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DEPARTMENT OF MECHANICAL ENGINEERING

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CERTIFICATE

This is certify that, the project entitled **"DEVELOPMENT OF MATHEMATICAL MODEL FOR VACUUM DAMPED RECOIL SYSTEM"** is bonafide work done under our guidance and is submitted by **Yogesh A. Varade** to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur for the partial fulfillment of requirement for the award of post-graduation degree, **Master of Technology (M. Tech.)** in **Mechanical Engineering Design (M.E.D.)** .

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ABSTRACT

The recoil system is mainly used to absorb the recoil force during firing, and furthermore it can use compressed gas or springs to return the gun tube to its original position for artillery weapons. In other words, the recoil motion is the rearward movement of the gun during and after firing. The recoil motion is caused by the reaction of the projectile and the propellant gases. After recoil, the gun and connecting parts return to the original firing position. In recent years, the development trends of artillery weapons with recoil systems focus on the reliability and simplicity. Therefore, a small volume, high recoil efficiency, and low cost of recoil systems are necessary.

This thesis presents development of mathematical model for vacuum damped recoil system, formulated to predict response of vacuum damped recoil system. Mathematical models usually describe a system by a set of parameters and set of equation that establish relationship between the parameters of recoil system. The objective of the present work is to create a mathematical modeling of the vacuum damped recoil system, which include the recoil system parameters such as recoil time, vacuum developed, recoil length, force to pull the barrel and mass of barrel. Finally, the relation between these parameters is setup by formulating the mathematical model for recoil time and force of vacuum damped recoil system.

A crucial part of the mathematical modeling process is the validation of whether or not a given mathematical model describes a system accurately. After developing the mathematical model for vacuum damped recoil system its validation is successfully carried out, which show correctness of mathematical model.

RESULTS AND CONCLUSION

8.1 RESULTS

1. Thus mathematical model is developed for vacuum damped recoil system to calculate recoil time and force.

$$\text{Recoil time } t = 0.0511 \frac{l}{d}\sqrt{\frac{m_b}{dp}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(A)}$$

$$\text{Force } F = 0.213\, lpd \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(B)}$$

2. By using equation (A) and (B) recoil time and force can be calculated respectively for vacuum damped recoil system by knowing the other parameters in the equations.
3. The value of constants k_1 and k_2 in mathematical model of recoil time and force respectively are calculated as 0.0511 and 0.213.
4. For recoil time the coefficient of determination R^2 = 0.863 (86.3%), it is clear that the experimental and analytical recoil time good fit to each other, hence the mathematical model develop for recoil time is valid.
5. For force the coefficient of determination R^2 = 0.895 (89.5%), it is clear that the experimental and analytical force good fit to each other, hence the mathematical model develop for force is valid.
6. Thus studied the vacuum damped recoil system.

8.2 CONCLUSION

Recoil system is core part of artillery weapon and performance of artillery weapon is depending on it. The time between two consecutive firing should be minimum thus the recoil system must be reliable and simple in maintainability. The vacuum damped recoil system is reliable and simple to use. The mathematical model is developed for vacuum damped recoil system to calculate recoil time and force. To validate these mathematical models, coefficient of determination R^2 is calculated. Coefficient of determination is an

important tool in determining the degree of linear correlation of variables ('goodness of fit'). The coefficient of determination for experimental and analytical recoil time comes 0.863 and correlation coefficient is 0.929 very close to 1 which interpreted strong positive relation between experimental and analytical recoil time, good fit to each other. In the same way the coefficient of determination for experimental and analytical force comes 0.895 and correlation coefficient is 0.946 very close to 1 which interpreted strong positive relation between experimental and analytical force, good fit to each other. Hence it is concluded that mathematical model formulated for recoil time and force of vacuum damped recoil system is valid, recoil time and force can be calculated using this model very easily by knowing the other parameters in the model.