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Mechanical characterisation of Nb3Sn cable insulation systems at ambient and cryogenic temperature used for HL-LHC accelerator magnets.

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The performance of accelerator magnets is strongly relying on the dielectric strength given by the electrical and mechanical robustness of the insulation system. This is in particular relevant for the current development of high field superconducting Nb3Sn magnets with their insulation system made from fibre reinforced resin. During the assembly and operation, this insulation system is exposed to high mechanical compressive and shear stresses. The focus of the study was aiming to investigate this mechanical shear strength of the composite. The experimental tests have been performed at room and cryogenic temperature, determining the mechanical strength and the failure mechanisms of the cable insulation system. Within this test the inter-laminar shear strength (ILSS) and non-standardized combined shear compressive strength were determined. The test sample preparation was based on the manufacturing procedures and materials used in the series fabrication for the CERN HL-LHC Nb3Sn coils. The individual insulation systems are varying in the S2-glass yarn density, the sizing, and the fibre volume fraction. Furthermore, the presence of mica insulation on the mechanical strength has also been studied. This paper describes the applied measurement procedures used during the test campaign, and presents the relevant measurement results, identifying the mechanical limitations of the insulation system.

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