements

- QA bending tester.
- Trained operator/s
- Data collection and analysis software.
- Moisture meter
- Callipers
- Should be written into mill operating procedures.
- Should be linked to mill stock control systems.

Quality Assurance Bending Tester
### QA Scheme outline

- Production to be sampled at 1:1000 boards or minimum one per size, per grade, per batch.
- Test for bending stiffness and proof load bending strength.
- Continuous or batch monitoring can be used.
- QA testing related to timber stock control systems (QA testing must be done prior to timber leaving mill).
- The QA process is Third Party Audited.
- Specific Grade marking criteria
- Retest provisions.
- Equipment to be regularly calibrated.

### Acceptance Criteria

- Minimum sample size = 30. Acceptance checks done on a rolling 30 sample basis.

  - Mean bending stiffness to be greater than target MoE

  - Fifth percentile bending stiffness to be greater than target fifth percentile MoE.

  - Proof load failures to be no more than 1 in 30.
QA Software Output

Data Printed: 13-Feb-06
No. of Test Boards: 263

Test Period: 24-Jul-04
No of Proof Load Fails in 8k: 10

No of Proof Load Fails in 8k:

Date Printed: 26-Jul-04

Demonstration data: 8-Feb-05

No. of Test Boards: 24

Proof Fb (MPa)
F target (MPa)
0.90 F target (MPa)
E mean (GPa)
0.67 E target (GPa)
0.625 E target (GPa)
Rolling average M

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