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DYNAMIC ANALYSIS OF WATT AND MODIFIED WATT GOVERNOR TO INCREASE MINIMUM SPEED

SURARAPU GIRIBABU[1], UOTKURI NAGAMANI[2] and MEKALA RAJITHA[3]
[1,2,3] *Assistant Professor in Department of Mechanical Engineering, TKRCET Hyderabad*

Abstract- The function of the governor is to maintain the mean speed of the engine with in specified limits whenever there is a variation of the load. The objective of our investigation is modifying the Watt Governor (pendulum type) to increase minimum speed limit. Generally we seen that watt governor is best suitable for 60-80r.p.m [4] minimum speeds only, in our study we extend lower arm and fly ball position of the watt governor to the downside from the intersection of link and arm, and then we derive the equation for governor speed. This analysis carried out by extension of lower links of the governor and position of fly balls. And also identify the stress concentration areas, areas which are most susceptible to failure when governor is rotating about its axis, also the value of these stresses is measured. This analysis is carried out with the help of PRO E and ANSYS. Effect of the "WEIGHT OF THE ARMS" is the major area of concern for our study and all the calculations are done considering the weight of the arms. Weight of the arms acts on the centroid of the arms and when the governor assembly rotates, centrifugal force starts acting on the centroid of the arms and tends to deflect the arms, this deflection or bending is to be observed. In our work, we have done the Stress analysis on a particular configuration of governor assembly and then various materials are suggested on a theoretical basis.

Index Terms: speed of governor, total deformations equivalent elastic strain, and equivalent stress

I. INTRODUCTION

A Governor, or speed limiter is a device used to measure and regulates the fuel supply to the engine with respect to the engine load variations, when a load on the engine increases sleeve move downwards and due to attached bell crank lever to the supply valve, the fuel supply will decreases and vice-versa. This can regulate the fuel supply to the engine automatically. A classic example is the centrifugal governor, Also known as the watt. Centrifugal governors were used to regulate the distance and pressure between millstones in windmills since the 17th century.

James watt designed his first governor in 1788 following a suggestion from his business partner Matthew Bolton. It was a conical pendulum governor and one of the final series of innovations Watt had employed for steam engines. James Watt never claimed the centrifugal governor to be an invention of his

own. Centrifugal governors were used to regulate the distance and pressure between millstones in windmills since the 17th century. It is therefore a misunderstanding that James Watt is the inventor of this device.

Another kind of centrifugal governor consists of a pair of masses on a spindle inside a cylinder, the masses or the cylinder being coated with pads, somewhat like a drum brake. This is used in a spring-loaded record player and a spring-loaded telephone dial to limit the speed.

And also identify the stress concentration areas, areas which are most susceptible to failure when governor is rotating about its axis, also the value of these stresses, strains, total deformation is measured. This analysis is carried out with the help of pro e and ANSYS.

II.SPEED OF WATT GOVERNOR:

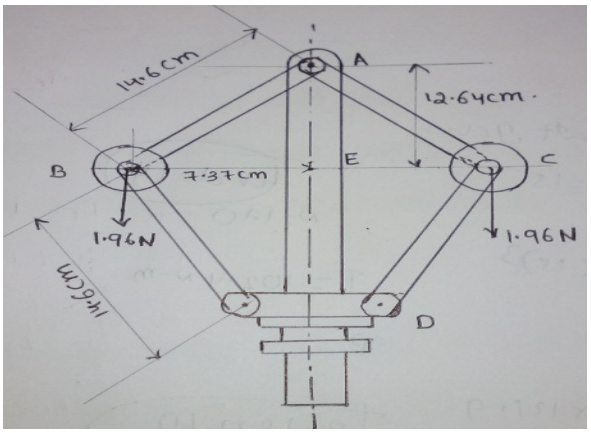

Fig II.I: Watt Governor [i]

We Know that, $h_1 = AB^* \cos\alpha$

$= 14.6 * \cos 30^0$

$h_1 = 12.64$ cm $= 0.126$ m.

Minimum speed: $N_1^2 = \frac{895}{h1} = \frac{895}{0.126}$,

$N_1 = 84.2$ r.p.m

Assume sleeve to be lift 20 mm,

Maximum speed: $N_2^2 = \frac{895}{h2} = \frac{895}{0.106}$

$N_2 = 91.77$ r.p.m.

III. DESIGN OF MODIFIED WATT GOVERNOR TO INCREASE MINIMUM SPEED:

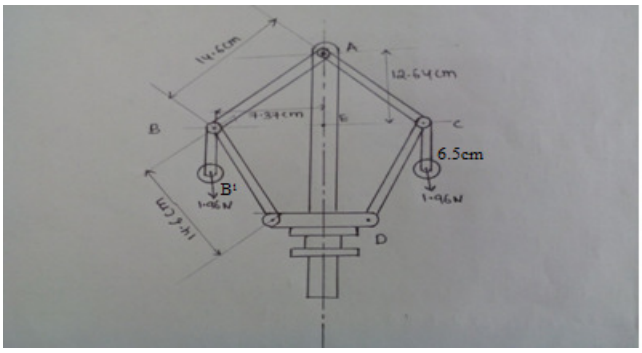

Fig III.I: Modified Watt Governor [ii]

Length AB = 14.6 cm= 146 mm,

BE = 7.37 cm =73.7 mm,

BB^1 = 6.5 cm = 65 mm,

Height of the governor WKT h1= AB* cosα

$= 14.6 * \cos 30^0$

= 12.64cm=0.126m

For minimum speed (N_1)

$N_1^2 = \frac{895}{BM - BB'}$

Where BM = AE = h_1 =12.64 cm = 0.126 m

And BB' = 6.5 cm = 0.065m.

$N_1^2 = \frac{895}{0.126 - 0.065}$, N_1=121.2 r.p.m

Assume sleeve to be lift 20 mm

For maximum speed (N_2)

$h_2 = h_1 - 0.02 = 0.126 - 0.02 = 0.106$

$N_2^2 = \frac{895}{0.106 - 0.065}$, N_2 = 147 r.p.m.

The range of speed of the governor is $N=N_2-N_1$= 147-121.2 = 25.8 r.p.m.

IV. ANALYSIS FOR WATT GOVERNOR

IV.I TOTAL DEFORMATION

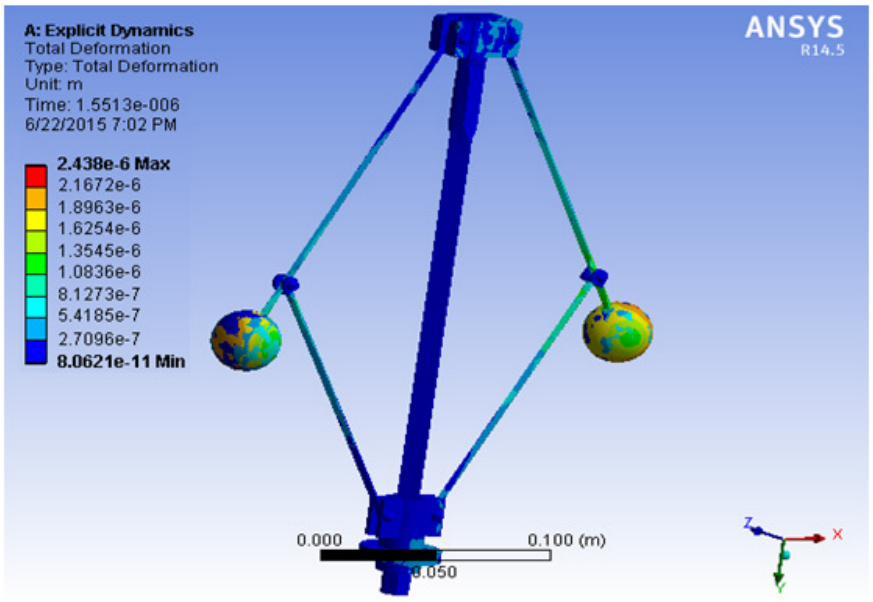

Fig IV.I: **Total deformation**

IV.II EQUIVALENT ELASTIC STRAIN

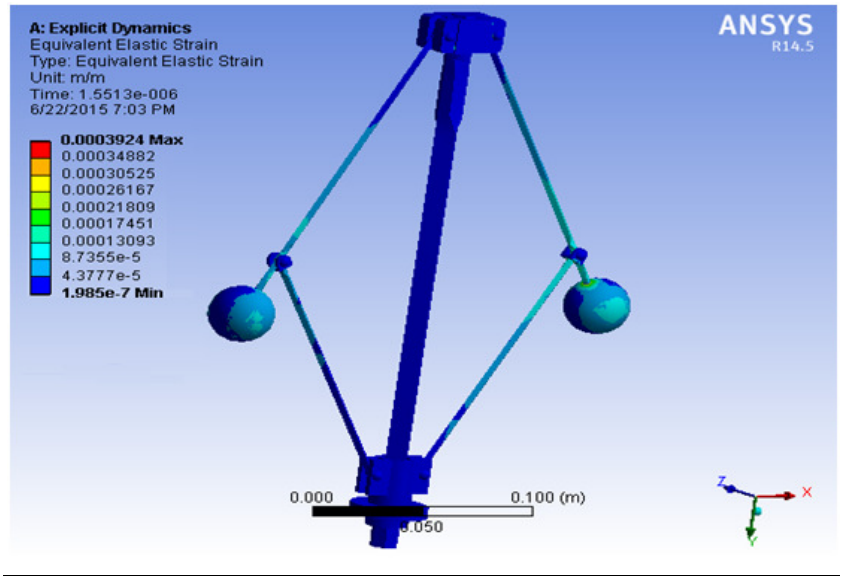

Fig IV.II equivalent elastic strain

IV.III EQUIVALENT STRESS

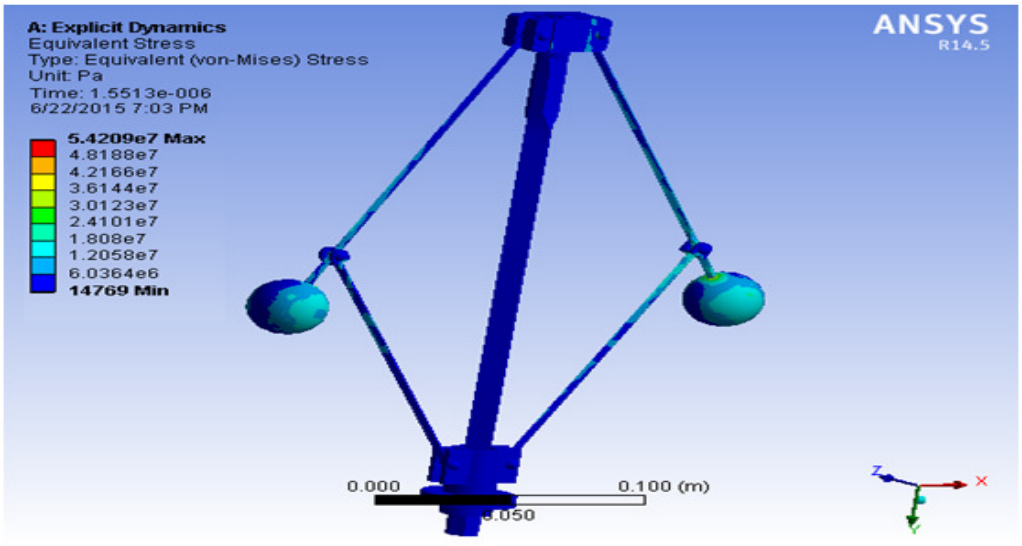

Fig IV.III equivalent stress

V. ANALYSIS FOR MODIFIED WATT GOVERNOR

V.I TOTAL DEFORMATION:

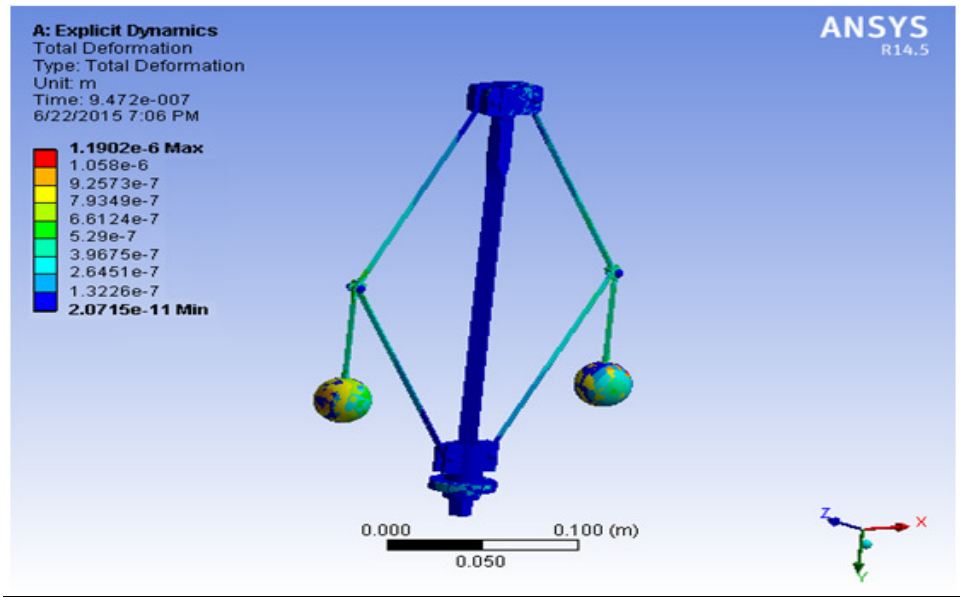

Fig V.I: Total deformation

V.II EQUIVALENT ELASTIC STRAIN:

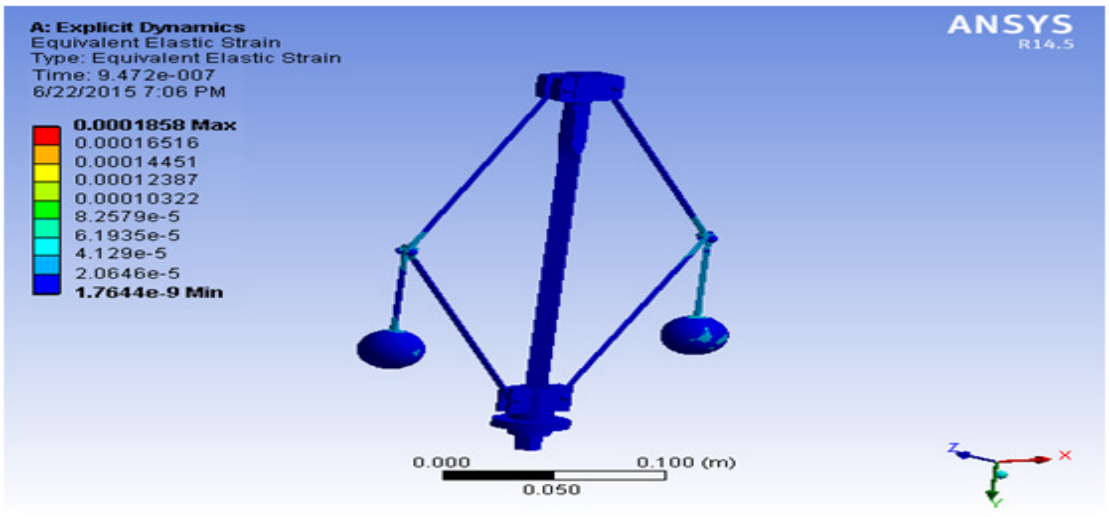

Fig V.II: equivalent elastic strain

V.III EQUIVALENT STRES

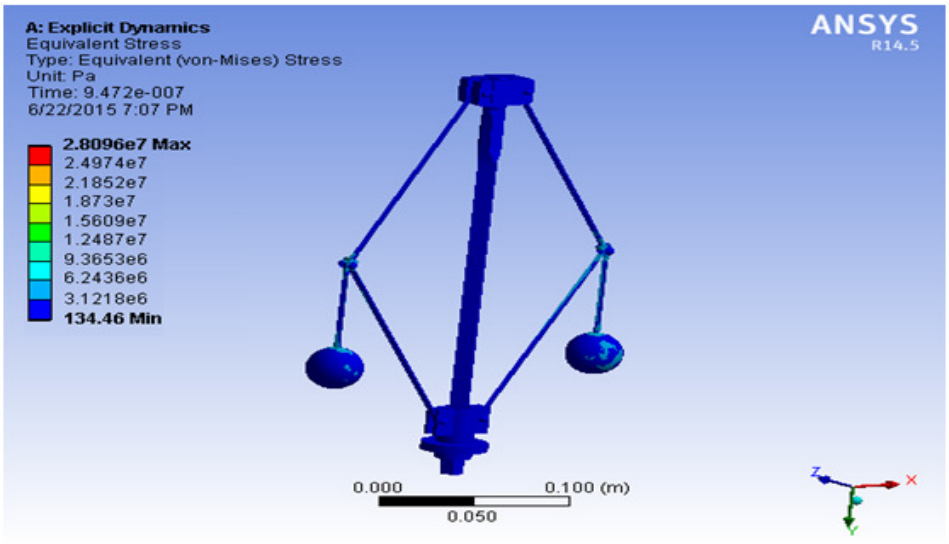

Fig V.III equivalent stress

VI. RESULTS AND DISCUSSIONS

A. The following table indicates, which we got the results during the different analysis of watt governor

TYPE OF ANALYSIS	WATT GOVERNOR		MODIFIED WATT GOVERNOR	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
TOTAL DEFORMATION	8.0621e-011	2.438e-006	2.0715e-011	1.1902e-006
EQUIVALENT ELASTIC STRAIN:	1.985e-007	3.924e-004	1.7644e-009	1.858e-004
EQUIVALENT STRESS	14769	5.4209e+007	134.46	2.8096e+007

1. The modification of Watt Governor will may replace the porter governor some extent and the dynamic analysis of governor gave better results when comparing with the values of total deformation, equivalent elastic strain, stress between watt and modified watt governor. Hence the design is safe.

2. So that the above following table which is concluded, with dynamic analysis the no some changes will happens in values, compare with watt governor, So that it may not be affected on the governor. So I think we can replace porter governor with modified governor at some extent.
3. Generally we seen that the Watt Governor is suitable for lower speeds only (i.e. 60-80 r.p.m), but by small modification it can also used for above the lower speeds (i.e. 120 -130 r.p.m).

VII. FUTURE SCOPE

1. Analysis of Stress concentration on various elements of the governor which minimizes the failures.
2. Analysis on different materials for sleeve, spindle and arms.
3. Vibration analysis will give better results in accuracy.
4. Study on various factors (i.e. stability, sensitivity, and hunting) of the governors

VIII. CONCLUSIONS

1. Modification of Watt Governor gives better results when compare with Watt and Porter Governor.
2. To study the effect of extension of lower arm on variation in minimum speed of the governor
3. To maintain 120r.p.m, minimum speeds by Porter Governor it needs 250mm arm lengths, 5kg fly ball weight, 11.5kg central sleeve load whereas modified Watt Governor needs only 146mm arm length, 0.126kg fly ball weight and no central sleeve load.
4. The modification of Watt Governor will may replace the porter governor some extent and the dynamic analysis of governor gave better results when comparing with the values of total deformation, equivalent elastic strain, stress between watt and modified watt governor

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