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Analysis and Performance Evaluation of Twin Leaf form Spring for Damping Engine Vibrations in Agriculture Sprayer

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Abstract **-Many a agriculture equipment operated as hand held or back mounted are operated using micro – petrol/gasoline engine. These engines range between 1 to 1.5 Kw power and are mounted on the frame that is held and supported on the back of the operator. Generally agriculture spray pumps are commonly used in this manner. The operations of these engines is not vibration free, these vibrations are damped using rubber bushes between engine base and mount plate. As these engine vibrations are substantial they lead to back pain and other health disorders hence need to be effectively damped. The Twin leaf form spring device uses the concept of stiffness of steel and shock absorbing capacity of poly vinyl rubber elastomer to create the desired damping effect.**

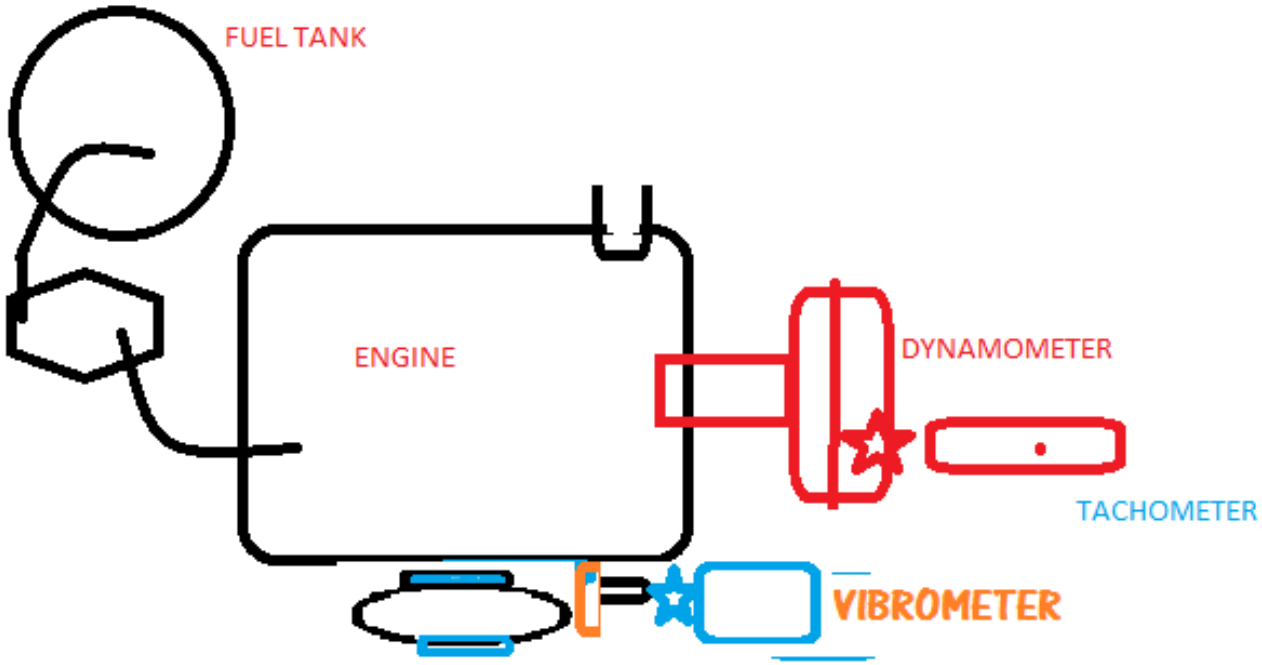
The arrangement will be introduced between the engine base and the mount plate along with foundation bolts. The paper presents the analysis of the elastomer inserts used for damping the top / bottom mount brackets and vibrational performance of the device as to amplitude, velocity and acceleration of the engine base before and after use of damper at various throttle openings.

Keywords- **Finite Element Analysis, Agriculture spray, Elastomer inserts, modal analysis. Testing.**

IV. Experimental Analysis

4.1 Schematic of test Rig and Test Setup

Schematic of the test rig is as follows :



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4.5 Testing Result for Performance Evaluation of Twin Leaf Spring Damper for Various Throttle Opening of the Engine (Spring Steel Spring Without Centre Hole)

Fig.4.5 Spring steel without centre Hole

Procedure of Trial:

1. The engine is started.
2. The throttle is taken to full opening position to generate maximum rpm @no load condition.
3. Speed at engine output pulley is measured.
4. The vibration parameters of displacement and acceleration are measured.
5. The throttle is closed by 10% (i.e 90 % throttle opening is maintained) approximately
6. Speed at engine output pulley is measured.
7. The vibration parameters of displacement and acceleration are measured.
8. Similar set of readings are repeated and tabulated in result table below.

Table 4.2
Test result for spring steel without centre hole

SR .NO	% Throttle opening	SPEED	Displacement (mm)	Acceleration mm/sec2
1	100	5000	0.96	702
2	90	4640	0.91	685
3	80	3890	0.86	651
4	70	3190	0.79	626
5	60	2920	0.71	591
6	50	2510	0.64	583

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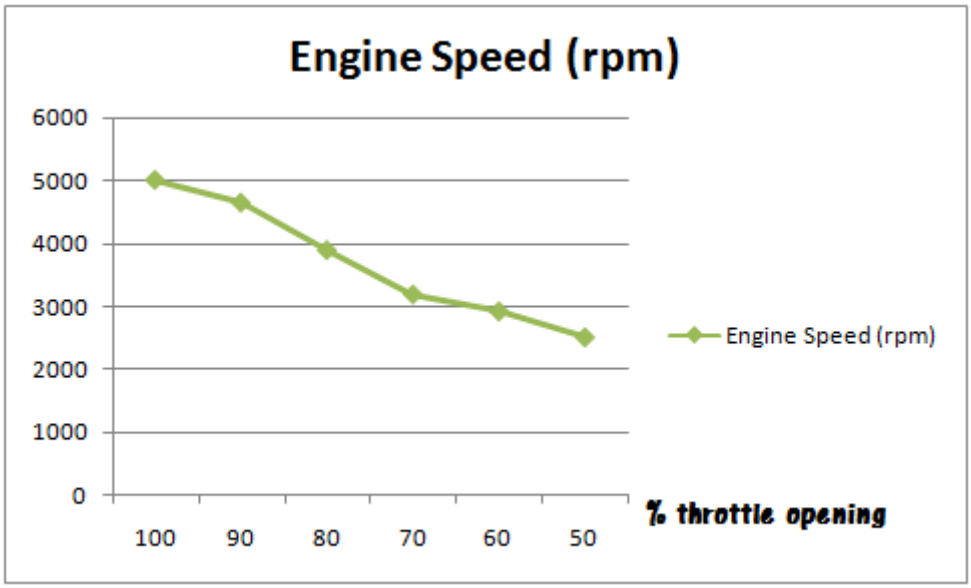

Fig.4.6 Engine speed v/s throttle opening

The engine speed increases with increase in throttle opening

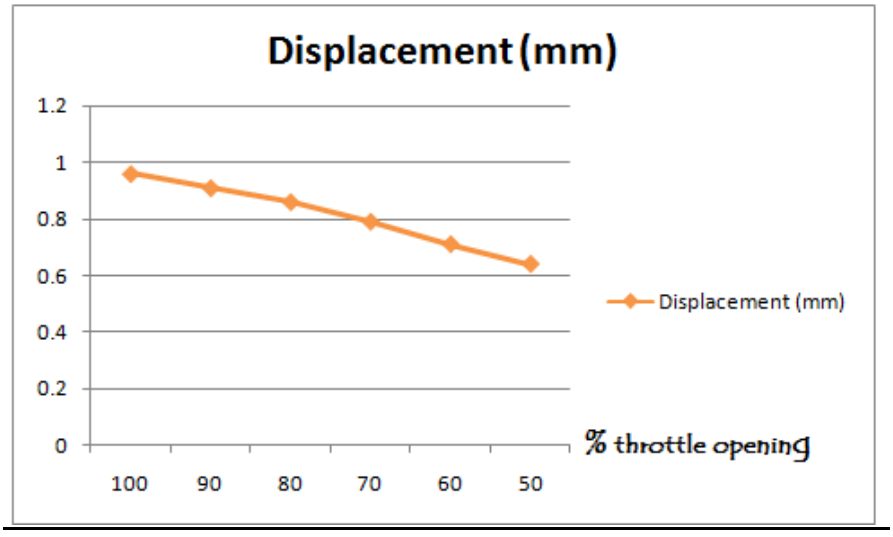

Fig.4.7 Displacement v/s throttle opening

Engine vibration displacement increases with increase in throttle opening as engine speed increases but is maintained well below 1mm by use of the twin leaf spring damper.

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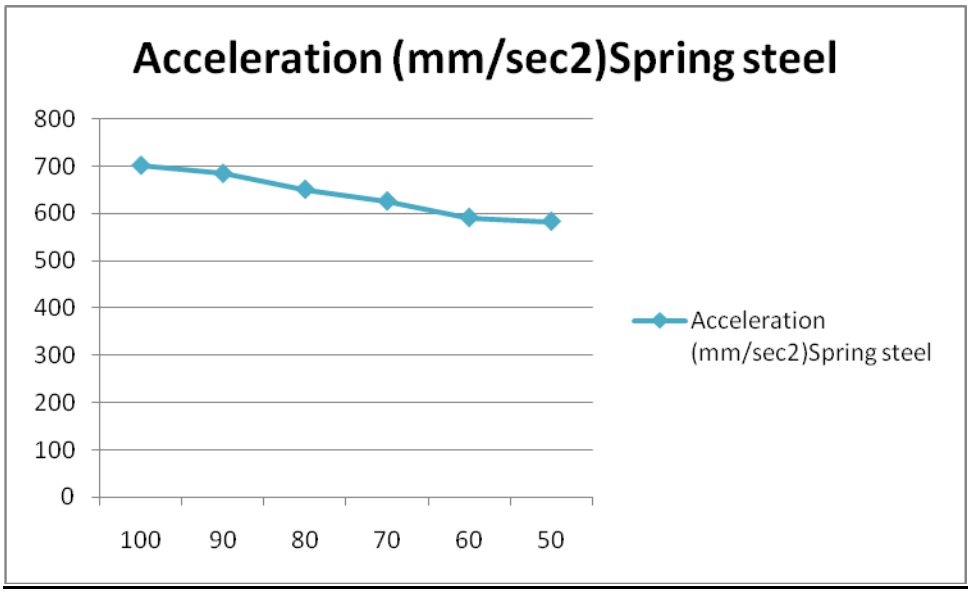

Fig.4.8 Acceleration v/s throttle opening

Engine vibration acceleration increases with increase in throttle opening as engine speed increases but is maintained well below 1m/sec2 by use of the twin leaf spring damper.

4.6 Testing Result for Performance Evaluation of Twin Leaf Spring Damper for Various Throttle Opening of the Engine (En8k Spring Without Centre Hole)

Table 4.3
Test result for En8k without centre hole

SR .NO	% Throttle opening	SPEED	Displacement (mm)	Acceleration mm/sec2
1	100	5000	1.12	756
2	90	4640	0.94	710
3	80	3890	0.89	681
4	70	3190	0.81	656
5	60	2920	0.74	611
6	50	2510	0.67	593

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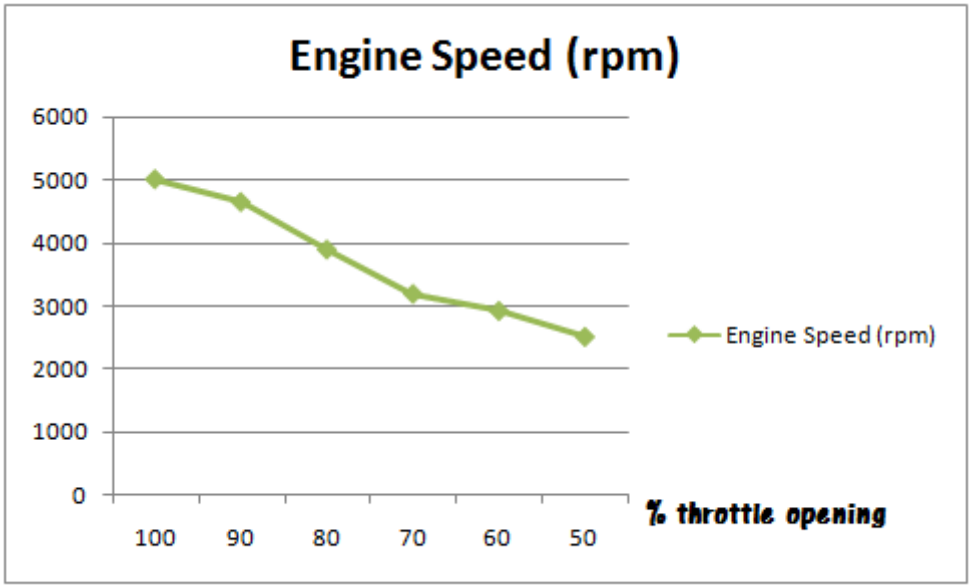

Fig.4.9 Engine speed v/s throttle opening

The engine speed increases with increase in throttle opening.

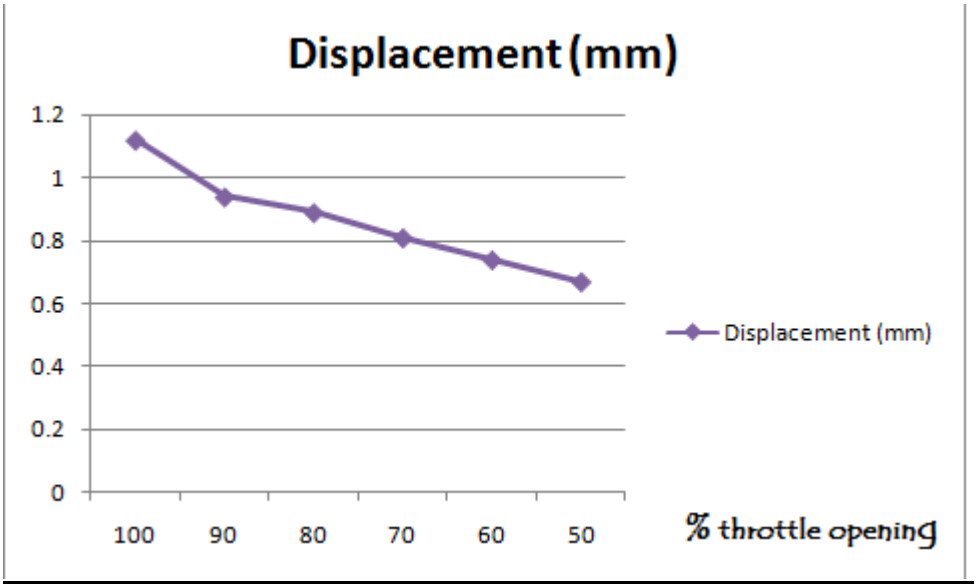

Fig.4.10 Displacement v/s throttle opening

Engine vibration displacement increases with increase in throttle opening as engine speed increases but is maintained slightly above 1mm by use of the twin leaf spring damper.

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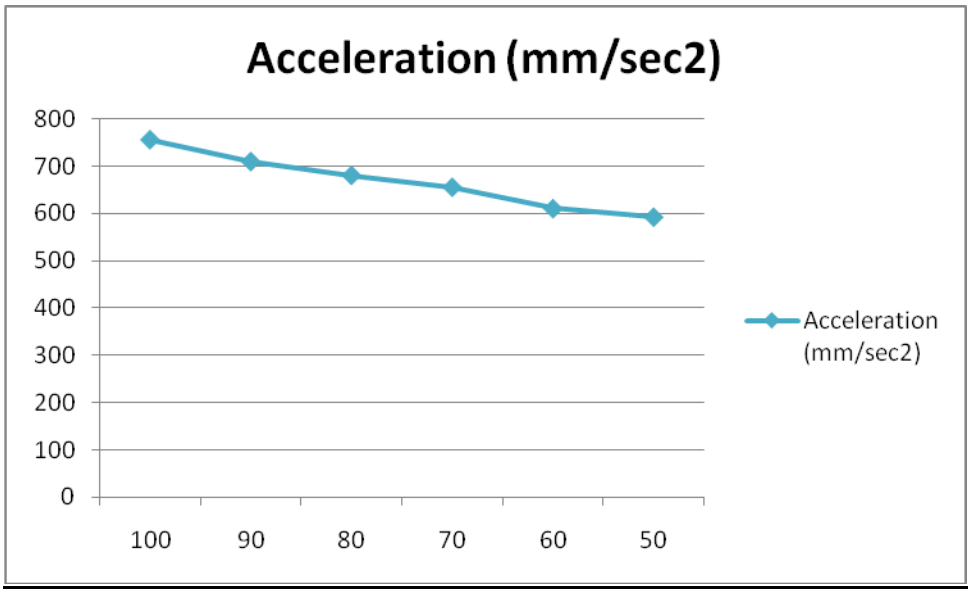

Fig.4.11 Acceleration v/s throttle opening

Engine vibration acceleration increases with increase in throttle opening as engine speed increases but is maintained well below 1m/sec2 by use of the twin leaf spring damper.

4.7 Comparative graphs (spring steel spring ----En8k spring)

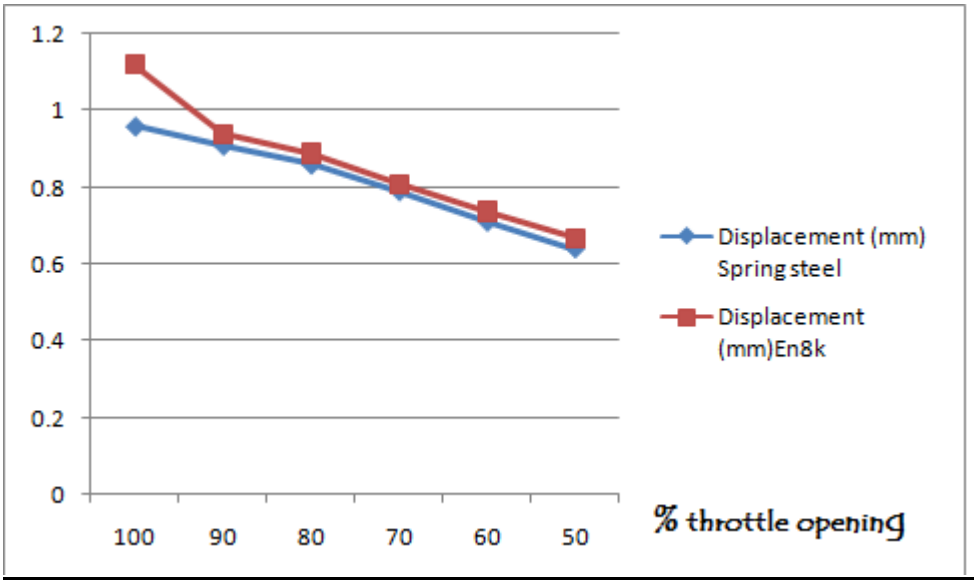

Fig.4.12 Displacement v/s throttle opening

The spring steel spring shows less displacement than the En8k spring suggesting that the spring steel springs shows better performance.

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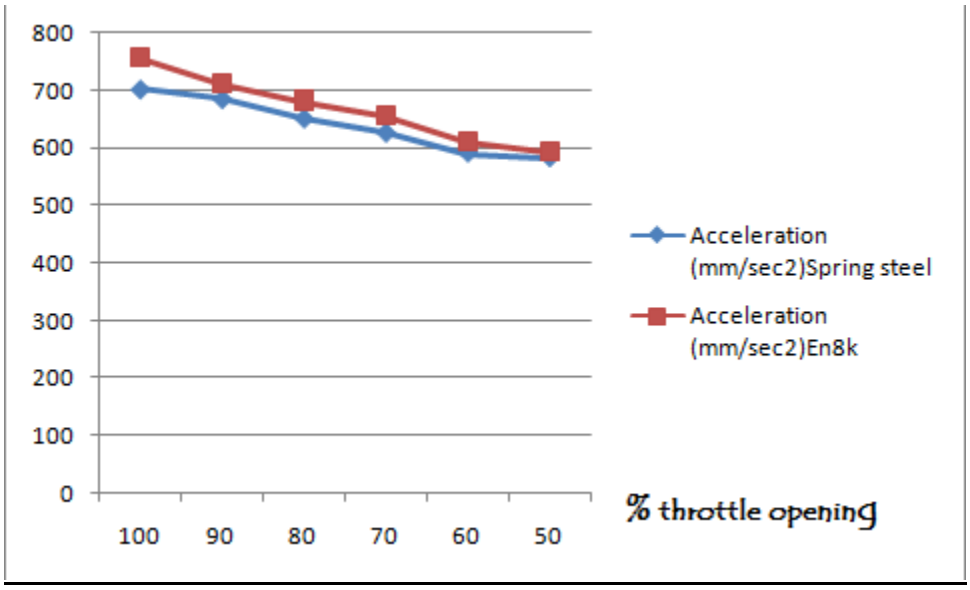

Fig.4.13 Acceleration v/s throttle opening

The spring steel spring shows less acceleration than the En8k spring suggesting that the Spring steel springs shows better performance.

4.8 Comparative graphs spring steel spring (plain) Vs Spring steel spring with hole

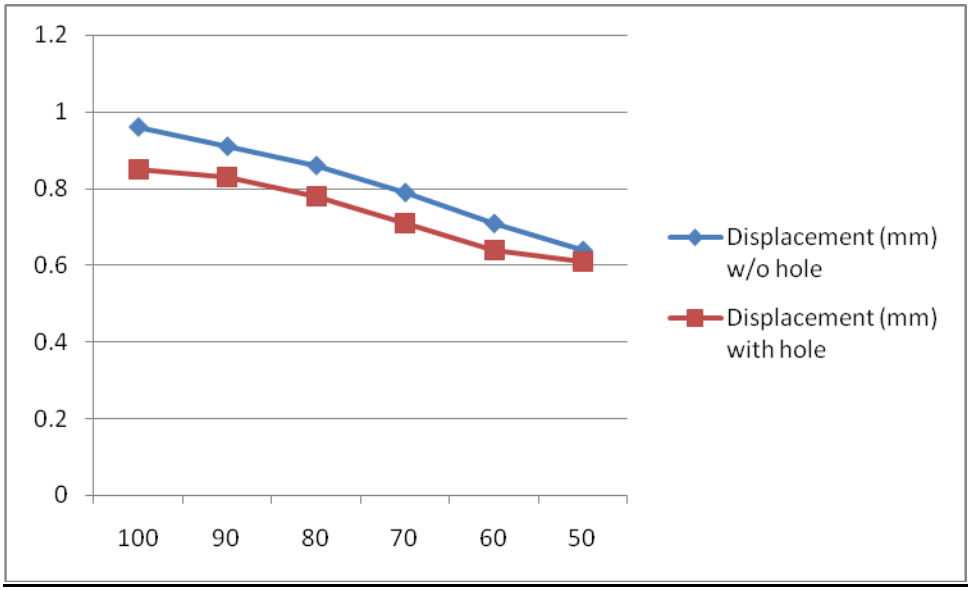

Fig.4.14 Displacement v/s throttle opening

The spring steel with hole shows less displacement than the Spring steel spring without hole suggesting that the Spring steel springs with hole shows better performance.

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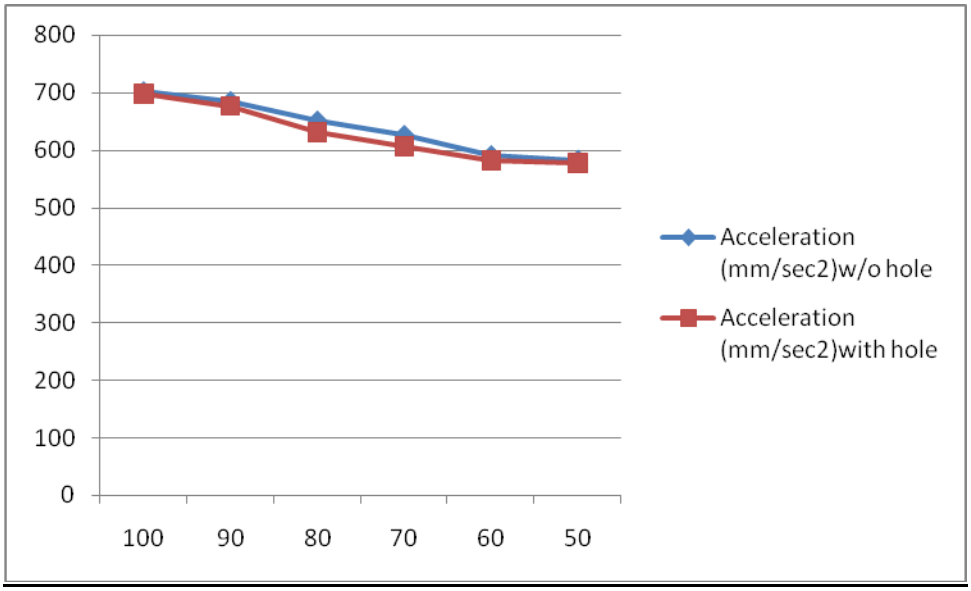

Fig.4.15 Acceleration v/s throttle opening

The spring steel with hole shows less acceleration than the Spring steel spring without hole suggesting that the Spring steel springs with hole shows better performance.

4.9 Performance Evaluation as to Performance of Conventional Rubber Mount for Various Throttle Opening of the Engine.

Fig.4.16 Rubber Mount

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Table 4.4
Test result for Rubber mount

SR .NO	% Throttle opening	SPEED	Displacement (mm)	Acceleration mm/sec2
1	100	5000	2.21	756
2	90	4640	2.36	778
3	80	3890	2.48	796
4	70	3190	2.68	810
5	60	2920	2.76	832
6	50	2510	2.98	851

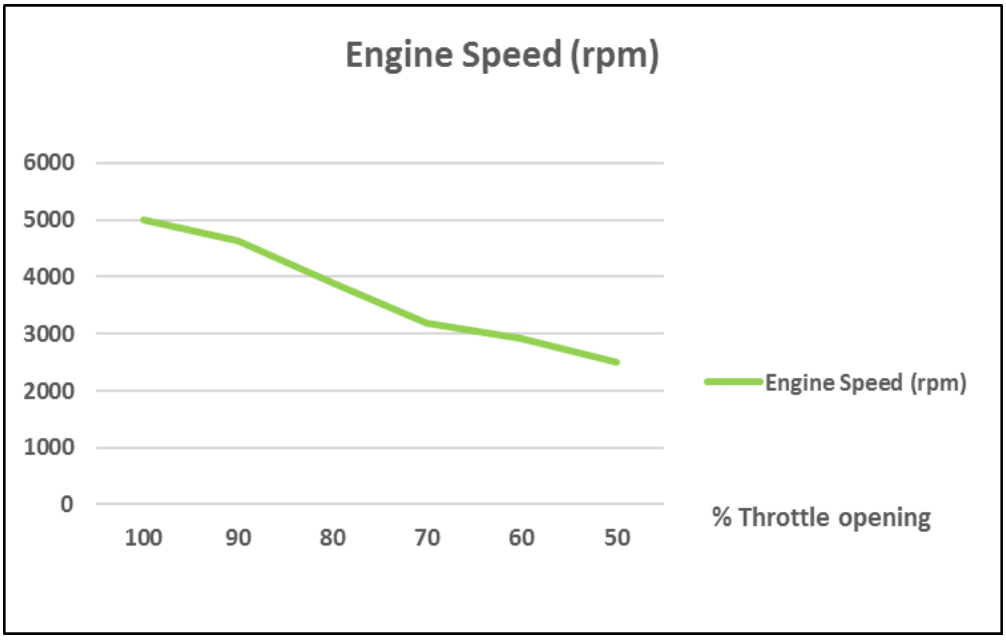

Fig.4.17 Engine speed v/s throttle opening

The engine speed increases with increase in throttle opening.

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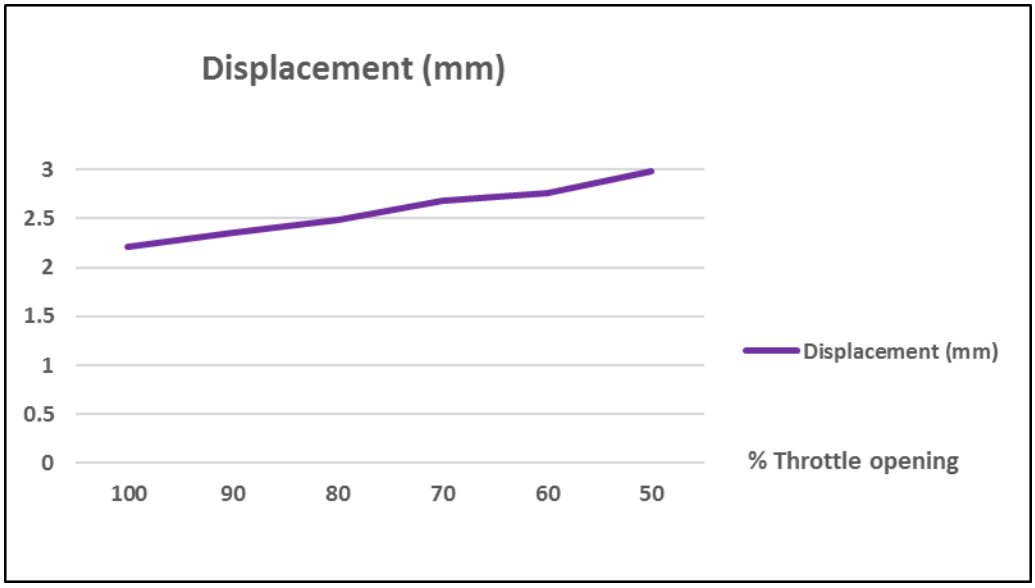

Fig.4.18 Displacement v/s throttle opening

Engine vibration displacement decreases with increase in throttle opening as engine speed increases.

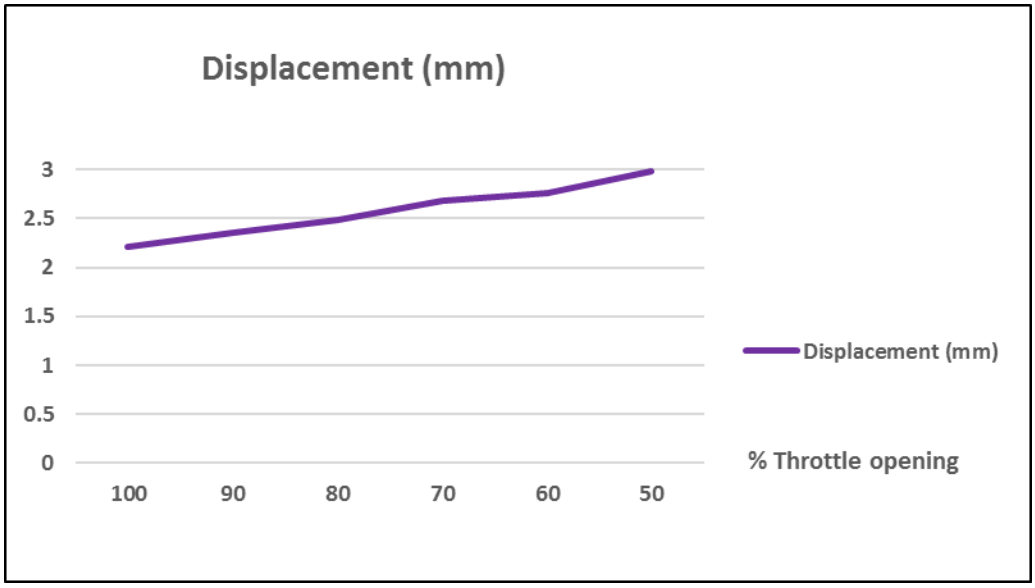

Fig.4.19 Acceleration v/s throttle opening

Engine vibration acceleration decreases with increase in throttle opening as engine speed increases.

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4.8 Comparative graphs Rubber MountVs Spring steel

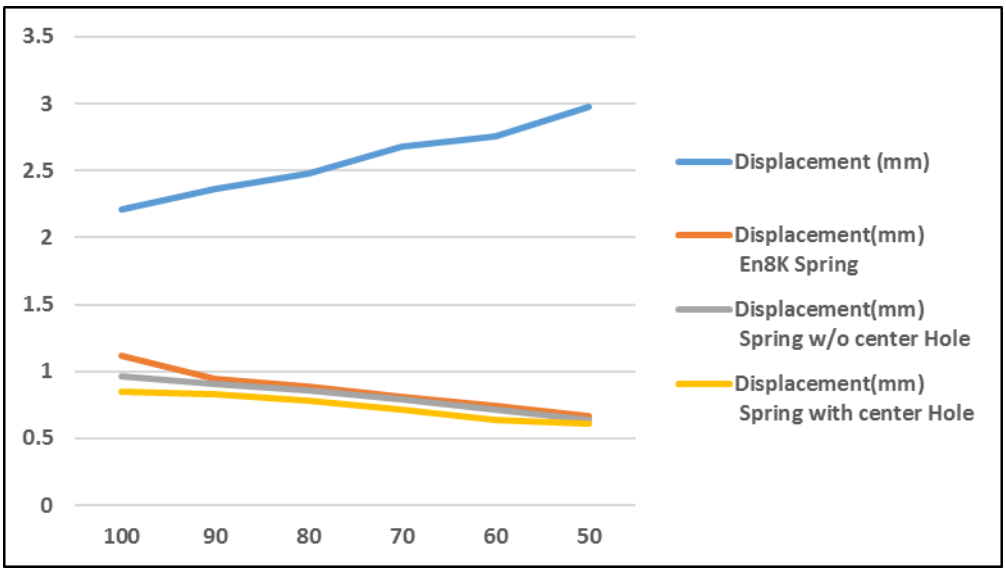

Fig.4.20 Displacement v/s throttle opening

The Rubber mount shows less displacement than the spring steel.

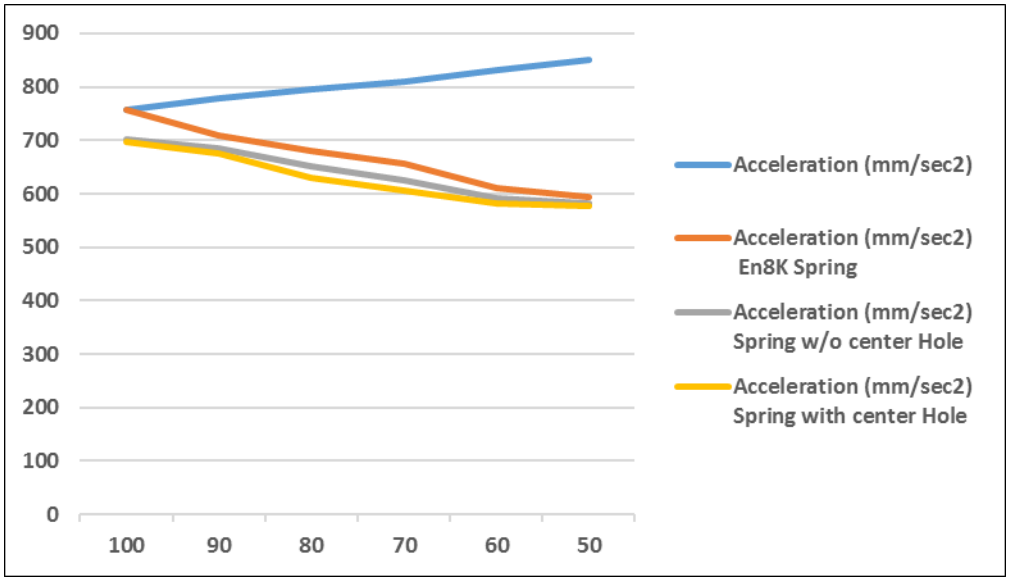

Fig.4.21 Acceleration v/s throttle opening

The Rubber mount shows less acceleration than the Spring steel.

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V. Final Results And Discussion

1. The top/bottom clamp bracket analysed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.
2. The Spring steel leaf analysed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.
3. The eartlon liner analysed using ANSYS shows stress well below allowable limit and deformation is negligible hence it is safe under given system of loads.
4. Engine speed increases with increase in throttle speed.
5. The displacement value of acceleration increases with engine speed but is maintained well below 1mm by the twin leaf design.
6. The acceleration value of vibration by use of the twin leaf design is maintained well below 1m/sec2 which is far below permissible limit of 6.8 m/sec2 for hand arm vibration in hand tools.
7. Performance of the spring steel springs with centre hole is better than that of the spring steel spring without centre hole
8. Performance of the spring steel springs with centre hole is better than that of the EN8k spring without centre hole

VI. Future Scope

1. Central stiffener can be provided as a helical compression spring to improve load handing ability
2. Hydraulic damper can be inserted between the top and bottom plates to improve load handling ability.

Advantages:

1. Low cost solution to vibration reduction
2. Easy installation
3. Minimum maintenance
4. Low space requirement

Disadvantages

1. Moderate load handling capacity
2. Suitable to Fractional horse power engine.ie cannot be used for heavy engines.

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