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COLLEGE OF ENGINEERING DESIGN ART AND TECHNOLOGY
SCHOOL OF ENGINEERING

STRENGTH CHARACTERISATION OF TIMBERS FOR BUILDING CONSTRUCTION IN UGANDA

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ABSTRACT

The specific objectives of the study were to: assess timber-use practices; determine strength properties of selected timber species; develop a timber strength class system; model timber flexural behaviour; establish a relationship between flexural strength of structural size and small clear timber and develop a non-destructive approach for predicting flexural strength. Small clear tests were conducted in bending, compression and shear parallel to grain using standard procedures of the American Society for Testing and Materials (ASTM), ISO 8905 (1988), and BS 373 (1957). Structural size bending tests were conducted following ASTM ISO 8905 (1988), AS/NZS 2878 (2000); BS 4978; ASTM D198-02; ISO/FDIS 13910:2004 and BS 373 (1957). Finite Element Modelling of timber flexural behaviour was accomplished using COMSOL Multi-Physics 3.4. An approach for non-destructive evaluation of flexural strength of timber using a non-destructive load (P_{5mm}) was developed.

The allowable MOR of the timbers varied from 3.9 N/mm^2 to 20.3 N/mm^2; mean MOE varied from 5,760 N/mm^2 to 13,440 N/mm^2; shear parallel to grain varied from 7.2 N/mm^2 to 13 N/mm^2; compression parallel to grain varied from 20 N/mm^2 to 59 N/mm^2; and density varied from 322 Kg/m^3 to 595 Kg/m^3. Four timber strength classes: SG4, SG8, SG12 and SG16 were proposed. It was concluded that structural size MOE and MOR can be estimated from small clear MOE and MOR using reduction factors of 40% and 20% respectively. The NDE approach can be used to predict MOE and MOR of structural size timber. The flexural deflection of timber can be modelled using Finite Element Methods but only up to the elastic limit. It was recommended that more research into the effect of complex knots, cross-grain and grain angle on timber strength be done; post-elastic behaviour of wood should be investigated using numerical modelling and the NDE prototype should be improved to enable precise timber grading.

Keywords: Building, strength, standards, small clear specimens, MOE, MOR, flexure, allowable stress, lesser-known species, modelling, non-destructive evaluation