Load Test Procedure for Wood Roof Trusses for Houses

DBR Housing and Structures Section

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SUBJECT LOAD TEST PROCEDURE FOR WOOD ROOF TRUSSES FOR HOUSES

A. PURPOSE OF TEST

The purpose of this test procedure, which has been prepared by the Division of Building Research in consultation with the Forest Products Research Branch of the Department of Forestry and the Central Mortgage and Housing Corporation, is to demonstrate the stiffness and strength characteristics of wood roof trusses (trussed rafters) for houses, and provide a method of assessing the suitability of truss designs in terms of the criteria given in Section P of this Note which are based on the requirements in the Housing Standards.

B. SCOPE

This test method is intended to apply only to trusses that support roof loads and limited attic storage loads such as is the case for attics that are not accessible by a stairway. Where the truss is intended to support floor loads or enclose a space accessible by a stairway, or supports any unconventional loads, the test loads and the acceptance criteria shall be determined by the authority having jurisdiction.

C. ORIGINAL ACCEPTANCE TEST

Proponents and manufacturers of new roof truss designs shall submit design drawings to the authority having jurisdiction containing full fabrication details and, upon notification by the authority having jurisdiction, arrange to have a loading test carried out according to the procedure described in this Technical Note.

D. RETEST AT LATER DATE

The authority having jurisdiction reserves the right to order at any time a retest of a truss design already accepted to prove that production models of the truss will satisfy the original performance requirements.

E. TESTING AUTHORITY

The selection and testing of trusses shall be supervised and witnessed by the testing authority who shall be a registered professional engineer or architect qualified in this field, or other person approved by the authority having jurisdiction. The testing authority shall prepare a report on the test as described in Section O. This testing authority shall not be an employee of the truss plate manufacturer, truss manufacturer, or truss designer.

F. FABRICATION AND SELECTION OF TRUSSES

(1) Six trusses shall be taken at random from the regular production or be fabricated with the same type of equipment and methods as will be used for the regular production of trusses. The species of lumber used in the test trusses shall not be stronger or stiffer than the species to be used in the regular production of trusses. The relative strength and stiffness of species may be determined from CSA specification 086-1959.

(2) All lumber used in these trusses shall be grade marked and moisture content measurements shall be taken immediately prior to fabrication with a calibrated moisture meter.

Where a maximum moisture content is not specified for the production line trusses, the trusses shall be assumed to be manufactured from unseasoned lumber and the test trusses shall be fabricated from lumber with a moisture content in excess of 19 per cent*. Where a maximum moisture content is specified for the truss design, the moisture content of the lumber for the test trusses immediately prior to fabrication shall be within 3 per cent of specified moisture content.

(3) The two trusses which appear to be the least satisfactory with respect to materials and workmanship shall be selected by the testing authority from the six fabricated during his presence, marked with his signature and tested in his presence. These trusses shall be tested individually or as a pair.

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* The performance of trusses can be considerably affected by the moisture content of the lumber during fabrication. In general, trusses fabricated from green lumber will not perform as well as trusses fabricated from dry lumber.

(4) In the case of hip roof truss systems, the trusses in the system may be tested individually or in pairs if, in the opinion of the authority having jurisdiction, the system can be properly evaluated in this manner. Alternatively, the completely assembled sloping section of the hip roof shall be tested.

(5) When a retest is ordered by the authority having jurisdiction, the procedures described in F (1) to (4) shall also apply.

G. TESTS OF SINGLE TRUSSES

The top chord may be prevented from buckling in tests on individual trusses by lateral restraints, provided these do not in any way restrain vertical deflection of the truss or assist in carrying any applied load.

H. TESTS OF PAIRS OF TRUSSES

(1) When tested in pairs, the test trusses shall be supported on nominal 2 x 4 wood plates laid on firm supports approximately 16 in. high. The 2 x 4 supports shall be located at the positions where the trusses are designed to be supported in actual use.

(2) In order to provide lateral stability during the test, trusses tested in pairs should be spaced on at least 2-ft centres on the prepared supports even if they are designed to be more closely spaced in actual use. (See footnote on page 5 for computing the design load.)

(3) The top chords shall be sheathed with plywood. The length or width of the plywood sheets shall not exceed 4 ft nor shall the thickness exceed 3/8 in. Plywood sheets are to be placed with the face grain at right angles to the top chords. The sheathing shall be nailed to the upper chords with 2-in. common nails at 6-in. spacing and a gap of at least 1/8 in. left between sheets.

(4) The bottom chords shall be sheathed with 1-in. board sheathing or 3/8-in. plywood to support a uniform ceiling load. For low sloped trusses it may be necessary to extend the sheathing on each side of the trusses so that the ceiling load can be applied outside the trusses. As an alternate method the ceiling load may be applied to the lower chord panel quarter points on slats laid at right angles to the trusses.

I. SAFETY PRECAUTIONS DURING LOADING

Where weights are used for loading, provision shall be made to prevent complete collapse or overturning of the trusses which could result in injury to people near them. Such safety supports shall not be in contact with the trusses during test and should be adjustable in height so that they can be maintained within 2 in. of the members they are intended to catch.

J. DEFLECTION MEASUREMENTS

(1) Deflections shall be measured at the following points on the lower chord of the two trusses:

(i) Mid span

(ii) All splices of lower chord

(iii) All panel points (joints) between end supports

(iv) Point of maximum deflection

(v) The end of the cantilevered lower chord of cantilevered trusses.

(2) Wherever possible, deflections shall be measured by means of a taut wire or string not more than 1/50 in. diameter. A graduated scale with graduations of 1/16 in. or finer shall be attached to the lower chords where deflection measurements are required. A mirror shall be held against the face of the member, behind the line when taking deflection measurements to avoid errors in parallax. Other methods for measuring deflections may be used if they are specifically approved by the authority having jurisdiction.

(3) When the trusses are not cantilevered, the wire or string shall be fastened at one end to a screw or nail located in the lower chord member above the centre of a support and held taut by means of an elastic or spring inserted between the other end of the line and a screw or nail in the lower chord member over the centre of the other support. Alternatively, the line may be kept taut by suspending a weight of about 5 lb from one end of the line. Precautions shall be taken to ensure that the line does not contact the truss during the test.

(4) When trusses are cantilevered the deflections shall be measured by means of a taut line spanning the total length of the bottom chord. The line shall be located about 2 in. above the support at the cantilevered end so that it will not contact the support when the cantilevered portion deflects. A scale shall be placed on the lower chord above this support to measure the movement of the line relative to the scale. The lower chord deflections shall be determined by plotting the values obtained from the various scale readings and measuring deflections at the required locations relative to a line drawn through the two support points. The deflection of the cantilevered portion is measured relative to an extension of this line. As an alternative to plotting these values the true deflections may also be determined by calculations.

K. JOINT SLIPPAGE

Mark each joint with a pencil line across the joint so that movement of gusset plates relative to the member can be measured.

L. LOADS

The design loads shall be:

(1) Upper Chord (Snow Load) - the greater of the following two loads:

(i) Sixty per cent of the ground snow load specified in Climatic Information for Building Design in Canada, 1961, Supplement No. 1 to the National Building Code of Canada, for the area in which the trusses are to be used. *

(ii) $22\frac{1}{2}$ lb/sq ft. *

(2) Lower Chord (Ceiling Load):

10 psf where the attics are not accessible by a stairway.

M. LOADS FOR TESTING

(1) Loads may be applied by means of weights, such as concrete blocks, sand bags, or billets, hydraulic jacks, or other suitable apparatus.

(2) The method of measuring the loads shall be accurate to ±5 per cent. Where weights are used, a minimum of five of each type of weight used in applying the load shall be weighed to determine the average weight per unit.

(3) When loaded in pairs, both trusses shall be loaded equally. Where the trusses are to be supported at or near the ends of the lower chord and have an ordinary roof overhang, none of the test load shall be applied outside of the truss span.

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* N. B. The total design snow load for the two upper chords for trusses tested in pairs may be computed as follows:

$W = 2\,SwL$

W = total design snow load on upper chord, lb
S = spacing of trusses to be used in house, ft
w = design snow load, psf
L = span of truss - inside dimension between supports, ft.

(4) When trusses are the cantilevered type in which the support at one or both ends is located more than 2 ft in from the end of the lower chord, the overhang on the cantilevered end, including the eave projection, shall be loaded with the same unit ceiling and roof load as applied to the remainder of the truss.

(5) Where weights are used, they shall be distributed uniformly along the truss and sufficient spacing left between the weights to avoid mutual support of the load due to arch action.

(6) Where hydraulic jacks or other suitable loading apparatus is used for loading the upper chord by applying concentrated loads, these loads shall be spaced uniformly along the truss at not more than 12 in. o. c. Alternatively, if the top chords are divided into equal segments or panels, the loads may be applied at the quarter points of the panel so that each concentrated load equals half the load on that panel if it were uniformly loaded.

N. TESTING PROCEDURE

(1) All deflection readings shall be accurate to the nearest 1/32 in. (0. 03 in.).

(2) The zero deflection readings shall be taken prior to the application of the ceiling load.

(3) The design ceiling load shall be applied to the lower chord at a steady rate.

(4) After the design ceiling load has been applied for at least five minutes, deflection readings shall be taken.

(5) A load equal to 1 1/3 times the design snow load shall then be applied to the top chords at a steady rate.

(6) Deflections shall be recorded five minutes after load application, and after one hour. Any joint slippage exceeding 1/16 in. shall be measured. Noticeable buckling of members or plates shall be noted.

(7) The load on the upper chord shall be increased to 2 2/3 the design snow load, and maintained for 24 hr.

(8) As an alternative to (7), the load on the upper chord may be increased to 3 1/3 times the design snow load, and retained for one hour rather than 24 hr.

(9) Except when otherwise permitted by the testing authority, the total test loading shall be in place within 4 hr of the start of the application of the ceiling load.

O. REPORT

A report shall be submitted by the testing authority. This report shall include the following:

(1) Scale drawings of the trusses which were tested showing the span (the inside dimension between supporting 2 x 4 plates), slope, member sizes, lumber grades and species; details of each joint showing gusset plate size, thickness, and number of nails; tolerances required for gusset plate locations and joint fittings; design loads of top and bottom chords (lb/ft); drawing number and date, together with the stamp or seal of a registered engineer or architect.

(2) Slivers of wood (approximately 2 by 1/2 by 1/8 in.) obtained by the testing authority from each top chord member and bottom chord member for positive identification of the lumber species.

(3) Photograph of the trusses loaded with 1 1/3 the design roof load and 2 2/3 or 3 1/3 the design roof load.

(4) Brief description of fabrication method.

(5) Moisture content of lumber (each member) at time of fabrication.

(6) Type of loading used for test.

(7) Total loads applied to the upper and to the lower chords of both trusses at 1 1/3 times the design snow load.

(8) Total loads applied to the upper and to the lower chords of both trusses at 2 2/3 or 3 1/3 times the design snow load.

(9) If trusses were tested to failure, the failure load should be stated.

(10) Deflections of lower chord of each truss at:

(i) design ceiling load, and

(ii) design ceiling load plus 1 1/3 times the design snow load.

(11) Joint movement exceeding 1/16 in. at 1 1/3 times the design snow load.

(12) Statement of whether trusses had collapsed or withstood 2 2/3 the design snow load for 24 hours or 3 1/3 the design snow load for 1 hr.

(13) Statement that truss fabrication and load test was performed in accordance with these requirements.

(14) Statements that:

(i) deflection at any point on the lower chord of each truss did or did not exceed 1/360 of the clear span after 1 1/3 times the design snow load plus the design ceiling load had been applied for 1 hr;

(ii) the trusses had or had not collapsed after 2 2/3 times the design snow load plus the ceiling load had been applied for 24 hr, or after 3 1/3 times the design snow load plus the ceiling load had been applied for 1 hr.

P. ACCEPTABLE PERFORMANCE

(1) A truss is considered to have acceptable performance if:

(i) The maximum deflection of the lower chord does not exceed 1/360 of the span when loaded with 1 1/3 the design snow load plus the ceiling load for 1 hr, and

(ii) The trusses can withstand the ceiling load plus 2 2/3 times the design snow load for 24 hr, or the ceiling load plus 3 1/3 times the design snow load for 1 hr, and

(iii) In the case of cantilevered trusses, the bottom end of the cantilevered lower chord does not deflect more than 3/8 in. after being loaded with the ceiling load plus 1 1/3 the design snow load for 1 hr, and must meet the requirements in paragraphs (i) and (ii).

(2) If both trusses meet the requirements in paragraph (1), the design is considered acceptable. If only one truss meets the requirements in (1) a retest is permitted. If both trusses in the retest meet the requirements, the design is considered acceptable. If one or more fails to meet the requirements in a retest, or if both trusses fail in the original test, the design is considered unacceptable.