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Research on residual bending capacities of used wood members based on the correlation between non-destructive testing results and the mechanical properties of wood

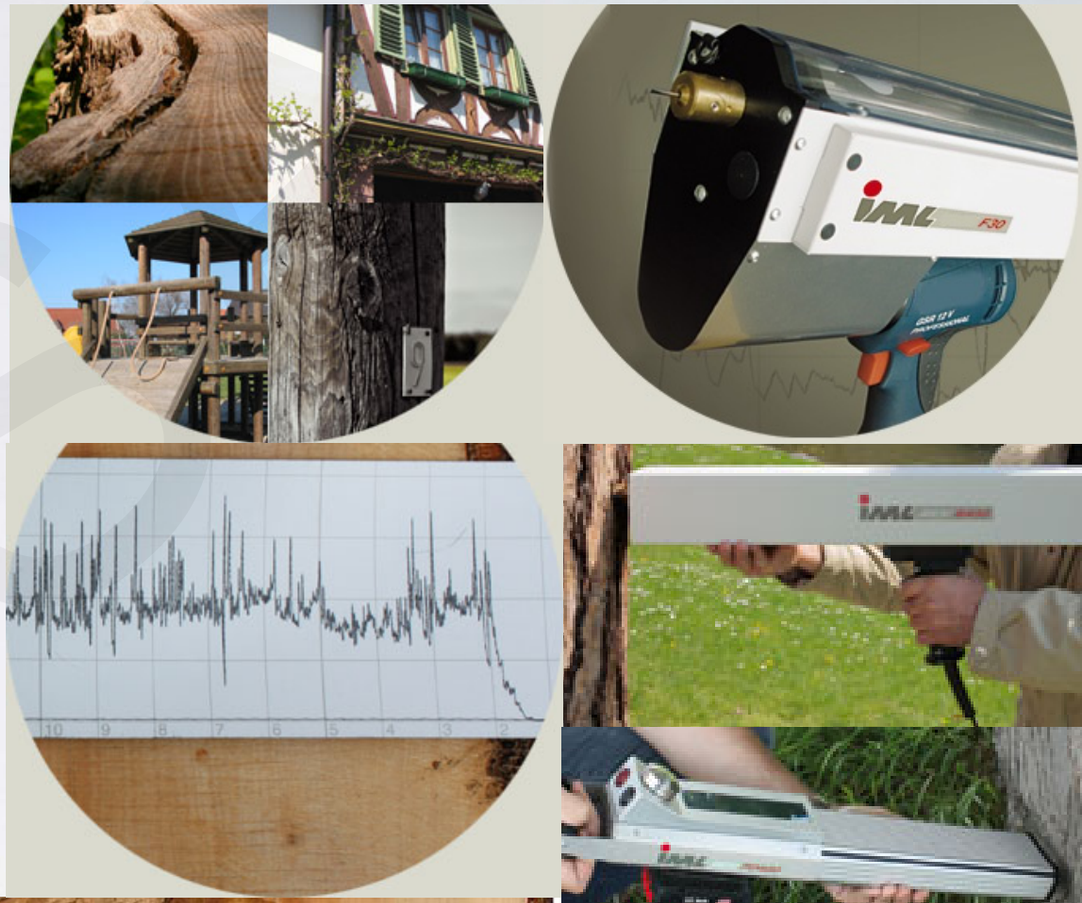
Key words:

Used wood members, Non-destructive testing, Mechanical test, Residual bending capacity.

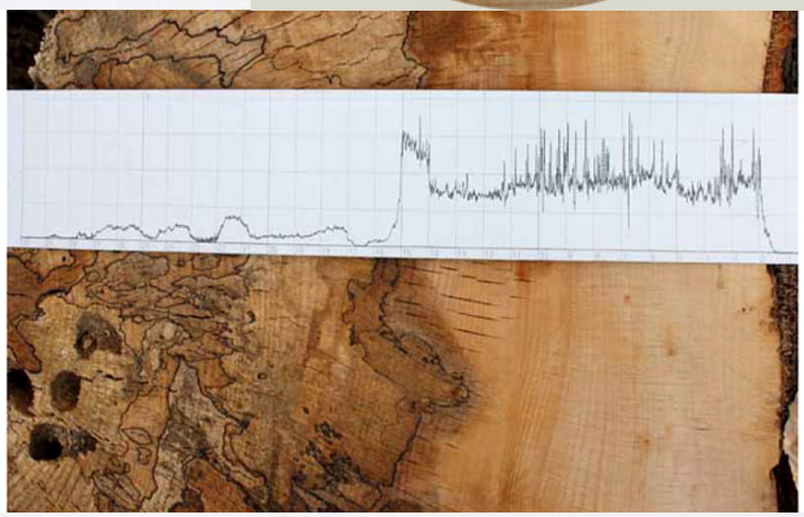
1.Introduction

Application of Non-destructive Testing
(Drilling Resistance Measurement)

1. Care and inspection of trees along streets
2. Evaluation of damages on forest trees
3. Inspection of construction wood
4. Research and development



A correlation between NDT results and mechanical wood properties has been determined by an experimental campaign of NDTs on ancient chestnut elements (C Calderoni *et al.*, 2010).

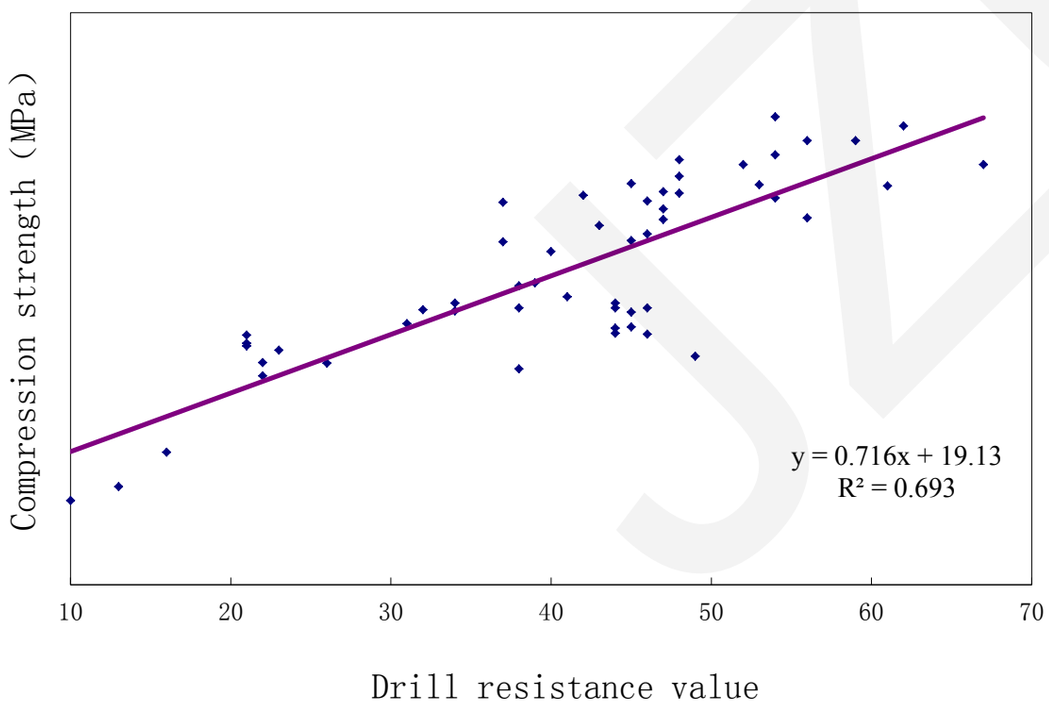


2.Experimental program

Content：1.Test of small specimens 2.NDT of wood beams 3.Residual capacity experiment of wood beams

Objective：to evaluate the residual bending capacities of used wood members

Results: 1.Relation between strengths of small specimens and drill resistance values



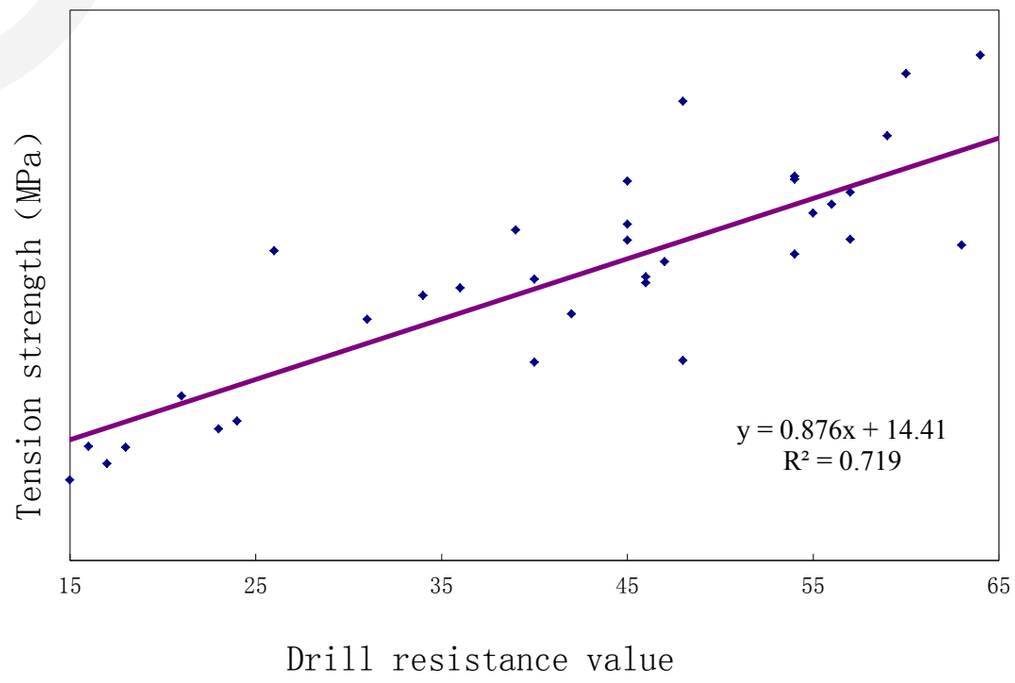


Fig.1 Relation between timber strengths and drill resistance values

2.Experimental program

Results:2.Drill resistance values which reflects the imperfections and strength of wood 3. Failure modes and ultimate loads of used wood beams

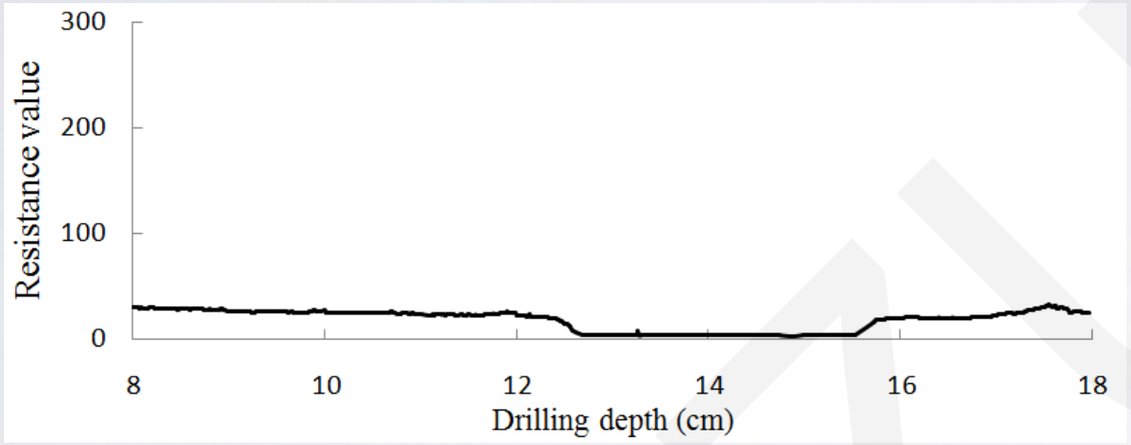


Fig.2 Resistance-depth curves tested by the Resistograph

Table 1 Failure modes and ultimate loads

No.	Failure modes after loading	Ultimate load	Ultimate tensile strain
BA1	Wood fractures in tension zone	96 kN	1782με
BA2	Wood fractures along original cracks in tension zone	92 kN	1921με
BA3	Wood in tension zone came into fractures; small surface cracks	142 kN	1574με
BB1	Wood damaged caused by knots in tension zone, cracks at the front end	172 kN	1693με
BB2	Wood fracture in compression zone, front end damaged by shear stress, wood fractures in tension zone finally	205 kN	2214με
BB3	Fractures in tension zone around knots, cracks at the front end	166 kN	1720με

3. Finite element analysis

Methods：

1.According to the results of NDT, the materials strengths of different zones of the wood beam are different

2.Simulations of initial imperfections

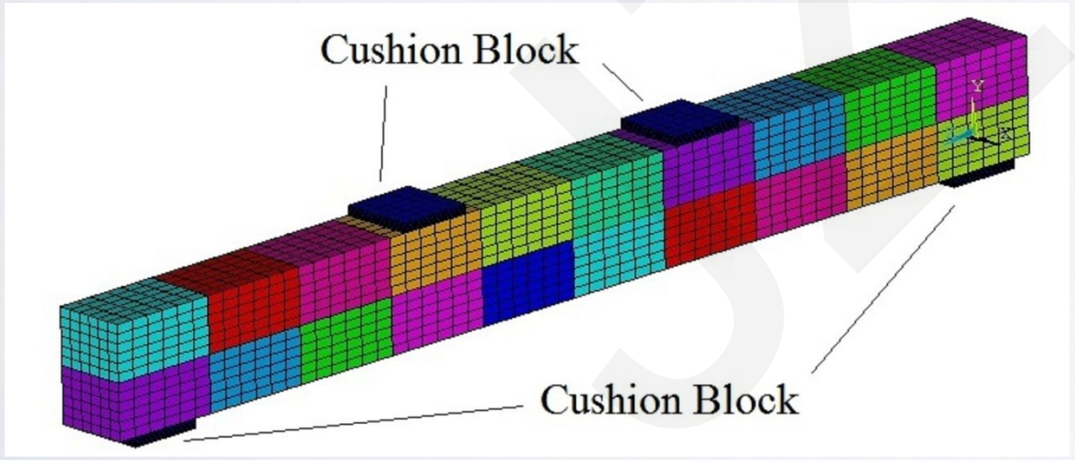
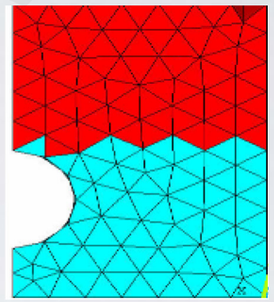
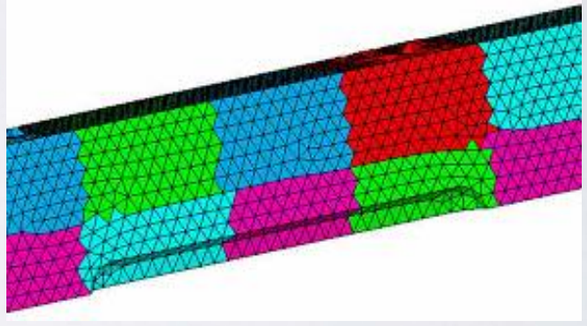


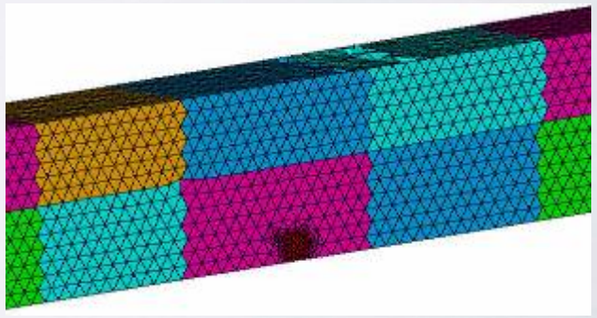
Fig.3 The finite element model



(a)Insects damage



(b)crack



(c)knot

Fig.4 FEM simulations of initial imperfections

4. Conclusions

(1) Compression strengths and drill resistance values are interrelated and the regression equation is y=0.716x+19.13, where the correlation coefficient R^2 = 0.693.

(2) Tension strengths and drill resistance values are also correlated and the regression equation is y=0.876x+14.41, where the correlation coefficient R^2 = 0.719.

(3) Initial imperfections have significant effects on the failure mode and the ultimate load.

(4) Influences of initial imperfections (damage by insects, cracks and knots) of specimens have been taken into account in FEA. However, ultimate loads of calculation values are all larger than those of test values but with less than 22% errors