REDESIGNING & ANALYSIS OF TRANSMISSION SHAFT ASSEMBLY OF COOLING TOWER

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ABSTRACT: This project aim is to find out the cause of vibration & Redesign & analysis of transmission shaft assembly of cooling tower. In the cooling tower, Transmission shaft assembly, we worked on that in existing design which gives maximum deflection on shaft, due to that maintenance work is more & also maintenance cost is also increased so minimize that maintenance work & cost. So minimize the above problem to increased transmission shaft diameter from 100 to 120mm.

INTRODUCTION

A Cooling tower is a heat rejection device which extracts waste heat to the atmosphere through the cooling of a water stream to a lower temperature. Cooling tower may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of closed circuit dry cooling towers. The Working fluid to near the dry-bulb air temp Common application include cooling the circulating water used in oil refineries, Petrochemical, power & steel industry for cooling building. .Transmission shaft assembly is one of the key components of the cooling tower. It consists of transmission shaft, rigid coupling, motor, Gear box, rubber bushes, Stainless steel disk, nut & bolt. To carry vibration & load. It should be rigid enough to withstand the shock, twist, and other stresses & its principle function is to carry the maximum load for static and dynamic condition safely.

REVIEW OF LITERATURE

1. Mr. Sagar r. Dharmadhikari; "On Design & Analysis of composite drive shaft using ANSYS and Genetic Algorithm"- This study deals with the review of optimization of drive shaft using the Genetic Algorithm and ANSYS. Substitution of composite material over the conventional steel material for drive shaft has increasing the advantages of design due to its high specific stiffness and strength. Drive shaft is the main component of drive system of an automobile. Use of conventional steel for manufacturing of drive shaft has many disadvantages such as low specific stiffness and strength. Conventional drive shaft is made up into two parts to increase its fundamental natural bending frequency.

2. Mr. Jianfeng Qian; "On Research and application of closed cooling tower''

This paper systematically reviews the research progress of the closed cooling tower at home and abroad. The abroad research of the closed cooling tower has been carried for a long time so it is relatively mature. Although the domestic research has carried out relatively late, it also made a lot of achievements through the continuous efforts of the researchers for the study of the closed cooling tower.

3. Mr. E Gottesman; "On Efficiency of Evaporative water cooling tower.''

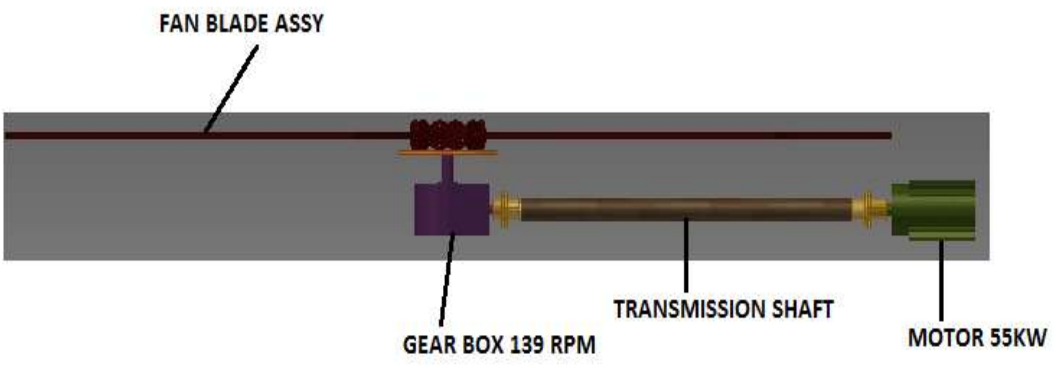
The operation of an evaporative cooling is influenced by several variables which are in the order of their relative practical importance.

1. Temperature & humidity of the ambient air.
2. Counter flow ratio of the air and water streams.
3. Temperature of the inlet water stream.

4. Mr. G. F. Hallel;
"On Research paper on performance curve formechanical draft cooling towers"

Techniques & method are given for calculating performance curve of both counter-flow & cross-flow type cooling tower. This procedure can be used during evaluation to assess and predict tower performance of various operating condition other than the

DESIGN OF TRANSMISSION SHAFT.



Mathematical calculations

Details of transmission shaft

Shaft length : 2735mm
Shaft OD : 120mm
Shaft ID : 100mm

Basic Assumptions:

Weight of shaft : 76.4Kg (self-weight)
Max RPM : 1500
Maximum Working temperature : 100 degree C

A) Calculating SFD, BMD and Stresses

Centrifugal Force (CF) $= m.\omega^2 R$
M=75.4kg
M=75.4kg w=157rad/sec R=0.120/2 meter
Thus,
Centrifugal force = CF = 112695.228N

Self Weight of transmission shaft = 75.4*9.81 = 740 N
Total Point Load=112695.2+740=113435N

Let R_a and R_b be the reactions at the ends A & B respectively.
Taking moment about A we have:
R_bx2735=740x1367.5+112695.2x1367.5
R_b=56717.5N=56.717KN
Similarly,
R_a=R_b=56717.5N
Calculating Bending Moments:
Bending Moment (BM) about A
BM_a=Rbx2735-740x1367.5-112695x1367.5
BM_a=0
Similarly,
BM_a=BM_b=0
BM_c=Rax1367.5+Rbx1367.5
=2x56717x1367.5
BM_c=155120995
BM_d=Rbx2535+Rax200-77643x1167.5
BM_d=22687000N-mm
BM_e=Rax2535+Rbx200-113435x1167.5
BM_e=22687000N-mm
Thus, maximum bending moment was observed at C (centre of the shaft)
BM_c = 155120995N-mm

Figure 3.8 Shear Force And Bending Moment Diagram

Using, Bending equation,

We know that, $\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$ by equations of Pure Bending **[15]**

I = Area moment,
Given by,
$I = \frac{\pi}{64} \times (D^4 - d^4)$ For a hollow shaft, (D= outer dia. d= inner dia.)
$I = 3.14/64(120^4 - 100^4)$
$I = 5267350 mm^4$
Thus,
Y_{max}= D/2 = 120/2 = 60 mm

$$\sigma_b = \frac{M}{I} y_{max}$$

σ_b=155120995X10X60/5267350
σ_b=1766N/mm^2
Bending Stress = 1766N/ mm^2 = 1766 Mpa.
Using Torsion Equation

$$\frac{T}{J} = \frac{\tau}{r}$$

T= Twisting Moment
J= Polar Area Moment of Inertia of Rotation,
τ= Torsional shear stress.
r= distance from Neutral axis to the fiber.

$$J = \frac{\pi}{32} \times (D^4 - d^4)$$

$J = 3.14/32(120^4 - 100^4)$
J=10534700mm^4
Power transmitted by Motor: $P = \frac{2\pi NT}{60}$
Torque: $T = \frac{60 \times P}{2\pi N}$
Power Of motor: 55KW
RPM of motor N = 1500 rpm
Thus T=60x55000/2x3.14x1500
T=350N-M=350000N-mm

T_{ax}= 350 N.m
In order to calculate maximum shear stress developed in the shaft due to twisting we take maximum Torque i.e. minimum rpm
Since, $\frac{T}{J} = \frac{\tau}{r}$
Therefore,
$\tau = 350 \times 10^3 \times 60/10534 \times 10^3$
$\tau = 1.99 N/mm^2$
Calculating, Equivalent twisting moment $T_{eq.}$
$T_{eq} = \sqrt{M^2 + T^2}$
Teq= 155121389 N-MM
We know that,

$$T_{eq} = \frac{\pi}{16} \times \tau_{eq} \times d_o^3 (1 - K^4)$$

Where, $K = d_i/d_o$
K=100/120=0.833
$\tau_{max} = 883.48 N/mm^2$
Equivalent bending moment

$$M_{eq} = \frac{1}{2}(M + \sqrt{M^2 + T^2})$$

$=1/2(106176973+\sqrt{(106176973.4^2+350000^2}$
Meq=155121192 N-mm
$M_{eq} = \frac{\pi}{32} \times \sigma_b \times d_o^3 (1 - K^4)$

σ_b=1767.134N/mm^2

Thus maximum bending stress induced due to combined twisting and bending moment
σb=1767.134N/mm^2
B) Calculating deflection of transmission shaft due to the loads acting on it.

Let Y_{max} be the maximum deflection of the furnace roll, this deflection will occur due to following conditions:

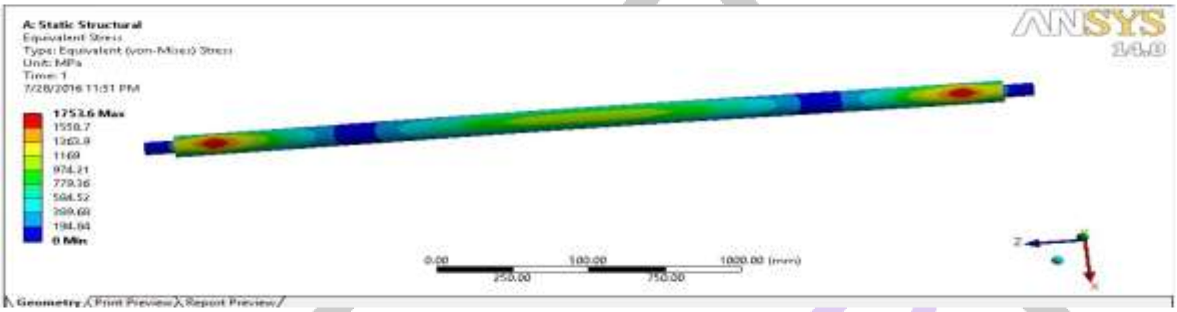
Self-weight of the roll i.e. P=740 N
Centrifugal force due to rotation of the shaft=112695.22 N
W = self-weight + centrifugal Force (CF)
= 740+112695.22=113435 N
L = 2.735m
E =195 GPA. At room temperature.
Applying method of superposition we have,
$Y_{max} = Y_I$

$$Y_I = \frac{-PL^3}{48EI}$$

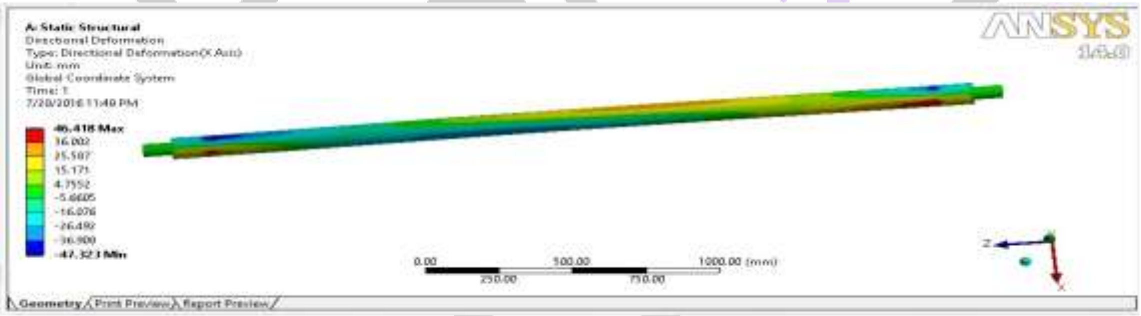
$Y_1 = -113435 \times 2735^3/(48 \times 195000 \times 5267350)$
Thus $y_1 = -48.070$mm
$Y_1 = 0.048$ Mtr (downward direction)

C) Angle of Twist

Thus,
$\Phi = T \times L / G \times J$
$= 155121389 \times 2735 / 195000 \times 10534700$
$\Phi = 0.2065$



Bending Stress on Modified Shaft



Deformation on modified Shaft

RESULT AND DISCUSSION

The maximum values of different parameters in the analysis of transmission shaft table

Parameter	Transmission Shaft	
	Existing Design	Modified Design
Bending Stress (Pa)	1832.75	1766
Twisting shear stress(Pa)	916.38	883.48
Total deformation (mm)	58.58	48.07
Angle of Twisting	0.134^0	0.120^0

Result of analysis

From the above table it can be seen that, the Bending stress, shear stress of Modified design is less than the existing Design. Due to this New Design is is better than the Existing System, More safer stresses are obtained in modified design, Which is givinig to better result than the existing system? Due to that the life of transmission shaft increased & maintenance cost reduced.

CONCLUTION

In order to eliminate the problem of bending in the Transmission shaft due to the stresses developed during its operation, transmission shaft had been analyzed considering or changing the diameter. Before doing the analysis of Transmission shaft, firstly it is checked that the design of Transmission shaft is safe or not.

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