Study On the Beam Bending Test of Basalt Fiber and Wood Composite Board

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Keywords: basalt fiber board and wood composite beam; Wooden beams; Experimental study

Abstract. Experimental study on the flexural bearing capacity of basalt fiber board and wood composite beam. Focuses on the composite plate of efficient splicing method and the paste of the basalt fiber in the beams bearing capacity, deformation and strain improvement. In addition to the structural measures have also made a number of exploration.

Introduction

Through the testing of composite beams for flexural basic experimental study on the mechanical properties of the failure mode, analyzes the stress and failure mechanism.

Production of basalt fiber board and wood composite beam specimen. The combination of large span beam test were divided into 4 groups, each group of 3 specimens. 4 groups of beam cross section is b×h=40mm×80mm, span 1200mm.Test point arrangement and loading device as shown in figure 1. See table 2.

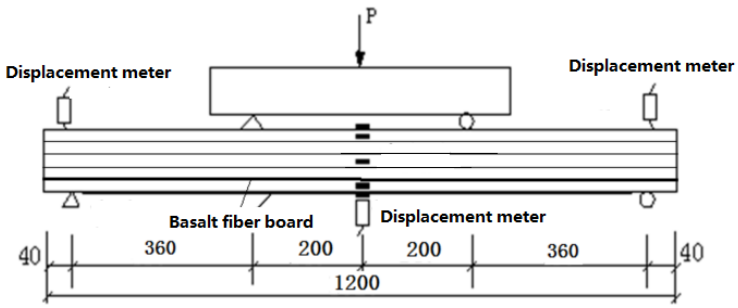

Fig.1 Measuring point arrangement and loading device

Table.1 Performance index of basalt fiber board

calculated thickness (mm)	tensile strength (Mpa)	elastic modulus (Gpa)	elongation (%)	density (g/cm^3)
1	>1500	129	1.68	2.8

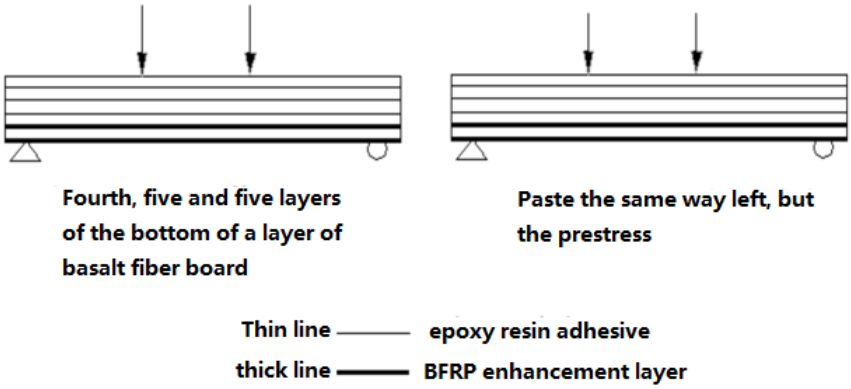

Fig.2 A combination of transverse combination beams

A combination of transverse combination beams. Combination beam transverse combination, each combination beam test test piece size 300mm×20mm×10mm single pine boards along the thickness direction of the blank, the group III and IV in order to improve cement board in the tension zone of tensile ability and overall mechanical properties, respectively in four, five layer and five layer bottom glue a layer of basalt reinforced material.

A combination of vertical combination beams. .For large span beams, due to the short length of splicing wood, longitudinal splicing, splice adopt tenon connection mode, the slot with epoxy adhesive, in the tension zone in order to improve the tensile capacity of the joint, with basalt fiber cloth wrap strengthen, as shown in Figure 3.

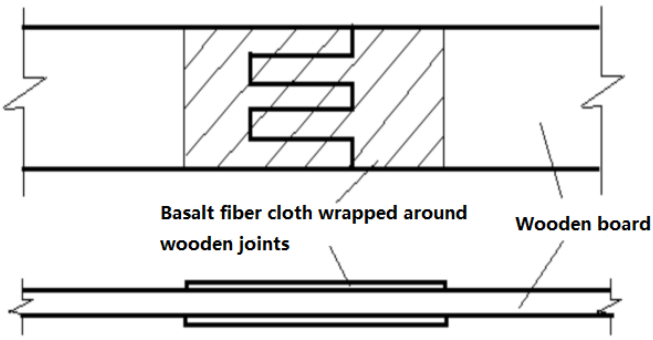

Fig.3 Combination beam longitudinal splicing method

Test results and analysis.

The characteristics and failure modes of the cracks in the test beams. From group I beam failure process can be seen, the destruction of composite beams is due to a defect in the tension zone, very easily under the office of the defective area have vertical or oblique fracture. For no bonded basalt fiber beam, as the tension crack zone development, eventually destroy the wooden beams; test group II composite beam in failure always from beam bottom about 1/3 of the generated at the longitudinal cracks, longitudinal cracks and cracks in the tension zone at the same time with the load increase and development, the final fracture connection, basalt fiber plate tensile, composite beams lose bearing capacity. Analysis of the causes of longitudinal cracks are: (1) if the wood is regarded as uniform, then the combination beams of pure bending is section will not produce shear stress, longitudinal cracks may is between basalt fiber composition board and wooden beams shear stress and normal stress caused by the transmission, then longitudinal cracks most likely appeared in located near the bottom of the beam, close to the basalt fiber of a longitudinal section. In the test, the crack is in the range of 1/2 ~ 1/3, and the analysis is not in conformity with the analysis. (2) considering the wood of the uneven of, the combined beams as laminated beam, in pure bending section will generate a shear stress, and shear stress maximum value is in the longitudinal section of the beam height 1 / 2, and then consider the basalt fiber board and wooden beams between shear stress and normal stress effect, longitudinal cracks should appear in the position and the experiment phenomenon is consistent, that such an interpretation is more reasonable. Group III and IV beam tension crack zone is not obvious, the deflection of the beam deformation,

final failure are lead to compression wood crushed, but group III beam basalt fiber board has fractured, rate is better to the utilization of the basalt fiber material, bearing capacity are also higher.

Average strain along the beam. The average strain of each test beam along the height of the beam is shown in Figure 4. From figure can be seen, not combined fiber board the wooden beams the position of the neutral axis slightly from 1 / 2 of the high beams to pull offset 1mm. Analysis of the reasons: 1) parallel to grain of wood tensile strength greater than wood compression strength parallel to grain, the composite beams in the destruction of the neutral axis will be slightly upward; 2) composite beams under bending neutral axis location with timber wood fiber texture distribution differences and timber processing error will have slightly to move up or down, the offset is generally very small, only the beam height of 1.25%, so calculation can think the neutral axis position in the Department of 1 / 2. In this experiment, the position of the neutral axis of the II~IV groups of beams is shifted from 2 to 3mm, the position of the neutral axis of the basalt fiber board and the neutral axis of the beam is shifted from the high to the 1/2. During the test, the position of the neutral axis of the beam in the IV group remained basically unchanged, which indicates that the basalt fiber board did not yield.

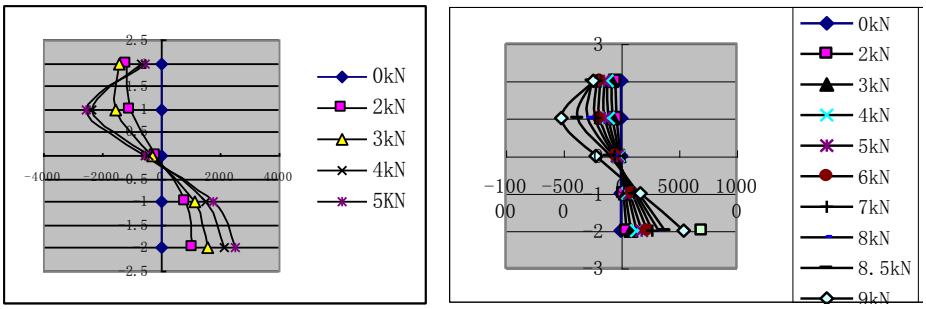

Fig.4 ML-I-1,ML-III-1--The strain distribution along the height of the beam in the beam section (the transverse coordinate is the strain; the unit $\mu\varepsilon$)

Table.2 Main test results

Group number	beam number	Combination method	Distribution ratio of basalt fiber/%	Ultimate load /kN	Limit load increase	Main failure characteristics
I	ML-I-1 ML-I-2 ML-I-3	Not paste	-	5.88 5.68 6.00	-	Beam wood fiber rupture
II	ML-II-1 ML-II-2 ML-II-3	Fifth layers of basalt fiber board	0.206	7.88 7.99 8.23	34.7% 36.6% 40.7%	Joint fracture beam wood fiber, basalt fiber board is broken
III	ML-III-1 ML-III-2 ML-III-3	A basalt fiber sheet is attached to the four or five and five layers of the base layer.	0.412	10.20 9.80 10.00	74.0% 67.5% 70.9%	Wood fiber beam bottom joint fracture, local tensile plate basalt fiber
IV	ML-IV-1 ML-IV-2 ML-IV-3	Same with group III, but the basalt fiber sheet is applied to Prestressed	0.824	10.23 9.82 10.11	74.9% 67.6% 72.8%	Combined beams pressure area is pressed fold, large deformation beam cannot continue loading; basalt fiber board not broken

Flexural bearing capacity. Table 2 lists the main results, can be seen, bonded basalt fiber board can significantly improve the ultimate load of the composite beams. While observing the failure characteristics of composite beams, easy to find the wood itself natural twill, cracks, joints of composite beams ultimate bearing capacity has great influence. In Experiment II group beam fiber rupture, and group III beam a slight pull off phenomenon, deformation at failure is more obvious, the material utilization ratio and ductility than in group II beams are much better. By pasting basalt fiber board, on the one hand can make up the wood of these defects, the intensity of timber to have larger play; on the other hand, fiber board and the combined beams collaborative work together to resist external loads, so as to improve the bearing capacity of composite beams. In this experiment, II, IV, III group of the test results of the above two aspects of the results of the numerical. In the composite test, the phenomenon of local basalt fiber board peeling is not occurred in the process of loading, proving that the bond strength between basalt fiber board and board is enough to meet the requirements.

Combined failure state of test beams. After the portfolio expected combination beams damage is mainly compression wood fiber is pressed bending or compressive brittle destruction, basalt fiber board breaking, so you can give full play to the strength of the basalt fiber board. And by the II group test beams observed phenomenon is: combined combination beams damage failure is start to tiny cracks in the composite beams in the tension zone of twill, furuncle scars at, along the transverse or oblique to development of longitudinal cracks until coalescence, wood fiber gradually torn and broken, the prominent wood fiber will cut basalt fiber board and lead to final destruction. Reason was due to the anisotropy of the mechanical properties of wood, especially radial tensile strength than along the fiber direction tensile and compressive strength are low, makes combination beams damage began in the lower part of the tension wood fiber tearing each other cracks and crack gradually coherent form one or two of the main crack and the combination of beam damage. It is proved that in the composite beams is pasted with a layer of basalt fiber board is not enough in four, five layer and five layer bottom glue a layer of basalt fiber board in the economy and the combined effect is more appropriate.

Summary

(1)The ultimate bearing capacity of the basalt fiber board and composite beam is effectively improved, with the increase of the number of the basalt fiber board is about (34.7~ 74.9%) , and it will increase with the increase of fiber content.

(2)Paste the basalt fiber board can improve the ability of beam deformation tolerance, the effect is more obvious.

(3)A U-shaped hoop anchorage construction measures is crucial to ensure the basalt fiber and the timber beam collaborative work, the basalt fiber board and give full play to the role. Appropriate anchorage, tectonic, basalt fiber plate bonding can improve the ductility of the beams; on the contrary, in the loading process local emergence of basalt fiber plate and the wooden surface spalling failure, and the ductility of the beams will decrease.

(4)Improve the deformation capacity of composite beams is applied, 4 prestressed obviously.

Acknowledgement

This work was financially supported by Scientific research project of Hebei Provincial Education Department (QN2014219).

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