"Design and Analysis of Hydraulic Testing Machine"

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Abstract

This topic puts emphasis on the basic terminologies and the introductory concepts in testing of the casting products with the help of hydrostatic testing machine. The topic describes the basics of casting process, types of casting product that applies to the context, different types of defects testing method and how the hydrostatic testing machine can be used for testing of different types of products.

Keywords: Stumpo*, Fuga, Analysis, Cementing*

INTRODUCTION

This topic is related to hydrostatic testing machine which is used for finding out the defects in hollow products and pipes. As per the visit in TruForm Techno casting industry we found that for the testing of leakage of pipe there is this machine called as Hydrostatic Testing Machine is used. The machine generally takes 40 minutes for the testing purpose which is way more considering one job only. In the proposed design we worked on minimizing the testing time of machine. Here Stumpo is a Italian word means casting, Fuga is a Spanish word means leakage and Makina is a Albanian word means Machine hence, Stumpo Fuga Makina (Hydraulic Testing Machine) is a machine which is used for checking the leakage in the pipes which are casted.Following are products that company manufactures:

Fig 1: Ductile Iron Pipe Fitting

Fig2: Engineering Casting

Fig3: Alloy Cast Iron Pipe Fitting

Fig4: Ductile Iron Manhole Cover

Following is the process which is adopted for casted products:

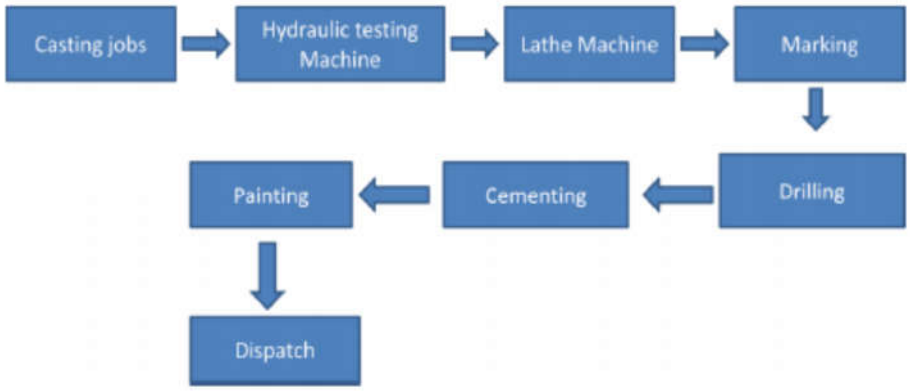

Fig5: Process Flow Chart

Need of the Project:

In TruForm Techno Products Ltd. the machine which is used by company is of old design which takes more of time to test the job, due to which it becomes late to go for furthermore processes which are to be carried out on the job.For ex. Machining process, painting etc. and therefore the delivery of the product might not be possible. If the order deadline is early and as the machine tests only one job at a time, then the remaining job instead of going for testing first goes to machining and then returns to Hydraulic testing machine. Now, if there is defect found on that machined job then it directly gets rejected and hence the manpower, electricity, time goes waste.

Problem Analysis:

In company the machine regularly tests 9 jobs per day. From our time study, we have concluded that the average time taken by a job for the testing is 36 min. in which only the filling of water itself takes 21 min. If the order deadline is early and as the machine tests only one job at a time, then the remaining job instead of going for testing first goes to

machining and then returns to Hydraulic testing machine. Now, if there is defect found on that machined job then it directly gets rejected and hence the manpower, electricity, time goes waste.

The present machine has only three jaws movable that is lower jaw and the side jaws which make it fatiguing and at the same time it is more time consuming procedure to fix the pipe bent in the machine for the testing purpose. There are two mechanisms given for both left and right side jaw for it's up and down motion which is operated manually and takes more effort of the operator.

Fig6: Hydraulic Testing Machine

Objectives:

1. The main objective of our topic is to increase the productivity.
2. The average time taken for testing the job is more and hence we are focused on minimizing the testing time.
3. To minimize the fatiguing process of fixing the job in machine.
4. To eliminate the use of two machines for varying job size, i.e. to use one machine for all the size of job.

Calculation and Specification:

DISCHARGE:

By varying the diameter
Calculation for:

4 Cm Diameter

$Q = 3.51 \times 10^{-4}$ m^3/sec

5 cm diameter

Q = 5.5 x 10-4 m^3/sec

Head loss due to friction:

hf= 4 x0.00946 x 11 x 0.28292/2 x 9.81 x 0.03

hf = 0.056 m

Then using Chezy formula :

To find loss of head per unit length of pipe,

V = c√mi

i= loss of head for per unit length of pipe

i = hf / l = 0.056 / 11

i = 0.00509

(Hydraulic mean depth) m = cross section area of pipe / perimeter

m= A /P = 7.0685x 10^{-4} / 3.14x d

m = 7.0685x 10^{-4} / 3.14x0.03

m = 749x 10^{-4} m

Chezy Equation:

V = c√mi

0.2829 = c√0.00749 x 0.00509

c = 45081 (Chezy constant)

Pressure head at inlet (H)

For maximum power transmission

hf = H/3

0.056 = H/3

H = 0.056 x 3

H = 0.168 m

Efficiency of power transmission (η):

h = H – hf

h = Net head available at outlet of pipe

h = 0.168 – 0.056

h = 0.112 m

Efficiency (η) = h/H

= 0.112/0.168

Efficiency (η) = 66.67 %

GEAR DESIGN:

Design Power

Pd = PR x KL

KL= 0.75 x 10^3 x 1.25

Pd = 937.5 Watt

1)Tooth Load

Ft= Pd/Vp

Vp = 0.7068 m

Ft= 937.5/0.7068xm

VR= 1.44

Ng= 346.15 rpm

rp=34.69

rg = 55.30

2) Formative number of teeth on pinion,

tfp = 32.83

tfg= 68.50

3) Beam Strength Equation

FB =So x Cv x Y x b x m x (1-b/L)

FB = 105 x 0.5 x 0.3975 x 8.5x3 x 3 x (1- 8.5x3/23.71x3)

FB = 1024.13 N

Since, Ft < FB

442.133 N < 1024.13 N

∴ Design is safe

Dp = 27 x 3 = 81 mm

Dg = 39 x 3 = 117 mm

Analysis of Machine:

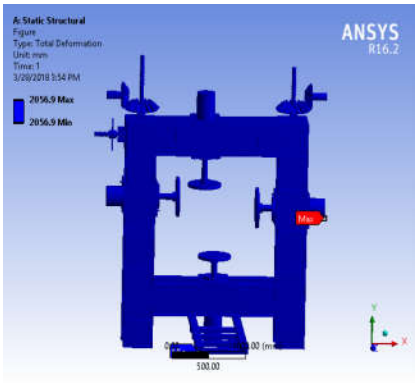

Fig7: Static Structural Deformation

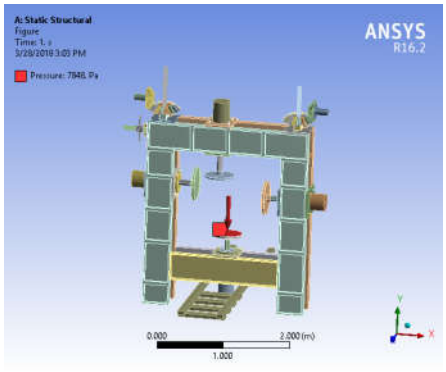

Fig8: Static Structure Analysis

CALCULATION FOR LEAD SCREW

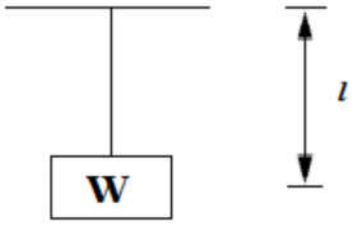

Fig9: Load on Lead Screw

Length= 160cm
Area= 2.82 x10^3 mm^2
∴ Stress= 1.39 N/mm^2
E=210 x 10^3 mpa
Strain= $\delta l / l$
But, E= Stress/Strain
210x10^3 = 1.39/Strain
∴ Strain= 6.61x10^{-6}
Strain= $\delta l / l$
∴ δl = 0.0105 mm

Bending of beam due to the self weight of actuator:

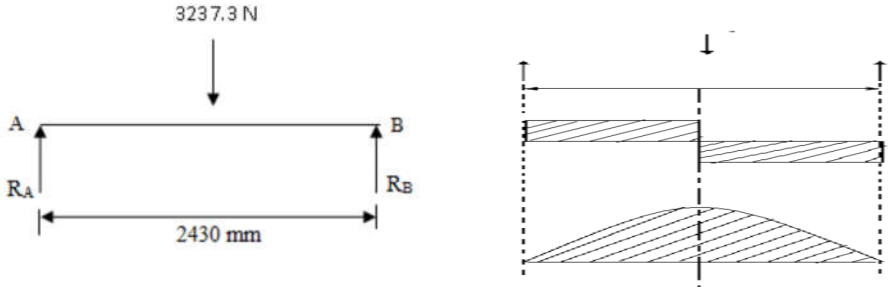

Fig10: Simply Supported BeamFig11: SFD & BMD Diagram

Calculating reactions at A and B,

R_B = 1618.65 N

R_A = 1618.65 N

Maximum bending of beam = 1618.65 x 1215 = 1.96 x 10^3 Nm

Deformation of Jaw:

$A = (3.14/4) \times d^2 = (3.14/4) \times 100^2 = 7.85 \times 10^3\ N/m^2$
$\sigma = P/A = 1962 / 7.85 \times 10^3 = 0.249\ N/mm^2$
$\delta l = PL/AE = 1962 \times 600 / 7.85 \times 10^3 \times 2 \times 10^5 = 7.5 \times 10^{-4}$ mm
$e = \delta l / E = 7.5 \times 10^{-4} / 600 = 1.25 \times 10^{-6}$

Time Calculation:

For pipe diameter 3cm discharge is $2 \times 10^{-4}\ m^3/sec$
And Velocity is 0.2829 m/sec
For filling 300 liters water in a product it takes 1500 sec.
By increasing the diameter of 5cm
Discharge = $3.51 \times 10^{-4}\ m^3/sec$
Calculating time required for filling 300 liter water
$3.51 \times 10^{-4} = x/5$
$\therefore\ x = 1.75$ liter
By comparing previous discharge with current discharge
$1.75/5 = 300/x$
$x = 857$ sec

EXPERIMENTAL RESULTS

Sr. No.	Parameter	Previous Values	New Values
1.	Time required for filling of water (sec)	1500	857
2.	Lead Screw (Vertical) (Stress)		
	i) Yield strength (mpa)	250	250
	ii) Ultimate strength (mpa)	460	460
3.	Lead Screw (deformation)(mm)		0.94561
4.	Bevel gear		
	i) Tangential load (N)		442.133
	ii) Bending load (N)		1024.13
	iii) diameter of pinion (mm)		81
	iv) diameter of gear (mm)		117
5.	Movement of lead screw (1 revolution) (sec)	18	4

Conclusion:

Since, our main objective of this topic was to reduce the testing time of machine. This is achieved by increasing the diameter of the nozzle thereby increasing the discharge of water. Fixing time of the casting job in the machine also be reduced as the upper disk is movable, it will make a easy process to fix the job.

Up and down motion of the side disk which was in the old design done by operator manually is done by the bevel gear mechanism which reduces the time.

After the analysis of the different machine parts is carried out in the ANSYS software and also designing the bevel gear analytically it has been found that the lower disk will fail on account of application of load. So, to overcome this failure we had to change the material for the lower disk as it will not going to sustain the load.

Best suitable material for this purpose is EN19 (high quality alloy steel). This material has properties like high tensile strength, good ductility and shock resistance, wear resistance. Properties like these provide more strength to the material which can sustain load.

By using ANSYS software we analyzed the stress, life cycle, endurance limit of the machine parts and on the basis of that we change the material of lower disk according to ANSYS report.

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