DETERMINING MODE I AND MODE II CONTRIBUTIONS IN END NOTCHED BEAMS

John Hermanson, Lawrence Soltis, Douglas Rammer

1. INTRODUCTION

The safe and efficient use of wood members in construction requires rational design criteria. One type of construction member often used is a beam with a sharp cornered end notch at the bearing area. In the United States, this end notch is limited to ten per cent of the beam depth for glue-laminated beams and to twenty five per cent of the beam depth for solid sawn timber beams. The notch length is limited to one third of the span length [1]. Since the effect of notches was not well understood these requirements are to limit the notch location to lower stress areas. Because of the unknown effect of end notches, the design calculations have been empirically based upon the net shear area[2].

It is recognized this design concept is incorrect as it is not related to the stress concentration and fracture stresses inherent in a notched beam. Our objective is to develop design criteria for notched wood beams based on mixed mode fracture analysis for an orthotropic material. This abstract gives observations from preliminary test results of beams with mixed mode failure phenomena.

2. EXPERIMENTAL PROCEDURE

Preliminary tests were conducted to determine a data base corresponding to a mixed mode analysis procedure. Three notch depths of 10, 25 and 50 per cent of the specimen depth were tested. The 10 and 25 per cent depths correspond to the maximum allowed at a support for glue laminated and solid sawn beams, respectively. The 50 per cent depth corresponds to work of other researchers [3,4,5,6].

Three notch lengths were tested. The first was equal to the width of support which is a common case in construction. The second was equal to the specimen depth which is the distance where beam loads need not be considered for shear design. The third was equal to one third of the span length which is the maximum length allowed in current design.

The specimens were 25.4mm wide and 44.5mm deep. It was assumed these dimensions are a large enough size compared to the localized plastic zone at the crack tip such that linear elastic fracture mechanics is applicable.

Two center to center bearing lengths of specimens, 222mm and 623mm, were tested. The first length equals five times the specimen depth which corresponds to the span used in ASTM D198 for shear of short deep members. The second equals fourteen times the specimen depth which corresponds to the span used in ASTM D143 for bending of long slender members.

A total of 360 three point bending tests were conducted which consisted of twenty replications of nine notch geometries and two spans. Specimens were loaded to failure with loads recorded as the fracture propagated from the notch through each of three metallic paint stripes.

3. OBSERVATIONS

Predicting a mixed mode fracture failure based on a single mode test method and properties is controversial [5,7]. We are currently analyzing the data to determine if a mixed mode test method is feasible and thus only general observations are currently available.

Of the 360 total tests we had 180 fracture failures and 180 bending failures. We observed no fracture failures in either test span or for any notch length when the notch depth was 10 per cent of the specimen depth. This appears to validate current design criteria limit for glue laminated beams.

The longer span was observed to have fewer fracture failures and faster crack growth than the shorter span.

Failures where mode I predominated were more dependent on notch depth than notch length. Failures where mode II predominated were more dependent on notch length than notch depth.

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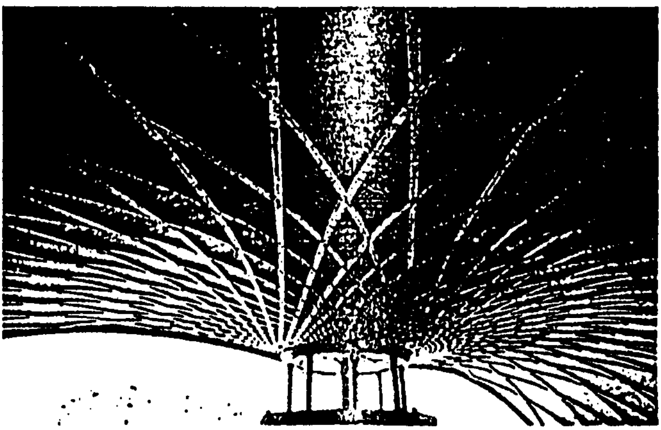

PROCEEDINGS

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