Title: **Mechanical properties and thermal degradation of bitumen-acacia sap composites**

Author: **Mbithi, Nelson Matheka**

Abstract: The rapid increase in traffic intensity, axle loading, rigorous climatic changes and commercial road transport continues to impose severe demands of load and environment on the highway system. Bitumen mostly used as a binder for road construction, waterproofing agent, coating, and insulation among others has poor mechanical and thermal properties. Different synthetic binder modifies that are being used to improved performance lead to environmental pollution during disposal. Therefore, there is need to use natural modifies which are environmental friendly and improve performance. Acacia sap which is stiff has been used successfully for bitumen modification. Composites of bitumen-acacia sap with different composition of sap percentage ranging from 0% to 62.5% were prepared by injection drawing process. The composites were analyzed by dynamic mechanical analysis (DMA 2980 TA) for relaxation processes and creep analysis, and thermogravimetric analysis (TGA) for thermal properties. The dynamic mechanical analysis measurements were carried out in the frequency scan of 0.3, 1,3,5,10,15,20 and 30 Hz and temperature range from 3 to 50°C. The dynamic mechanical analysis measurement indicated significant increase of the storage modulus and Loss modulus of modified bitumen; depending on the sap content in the bitumen matrix. One relaxation process was observed which was assigned to main chain motion followed Vogel-Fulcher-Tamman (VFT) law. There was also a shift towards a higher value of glass transition temperature of the modified bitumen as acacia sap loading increased. This implies increased resistance to deformation of the binder. Creep analysis showed that the creep decreased with increase of acacia sap loading in the composites and also increased with increase of time and temperature. Temperature dependence of storage master curves follows William-Landel-Ferry (WLF) law. The time-temperature superposition principle master curves indicated prediction of the long-term property of composites and extend up to more than 106s in time scale. The composites with 25% sap and more showed a tendency of faster decrease in storage modulus, which indicates that a low content of sap can enhance creep resistance of materials to a large extent. Thermal degradation measurements were carried out in an oxidative atmosphere using Lindberg/blue-TF55035C tube furnace at heating range of 25-550°C at a rate of 5 °C/min. TGA measurements for all composites showed a single step weight loss. The activation energy of thermal degradation of the blends decreased with acacia sap intake. This implied decreased thermal stability.