PROPOSAL

Submitted to American Lumber Standards Committee

Board of Review

Special Procedures for Re-testing Southern Pine Lumber to verify revised Design Values

September, 2011

Submitted by:
Southern Pine Inspection Bureau

Introduction:

Based on the limited strength testing of Southern Pine 2x4's in 2010-11, significant reductions in allowable properties were observed. To be conservative, the ASTM D1990 grade and size models were used to generate new design values based on the data from this sample of No.2 2x4's, with the caveat that a full "In-Grade" matrix of two grades in three widths would be tested to verify to newly assigned design values. This proposal documents the intended sampling, testing and analysis that will be performed to complete the full testing matrix.

Objectives: Provide timely and sufficient data to support the SPIB Board of Governors in their decision making process.

- Use data from the full In-Grade testing matrix to evaluate the appropriateness of the newly approved Southern Pine design values for all sizes.
- Evaluate the effect of applying a density requirement.
- Evaluate the properties of residual material after applying a density requirement.
- Evaluate whether Prime grades should have separate design values.

Testing Plan:

As was done with the limited No.2 2x4 testing, to broadly represent the entire southern pine producing region, SPIB has teamed with Timber Products Inspection to include subscriber mills from both agencies. The following sizes and grades will be sampled:

Grade	Size	MOE	MOR	UTS	UCS
SS	2x4	X	X	X	X
	2x8	X	X	X	X
	2x10	X	X	X	X
No.2	2x4*				X
	2x8	X	X	X	X
	2x10	X	X	X	X

*No.2 2x4 data for MOE, MOR and UTS was already collected in the first study.

Sample Size:

A minimum of 360 pieces shall be selected for each size/grade combination of each property (bending, tension, and compression parallel to grain) from the Southern Pine producing range. The pieces shall be selected from each of the regions within the range based on the proportion of production from that region. Production is based on reported footage to the two grademarking agencies, the Southern Pine

Inspection Bureau and Timber Products Inspection. No more than 10 pieces shall be collected for each physical property at each mill per test property. Sample piece selection shall proceed following the procedures in Appendix 1.

Selection of Mills to Sample:
Mills producing structural lumber (2x4-12 No.2 and higher) from the major species of Southern Pine shall be placed on a listing, by region, and randomized by the staff of the Forest Products Laboratory in Madison, WI. Mills shall be sampled in order of ranking until sufficient samples for that region have been collected.

Data Collected at Mill Site:
At the mill site, qualified agency inspectors will sample available sizes and grades from mill inventory. A minimum length of 12' will be selected, in order to permit a tension testing gauge length of 8' for all pieces tested in tension. Specific procedures for sample selection and data collection at the mill are included in Attachment #1. Data collected at the mill site will include:

> **Grade Characteristics** – all lumber must be on-grade and the inspector will identify and measure the grade controlling characteristic. If the grade controlling characteristic is not a strength reducing characteristic, then the maximum strength reducing characteristic will also be identified.
> **Growth Characteristics** – the inspector will record the absence or presence of pith, the average number of annual rings per inch, the percentage of summerwood, and whether the piece grades as Prime.
> Samples will be pulled until thirty on-grade pieces have been identified. Ten of these will be tested in bending, ten will be tested in tension, and ten will be tested in compression at the agency testing facilities. The lumber will then be bundled into two packs. One subset will include the pieces to be tested in bending and the pieces to be tested in tension and will be sent to the SPIB testing facility in Pensacola, FL. The other subset will be sent to the Timber Products testing facility in Conyers, GA for compression strength tests.

Data collected at Agency Test Facility:
Specific procedures for data collection and testing are included in Attachment #2. Data collected at the agency test facility will include:

> Ambient air and wood temperature, dimensions, moisture content, transverse vibration (E-Computer) E values, weight and edgewise E with one-third point loading and 17:1 span to depth ratio (as used in the original IGT program) and random location of the maximum strength reducing characteristic. The weight will be used along with the dimensions to calculate a specific gravity for the overall piece.

At the SPIB facility, edgewise E values will be taken with the lumber full-length. The piece will then be loaded to failure in edgewise bending. Failure load and failure code (per ASTM D4761, Appendix X1) will be recorded. Bending tests will be conducted in accordance with ASTM D4761 Sections 6 – 10.

Also at the SPIB facility, the tension samples of lumber will be tested for axial strength in tension in accordance with ASTM D4761, Sections 24-28. Failure load and failure code will be recorded. Grip length is two feet on each end and the distance between the grips is eight feet.

At the Timber Products facility, the compression samples of lumber will be tested for axial strength in compression in accordance with ASTM D4761, Sections 30-34. The sampling of two test specimens from each full size lumber member will be done in accordance with ASTM D4761, Annex A1. Failure load and failure code will be recorded for each specimen. The lowest strength value of the two specimens shall be recorded as the strength of the piece.

Analysis:
The moisture content of each member shall be taken using a 2-pin DC resistance moisture meter specifically calibrated for use on Southern Pine lumber. The moisture content readings will be adjusted to 73°F. The stiffness and strength properties (E, MOR, UTS, and UCS) will be calculated using measured dimensions and adjusted to a moisture content of 15% per ASTM D1990 Annex A1. A strength ratio will be determined for each piece so that a Grade Quality Index (GQI) can be determined as described in ASTM D1990 Section 3.2.3. for the bending, tension, and compression samples. Summarizing statistics will be prepared according to ASTM D1990 Section 5. Comparisons will be made with the original In-Grade Testing values for southern pine. The effect of implementing a Medium grain requirement will be evaluated and placement of the material that does not meet the Medium grain requirement will be explored. Additionally, the properties of Prime material will be compared to the Unclassified.

Review:
The SPIB Technical Committee will review the staff analysis of the data (mill data is to be held within the staff and Forest Products Laboratory. Data submitted to the FPL will have the mill identification removed). The Technical Committee will make recommendations to the SPIB Board of Governors who may take action as recommended or develop a response within. Results of the program will be made available as the Board of Governor's directs.

Attachment #1

SPIB REEVALUATION OF STRENGTH PROPERTIES

PROCEDURES at MILL

1. Meet Quality Supervisor at each mill. At TP Mills, both a TP Inspector and an SPIB Inspector will be present. TP inspectors are also welcome at SPIB mills.

2. Personally select a pack of the size and grade needed from inventory. Do not select or reject a pack based on an initial assessment, take the unit "as is" from inventory. If no 12' is available, request 14', 16', 18', or 20' (in that order). A minimum length of 12' is required for tension testing. Record the nominal lumber length (in feet) on the data sheet. Record the date the lumber was run on the data sheet. Record the nominal moisture content (KD19, SDRY, etc.) for the pack.

3. Remove the top 2 layers of lumber.

4. Have the quality supervisor verify the Unclassified grade of the next 30 pieces. No above grade or below grade pieces are to be tested. Grade marks must be legible on all pieces. Alternate placing the pieces into bending, tension and compression samples. Label each piece in order of selection as B1-T1-C1, B2-T2-C2, etc. The label on the piece shall match the piece number on the data sheet.

5. Identify and record the grade controlling defect on the bending, tension and compression Data Sheets. Mark the grade-controlling defect with crayon on the piece of lumber (type and location). If the grade-controlling defect is not a strength-reducing defect (knots, holes, distorted grain, slope of grain, splits, or decay), identify and record the maximum strength-reducing defect (MSRD) and mark this defect (type and location) with crayon on the piece of lumber. For the compression test pieces, identify and mark the two maximum strength reducing defects on each piece of lumber. Mark the defects as "D1" for the worst defect and "D2" for the second worst.

6. Pith, Rings per Inch, Percent Summerwood, and Prime: Record whether each piece contains the pith anywhere in the piece (Y or N). Record the average number of rings per inch on the numbered end of the piece. Rings per inch shall be determined along a radial line, as nearly 3" as is available. In pieces containing the pith, the measurement may exclude an inner portion of the radius as per ASTM D245, Section 5.6. Visually estimate the average

percentage of summerwood present at the numbered end of the piece. A forester's dot-grid shall be used to assist in quantifying the average percent summerwood. **Record Rings per Inch and Percent Summerwood for each end of the piece (record grade-marked end first / far end).** Record in the comment on the data sheet and the piece whether it would meet the grade requirement for Prime. (P for Prime)

7. Measure and record the moisture content at the time of selection. Mark the MC on the piece and on the data sheet.

8. The pieces shall be separated into two packs: the bending and tension samples for shipment to SPIB and the compression sample for shipment to TP. These packs shall be stored in an area protected from weather and physical damage until they can be picked up for shipment.

Attachment #2

STIFFNESS AND STRENGTH TESTING AT AGENCY FACILITY

Testing procedures shall be in accordance with ASTM D4761. Specific guidance is provided below.

1. Unload lumber and store in an area protected from weather and physical damage.

2. Lumber to be tested in bending and tension shall also be used to obtain a transverse vibration E value and full-size weight information, for the calculation of specific gravity. Set up the E-computer and allow it to "warm up" for at least 5-10 minutes.

3. Measure and record the width and thickness of each test piece, to the nearest 0.01". The thickness and width measurements shall be taken at the approximate mid-length of the piece.

4. Measure and record the length of each test piece, to the nearest 0.125".

5. Obtain and record a moisture content reading using a 2-pin moisture meter in accordance with ASTM D7438. This measurement shall be taken approximately 4' (to account for wood in tension grips) from the numbered end of the piece.

6. Record the ambient air temperature and the temperature of the wood.

7. All testing equipment shall be properly standardized using standards calibrated on an annual basis and traceable to NIST. Daily verification checks shall be performed on bending test equipment. Weekly verification checks shall be performed on tension testing equipment. All equipment electronics shall be allowed to warm up for 15 minutes prior to testing.

8. On the un-numbered wide face, place a mark 1" in from each end, centered across the width (1.75" from each edge). This allows correct positioning on the load cell tripod.

9. Check the set-up and standardization of the E-Computer. The span for the E-Computer must be 2" less than the nominal length of the lumber. (Effective 1996: No aluminum bar calibration is used. The K-factor is set at 79.4 for "true, dynamic E".)

10. With the number facing up, place the piece to be tested on the E-Computer supports with the numbered end on the load cell. The lumber shall be placed with a 1" overhang off the load cell end. The knife-edge support shall not be moved to adjust for overhang. Induce a vibration and obtain an MOE value. Store the E value to the computer disk (MOE1), as well as recording it on the data sheet.

11. With the number facing up, place the piece on the E-Computer supports with the numbered end on the knife edge. Again, the lumber shall be placed with a 1" overhang off the load cell end. Induce a vibration and obtain an MOE value. Store the E value to the computer disk (MOE2), as well as recording it on the data sheet.

12. Following the testing equipment manufacturer's procedure, obtain and record the edgewise-E value for each piece. The maximum strength reducing defect shall be randomly located within the test span. A linear scale shall be affixed along the test span. A random table generated over the range of this scale shall be generated and the MSRD shall be positioned as close a practical to the scale number picked sequentially from the random number table.

13. Edgewise Bending Testing:
All bending pieces shall be tested for Edgewise E. Bending properties shall be determined under the following conditions:

Selection of Loaded Edge:	Random – grademarks to be placed facing the test operator and toward the right.
Loading Location:	At third points of the test span
Span to Depth Ratio	17:1 – 2x4's use a 60" span 2x8's use a 123" span 2x10's use a 156" span
Lengthwise orientation:	The maximum strength reducing defect shall be randomly located within the test span.
Rate of Loading:	Maximum rate of stress of 16,000 psi per minute

15. Modulus of Rupture (MOR):
Following the testing equipment manufacturer's procedure and load the piece to failure in bending. Record maximum load. Record the specimen failure description in accordance with ASTM D4761, Appendix X1.

16. Axial Strength in Tension (UTS):
The clear span gauge length shall be 8'. The rate of loading is not to exceed 4000 psi per minute. Failure load should be obtained in approximately one

minute – not less than 10 seconds nor more than 10 minutes.

17. Axial Strength in Compression (UCS):
Two test specimens shall be obtained from each compression sample. Locate the most strength reducing characteristic in the piece. Mark and cut the board with the strength reducing characteristic centered in the length of the test specimen length. The minimum test specimen length for 2x4 is 14", for 2x8 and 2x10 it is 26". Contact surfaces shall be plane, parallel to each other and normal to the long axis of the specimen. Locate the next most strength reducing characteristic. Mark and cut a second test specimen.

18. Each compression specimen shall be weighed and have the dimensions recorded. A 2-pin moisture content value shall be obtained on each specimen. The strength value for the piece shall be the lower of the two test specimens cut from that piece.

19. Record any other notes that are significant about the piece (twist, etc.)

Clarifications of Procedures

1. Pieces must be **on grade**. We will permit pieces which measure over/under size with the calipers if they would ordinarily be accepted as on-grade during an inspection. If they are **below grade** (as determined by the quality supervisor) for scant width or thickness, they should be excluded from the sample. Pieces which are under/over length shall be excluded.

2. Ideally, pieces shall be no more than 19% MC at the time of test. Exclude pieces with moisture content greater than 23% when collecting the mill data.

3. Compression wood may be cited as the grade controlling defect. Generally, cite only knots, slope of grain as the strength reducing defects. Cluster knots are an item of interest and should not be overlooked. If no other strength reducing defects are present, compression wood may be cited. When reporting the "measurement" for compression, estimate the percentage of the cross section which is occupied by compression wood.

Commentary

Selection of samples involves consideration of a number of factors. A perfect plan would take a sample that is a perfect representation of the population. Time, capital, and manpower restraints place restrictions on attaining the perfect sample. The approach used follows that of the In-grade Testing Program as closely as possible. The following aspects have been suggested as affecting the results of the testing:

- Seasonality: Input from the SPIB Technical Committee suggested that season of harvest affects the mechanical properties of the lumber. Rather than seasonality the observed effect is more properly associated with site quality and access affected by meteorological events. A literature review of the Forest Products Society Interactive Library, the Forest Products Laboratory Online search, and a review of several wood engineering texts did not result in substantiation of this observation. There may be proprietary data that supports this conjecture. The depth of input received makes it worthwhile to pursue this through the ongoing Resource Monitoring Program. This can be accomplished by shifting the season when the RMP is conducted then comparing the sample characteristics.

- Prime Grades: Comments received indicate that Prime grades of dimension lumber may have different properties than non-Prime grades. This is attributed to sawing to exclude wane therefore obtaining more pieces with or near the pith. To account for this the RMP did not exclude Prime grades. In discussions with the Forest Products Laboratory we determined that creating a sub-sample, much like the CG or MG, would allow analysis to see if Prime differed from the No.2 Unclassified population. A sub-sample size of five pieces in the bending and Tension groups was selected. Based on information derived from this sub-sample a further analysis of the pieces that would grade Prime in the full matrix will be used to develop design values for the Prime grades.

- Piece Selection: Some comments suggest that individual pieces should be selected over a period of time to reduce the "snap-shot" effect. Other users of Southern Pine have commented that they don't buy lumber on a global basis but by the pack and thus the practical application is a "snap-shot". The current and past sampling is based on pack sampling. However, the small number of pieces selected from a pack would tend to reduce the overall "snap-shot" effect. The end result is a less than optimal compromise.

- Choice of Medium Grain as a Test point: Prior to 1977 the Standard Grading Rules for Southern Pine included the medium grain provision for No.2 and

higher lumber. A request to remove this restriction was approved by the SPIB Board of Governors and the ALSC Board of Review. Two changes were made to accommodate removal of the medium grain requirement: 1) an exceptionally light weight piece restriction was added which excluded pieces with less than 15% summerwood. 2) Design values were lowered in the higher grades. In-grade testing was conducted on lumber graded without the medium grain requirement. A review of the Resource Monitoring data indicated that the 5th percentile of MOE indicated a shift at less than four rings per inch and 30-35% summerwood. This coincides with the established definition of Medium Grain. Analysis of the test results may reveal no effect of a Medium Grain requirement or that some other density requirement would be more effective.

- Changes to the Resource Monitoring Program: The RMP was originally designed to ensure that when a "trigger point" was reached there was high confidence that the resource had changed. MOE was monitored because of the lower cost involved in obtaining data. The relationship between MOE and MOR exists but some anecdotal information indicates that the MOR may shift before the MOE trigger point is hit. Additional review is required to determine what changes may be needed in the RMP but an initial inclination is to add MOR evaluation to the procedures. The ALSC Lumber Properties Task Group has agreed that MOR is the desired property to monitor.