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## Mechanical Vibrations of the ATLAS ITk Structures Under Transportation Loads

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The main ITk structures for the ATLAS High-Luminosity LHC Upgrade consist of concentric carbon fiber cylinders, reinforced by hat stiffeners and thick flanges. These structures were manufactured in the US, and then shipped to Europe for dressing and assembly. Although very stiff when assembled, the cylinders are susceptible to large deformations under the dynamic loads occurring during transportation. In order to contain these vibrations, and avoid damages, appropriate shipping boxes were developed. Here we discuss the assumptions made on the road and air shipping loads, reviewing available standards and measurements. Numerical models were used to verify the structural integrity under the shipping loads. The vibrations during the transportation were then measured using accelerometers attached to the shipping boxes. The measured loads were compared with the numerical model results, which were found to be slightly stiffer than reality, due to the bonding assumptions between the different components. The validated model was then used to obtain a transfer function of the shipped assembly and compute the applied transportation loads. The results of this study could contribute to the safe and efficient transportation of similar structures in the future.

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