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Passive Control of Base Flows and Impact of Quarter Rib Radius and Locations at Sonic Mach Number
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Abstract
The study of turbulent flow at large Reynolds numbers continues to be an area of research with the advent of the space shuttle and the design and development of supersonic/hypersonic missiles and planes. Whenever there is a sudden expansion, this results in a low-pressure recirculation region at the blunt base of the shells, rockets, and missiles. As high as seventy percent of the total drag is because of the low base pressure in the form of base drag. Therefore, any increase in base pressure will enhance the range of the missiles, rockets, bombs, and artillery shells, leading to enormous savings in fossil fuels, a reduction in carbon emissions, and a reduction in global warming. This study assesses the effectiveness of passive control as a quarter circle at Mach M = 1 for a duct of diameter 22 mm of length L = 1D to 6D. The study was conducted for a nozzle pressure ratio of 1.5 to 5. At sonic Mach M = 1, when the passive control is placed at various locations in the duct, the optimum location and radius of the rib seem to be 1D, 1.5D, 2D, and 4 mm, resulting in a base pressure almost double the ambient pressure for orientation1 of the rib where flow from the Nozzle sees curved part of the rib. The base pressure equals the ambient pressure for a 3 mm rib radius at 1D, 1.5D, and 2D. When the rib is located at 0.5D, there is an increase in the base pressure due to the presence of the rib. However, the base pressure magnitude is lower than attained for 1D, 1.5D, 2D, and 3D rib locations. The best options for orientation 2 of the rib locations are 1.5D and 2D. No appreciable results are obtained when the rib is placed at 3D for both orientations.

Author Keywords
Base Drag; Critical Mach Number; L/D Ratio; Passive control; Rib

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