

Design of Solid Rocket Booster based on Collaborative Design Theory

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ABSTRACT

In this study, a design cycle of strap on booster is presented. This procedure, based on conceptual design of solid rocket motor and statistical studies of strap on booster, is derived. The conceptual design, usages the collaborative design that enables the user interfaces to affection the design parameters. Afterwards, the software of solid rocket design and simulation of missile flight has been produced.

KEYWORDS : Strap on Booster Design, Conceptual Design, Solid Rocket Motor

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P_e

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(\dot{m}) (M_e)

(C_f) (A_t)

(I_{sp}) (T) .[]

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			()
	×	γ	
	×	R	(m ² /sec ² °K)
	×	T_f	(°K)
	×	P_c	(bar)
	×	P_e	(bar)
×		M_e	
×		A_p/A_t	
×		A_t	(m ²)
	×	D_e	(m)
×		C_f	
×		Th	(N)
×		I_{sp}	(sec)
×		\dot{m}	(kg/sec)
	×	K_f	

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I_{sp}

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(P_c) γ P_e γ R

(M_e) ($\frac{A_e}{A_t}$) T_f

(C_f) ($\frac{A_e}{A_t}$) P_c



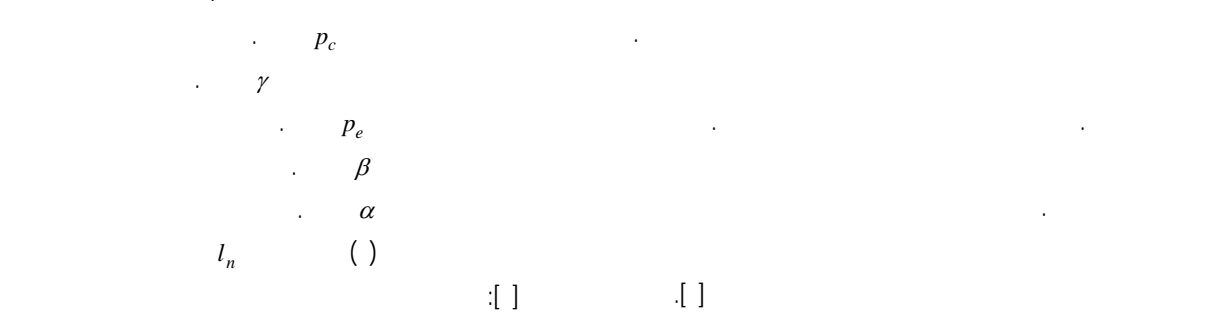
$$\lambda = \frac{A_{fuel}}{A_t} \quad (1)$$

$$A_{fuel} = \lambda \frac{\pi D_G^2}{4} \quad (2)$$

$$A_p = (1 - \lambda) \frac{\pi D_G^2}{4} \quad (3)$$

$$L_G = \frac{m_p}{\rho A_{fuel}} \quad (4)$$

$$\dot{r} = a p_c^n \quad (5)$$



$$l_n = l_1 + l_2 \quad (6)$$

$$l_1 = r_m \cot \beta \quad (7)$$

$$l_2 = l_3 - l_4 = (r_e - r_t) \cot \alpha - r_t \cot \beta \quad (8)$$

$$\rightarrow l_n = (r_m - r_t) \cot \beta + (r_e - r_t) \cot \alpha \quad (9)$$

$$\dot{m} = A_b \dot{r} \rho \quad (10)$$

$$D_{G_e} = D - 2(\delta_c + \delta_i + \delta_l) \quad (11)$$

$$m_{insul} = 0.02m_{motor} \quad ()$$

(A_p)

$$\frac{A_p}{A_t} \geq 2 \quad ()$$

$$0.3 \leq \frac{2 \times web}{D} \leq 0.6 \quad ()$$

$$web = t_b \times r \quad ()$$

$$p_c = f_s \cdot MEOP \rightarrow t_{cs} = \frac{p_c r_{cs}}{F_{tu}} \quad ()$$

$$m_{case} = (\pi D L_G) t_{cs} \rho_{cs} \quad ()$$

$$m_{noz} = 0.256 \times 10^{-4} \left[\frac{(m_p c^*)^{1.2} \varepsilon^{0.3}}{p_c^{0.8} t_n^{0.6} (tg(\theta_{cn}))^{0.4}} \right]^{-0.917} \quad ()$$

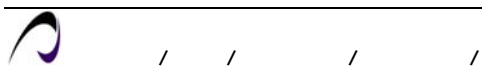
$$c^* = \frac{\sqrt{\gamma R T}}{\gamma \left[\frac{2}{\gamma+1} \right]^{2(\gamma-1)}} \quad ()$$

$$\varepsilon = \frac{A_e}{A_t}$$

$$/ \leq \frac{L}{D} \leq / \quad ()$$

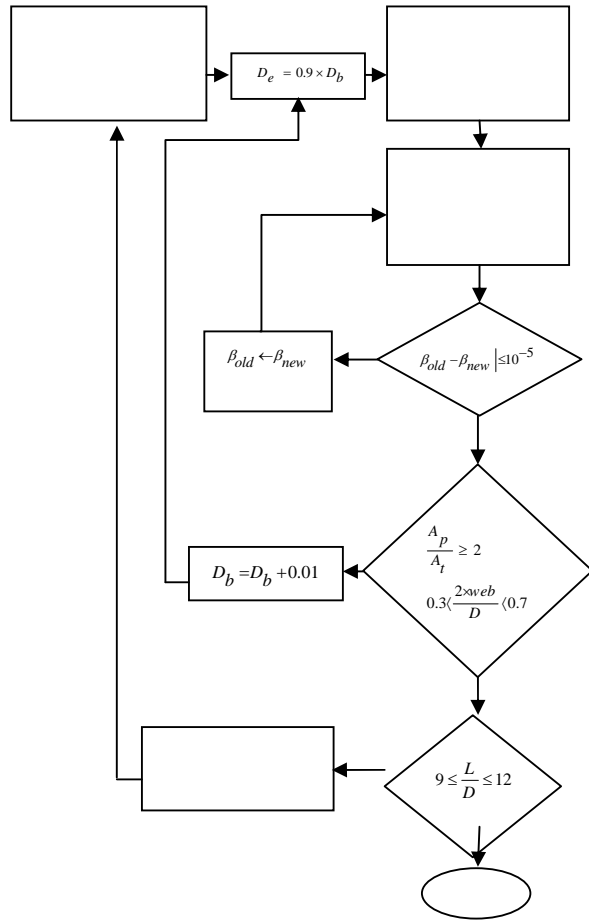
$$D = -0.0088 \times m_{motor}^2 + 0.1796 \times m_{motor} + 0.176 \quad ()$$

$$m_{ig} = 12.27 V_{port}^{0.571} \quad ()$$

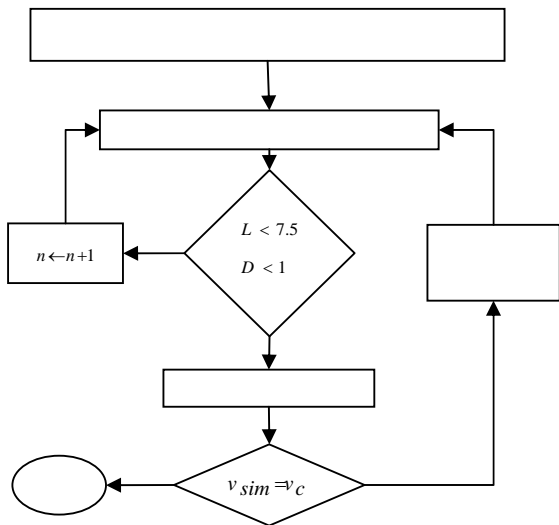


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$$M_T = M_I + \sum_{i=1}^n m_b$$

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$$M_I = M'_I + M_{SI} + M_{PI}$$

$$M_{SI} = M_{engin} + M_{control} + M_{\tan k}$$

$$m_b = m_s + m_p$$

$$M_T = M_I + n \times m_b$$

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$$\left. \begin{aligned} \alpha &= \frac{n \times m_p}{M_{PI}} \rightarrow M_{PI} = \frac{n \times m_p}{\alpha} \\ M_{\tan k} &= M_{PI} * ATO \end{aligned} \right\} \rightarrow$$

$$M_{\tan k} = \frac{ATO * n * m_p}{\alpha}$$

$$M_T = M_{PI} + M'_I + M_{engin} + M_{control} + \dots$$

$$\frac{ATO * n * m_p}{\alpha} + \frac{n \times m_p}{\alpha} + n \times m_p \times \left(\frac{1}{1-\beta}\right)$$

$$m_p = \frac{M_T - M_{PI} - M'_I - M_{engin} - M_{control}}{n * \left(\frac{ATO + 1}{\alpha} + \frac{1}{1-\beta}\right)}$$

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(Φ)	(\mathcal{G})		
/		(m/s)	(km)

()

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:()

(N)
(sec)
(kN * s) ()
(sec)
(m)
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/
/
/
/
(kg)
/
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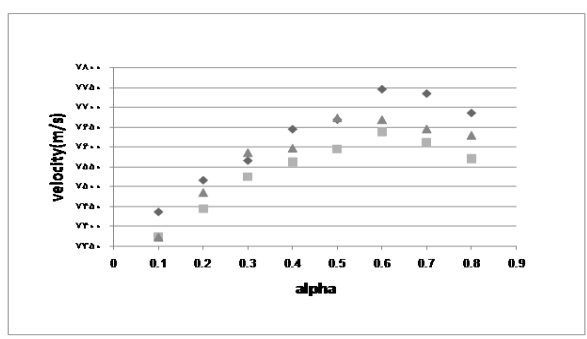
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α : ()

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$\alpha = /$

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α : ()

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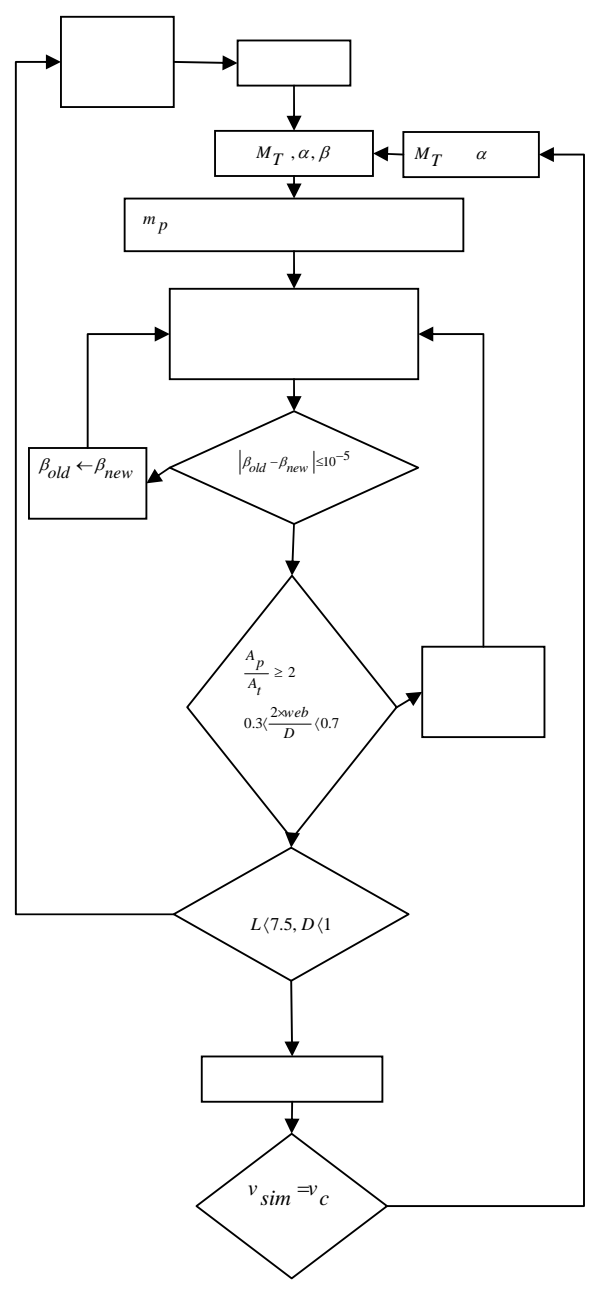
$$\frac{T}{W}$$

α
 α

$$1 \leq \alpha \leq 1$$

α

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()

α

α

M_T

α

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α

$\times /$

$\times /$

	(N)
/	(sec)
	(kN *s)
	(sec)
(m)	
/	
/	
/	
/	
(kg)	
/	
	(N)
	(sec)
(kg)	
/	ATO

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¹ Iteration

² Full Expansion

³ Volumetric Loading Fraction