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A New Design and Numerical Analysis on Mechanical Behavior of Bluff Bodies in Reacting Flow

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***Abstract:** The bluff-body flame stabilization scheme typically employed in turbojet and ramjet for after burners applications are of particular interest of this study. Where computational and experimental work of bluff bodies for reacting flow was already found in the literature. In this present study by using Mild Steel (MS), Stainless Steel (SS) the modeling and numerical analysis of different types of shapes in bluff bodies is numerically analyzed, moreover thermal behavior change in material properties of bluff bodies in reacting flow also analyzed. And cylindrical shape, square shape and different types of v-gutter sizes are analyzed in both numerically and by using simulation method. A 3-D modeling done by using SOLID WORKS, and analyzed by using ANSYS 14.5*

***Keywords:** Bluff bodies, V-gutter, burners.*

1. INTRODUCTION

Bluff bodies are used to stabilize the combustion flames. This phenomenon's are a frequently studied in aircraft engine afterburner applications. The flame behaviour in a confined duct as in an aircraft combustor is completely divergent from atmospheric flames. The laboratory flames as in an unvitiated environment to withstand the heat absorbed in the flame holder.

Bluff body flame holders are employed to hold and stabilize the flames. Bluff-body stabilized flames for reacting case helps in understanding the shear effect on the vortex in the flow. Numerous researches have been conducted previously in the concept of flashback, liftoff and blowout by using various shapes of bluff bodies [1-6] various researchers are reported the numerical simulations using computational methods for flow over bluff bodies in reacting and non-reacting conditions [7-10].

The principle characteristics of bluff body stabilized flames is the existence of a strong recirculation zone behind the flame holding devise, which is frequently in the form of a "Vee gutter" with the vee facing upstream. The current paper shows the mechanical behavior of bluff bodies in reacting flow.

2. METHODOLOGY

In this three dimensional modelling was done by using SOLID WORKS, whereas there are two types of design was made in this study they are v-gutter, cylindrical shape bluff bodies was modelled and analyzed. And there are two types of materials is used for analyzing purpose they are Mild Steel (MS) and Stainless Steel (SS). In this tube length is 600mm, V-gutter angle is 60 degree, and width is 62mm.

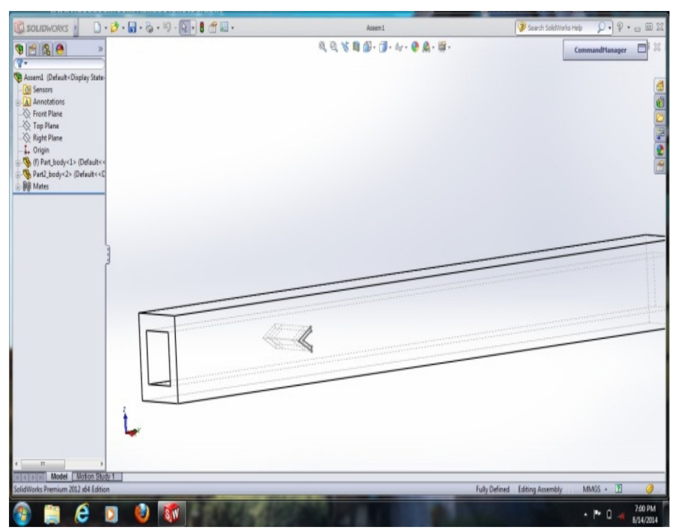

Figure1. 3-D modelling of V-gutter

Table 1. Material Properties

Sl. No.	Materials	Young's Modulus (GPa)	Poisson Ratio
1	Stainless Steel (SS)	210	0.28
2	Mild Steel (MS)	210	0.29

After designing this two sizes of bluff bodies it is transferred into IGES format for analyzing purpose. Where Static structural analysis was done by using ANSYS 14.5

2.1 Steps followed for the analyzing

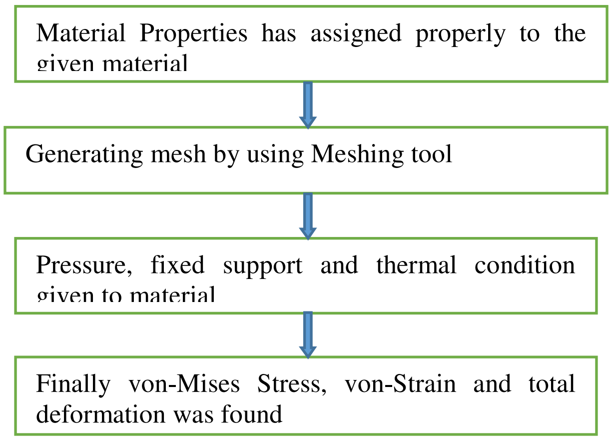

Figure 2. Steps to be followed for the Analysis

3. RESULTS AND DISCUSSION

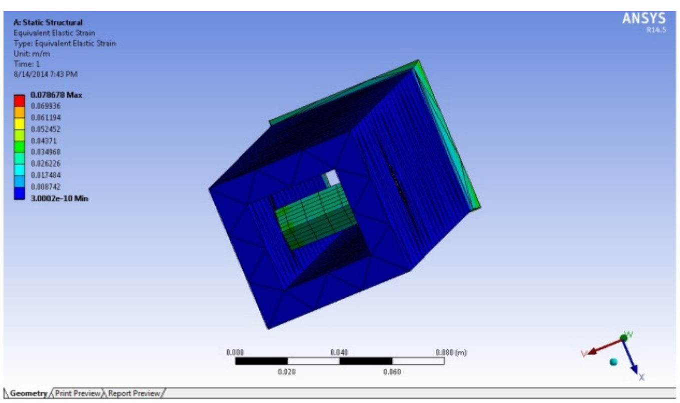

Figure 3. von-Mises Strain of V-gutter bluff body Using Stainless Steel

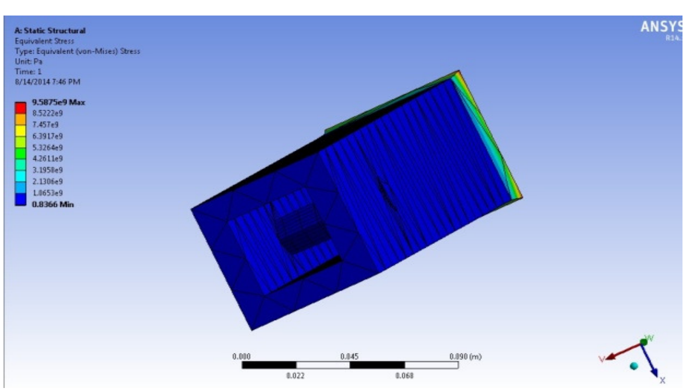

Figure 4. von-Mises Stress of V-gutter bluff body Using Stainless Steel

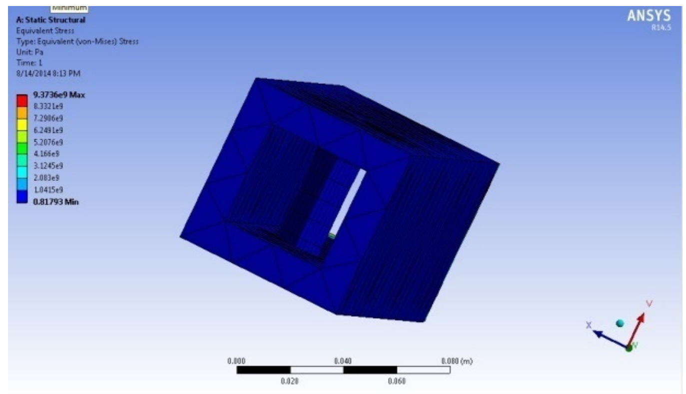

Figure 5. von-Mises Stress of V-gutter bluff body Using Mild Steel

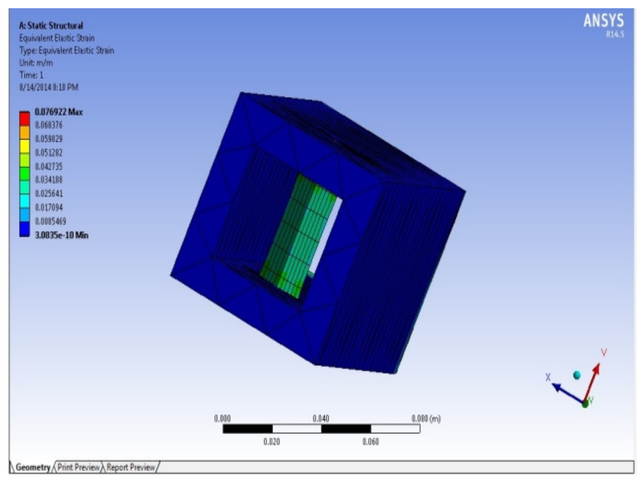

Figure 6. von-Mises Stress of V-gutter bluff body Using Mild Steel

Table 2. Stress and strain values of v gutter bluff body (SS & MS)

Material	Thermal Condition (°C)	von-Mises Strain (m/m)	von-Mises Stress (Pa)
Stainless Steel	700	0.0288	$3.510\ e^9$
	1000	0.0408	$4.969\ e^9$
	1300	0.0527	$6.427\ e^9$
	1600	0.0647	$7.885\ e^9$
	1950	0.0787	$9.587\ e^9$
Mild Steel	700	0.0270	$3.29\ e^9$
	1000	0.0390	$4.75\ e^9$
	1300	0.0509	$6.20\ e^9$
	1600	0.0629	$7.67\ e^9$
	1950	0.0769	$9.37\ e^9$

Table 3. Stress and strain values of cylindrical bluff body (SS & MS)

Material	Thermal Condition (°C)	von-Mises Strain (m/m)	von-Mises Stress (Pa)
Stainless Steel	700	0.027	3.7 e^9
	1000	0.039	5.4 e^9
	1300	0.051	7.1 e^9
	1600	0.063	8.7 e^9
	1950	0.077	9.1 e^9
Mild Steel	700	0.028	3.76 e^9
	1000	0.041	5.43 e^9
	1300	0.052	7.10 e^9
	1600	0.065	8.77 e^9
	1950	0.079	9.77 e^9

As we analyzed in different parameters in this two types of shape by giving different thermal conditions we found that V-gutter shape is withstanding more stress and strain.

4. CONCLUSION

Thermal Behavior changes in material properties of cylindrical and v-gutter bluff bodies are analyzed by using simulation method. A three-dimensional modelling was done by using solid works and analyzed by using ANSYS WORKBENCH 14.5. From the results we predicted that v-gutter bluff bodies with stainless steel withstand more strength compared to mild steel. Where thermal condition is increasing both von-Mises Stress and Strain are also getting increased.

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