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Design and Analysis of a Portable Concrete Mixer

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Abstract - *Concrete is one of the most important materials used in construction. It is one the most frequently used building materials. It is used worldwide and is almost used twice more than that of steel, wood, plastics, or any other metals combined. The ready-mix concrete industry is projected to cross 600 billion dollars in revenue by 2025. Due to this large scale and continuous requirement of concrete, the concrete mixer has become one of the most important machines on construction sites. It homogeneously combines water, sand or gravel used as aggregate and cement, to form concrete. Any concrete mixer uses a type of a drum to mix the components. A portable concrete mixer often is considered for small volume works or projects. It gives the workers enough time to mix and use the concrete before it hardens. In this project a portable concrete mixer has been designed and safety of the design has been verified by carrying out the analysis by giving specific boundary conditions and observing the deformation of each part.*

Key Words: concrete mixer, construction, portability, analysis, deformation

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I. INTRODUCTION

Concrete is prepared by mixing cement, water and various aggregates (mainly sand and gravel). It is very important to carefully select the proportions in which each component is used to make the concrete. This also defines the quality or grade of the concrete that is going to be formed. The main objective of this project was to design a concrete mixer, which is portable and can mix the components properly. Various calculations are carried out based on the grade of concrete to be formed, which then gives us the proportions of all the components to be used. According to the results derived from the calculations, the drum is designed first according to the required capacity. To support the drum with the expected or assumed load the yoke, base frame and hand wheel are designed.

II. METHODOLOGY / CALCULATIONS

A. Calculations –

a. Fix the concrete grade.
b. Assume mass of cement.
c. Determine mass of sand and gravels (aggregates) based on the standard proportions for the chosen grade.
d. Compute the mass of one batch.
e. Select the FOS for the design. (2 in our case)
f. Compute the mass to consider for design purpose depending on the FOS. (Assumed mass)
g. Calculate the volumetric capacity by referring to the standard value of density of the chosen grade.
h. Determine the drum dimensions based on the above calculations.
i. Calculate the mixing force. Selection of a standard motor (2HP & 25 RPM)
j. Concrete Grade : M10
k. Ratio of Components = 1:3:6Data for Calculations:
a. Mass of Cement = 10 Kg
b. Mass of Sand = 30 Kg
c. Mass of Gravel = 60 Kg
d. Mass of Water = 5 Kg
e. Total Mass = 105 Kg
f. Factor of Safety = 2
g. Assumed Mass (Total Mass x FOS) = 210 Kg
h. Volumetric Capacity = 0.0808 m^3
i. Length of Drum = 0.5 m
j. Diameter of Drum = 0.45 m

k. Thickness of the Drum = 6mm
l. Mixing Force (Assumed Mass x g) = 2060N
m. Minimum RPM of Drum for proper mixing = 25
n. Power of Motor = 1.49 kW (2HP)
o. Torque of Motor = 900 Nm

So, the total Load acting on the yoke (or the main frame) during the process of mixing =
DRUM ASSEMBLY LOAD + LOAD DUE TOONE FULL BATCH = 2989 N

Determination of Maximum force required:
$W = M_T \times g$
M_T = Mass of concrete + mass of drums
= (105+200)
= 305 Kg
Therefore Force required for proper mixing = (305 x9.8)
= **2990N**

Determination of Mixing Volume:

$V_{mc} = \pi r^2 h$
V_{mc} = Volume of Mixing chamberr= 0.225m
h = 0.500m
$\therefore V_{mc} = \pi \times (0.225)^2 \times (0.5)$
$= 0.80\ m^3$

Determination of Belt Length:
$L = \pi(r1 + r2) + 2x + (r1 + r2)^2 / x$
r1 & r2 = Radii of Smaller and Larger Pulleys
x = Distance between the centre of 2 pulleys
= 2d1 + d2
= 2(0.070) + 0.135
= 0.275 m
$\therefore$ L = 0.32185 + 0.55 + 0.003L = 0.875 m

Determination of Lap Angle:

$\alpha = 180 \pm 2\sin^{-1} (D_2\text{-}D_1/2C)$

For open belt, (used in this case), α is given as: $180 – 2\sin^{-1}(D_2\text{-}D_1/2C)$
$\therefore \alpha = 180 – 13.575$
$= 166.425°$

Number of teeth on Ring Gear of Drum:

Motor: 2HP, General Purpose, 3 Phase & 500 RPM Considering that 25 RPM is adequate for proper mixing, D_1 = Diameter of driver pulley = 0.070m
D_2 = Diameter of driven pulley = 0.135m N_1 = Speed of Driver = 500 RPM
N_2 = Speed of Driven
$\therefore N_1/N_2 = D_2/D_1$
$\therefore N_2 = N_1 x D_1/D_2$
= 500 x 0.070/-0.135
$\therefore N_2$ = 260 RPM
N_B = Speed of Bevel Gear = 260 RPM N_B = 260 RPM
N_R = 25 RPM
T_B = 13 (Standard)

$\therefore N_B \times T_B = N_R \times T_R$ 260 x 13 = 25 x T_R

$\therefore T_R = 260 \times 13/25$
$= 135$

Determination of Torque:

$T = Fl$
T = Torque
F = Mixing Force = 2990 N
L = Length of Paddle = 0.30m

$$\therefore T = 2990 \times 0.30$$
$$= 900 \text{ Nm}$$

Determination of Shaft Speed:

N = 500 RPM
D_S (Shaft Diameter) = 0.10 m

$V = \pi D_N / 60$

$= 3.142 \times 0.10 \times 500 / 60$
$= 2.6 \text{m / sec}$

B. Mass distribution table –

SRNO	PART	MASS (kg)	EQUIVALENTWEIGHT (g = 9.8) (Kg m/s^2)
1	MAIN ASSEMBLY	261	2557.8
2	DRUM ASSEMBLY	200	1960
3	STORAGE SPACEINSIDE DRUM (ASSUMED MASS)	210	
4	YOKE	9.3	91.14
5	MAIN FRAMEASSMEBLY	47	460.6
6	OTHER SUPPORTCOMPONENTS	5-6 (approx.)	53.9
7	ONE FULL BATCH	105	1029

Table 1-Mass Distribution Table

C. Motor Assembly Dimensions:

SR NO.	COMPONENT	LENGTH (m)	DIAMETER (m)	NO.OF TEETH (m)
1	SmallPulley	-	0.070	NA
2	Big Pulley	-	0.135	NA
3	Shaft 1	0.150	0.100	NA
4	Shaft 2	0.270	0.100	NA
5	Bevel Gear	-	0.102	13

Table 2-Motor Assembly Dimensions

D. Dimensions of Concrete mixer assembly:

SR NO.	PART	HEIGHT/LENGTH (m)	DIAMETER (m)	WIDTH (m)	NO. OF TEETH
1	DRUM LOWER	0.5000	0.450	0.060	NA
2	DRUM TOP	0.5000	0.450	0.060	NA

3	DRUM BRACKET	0.1000	0.250	-	NA
4	YOKE	0.900	0.050	-	NA
5	MAINFRAME	1.215	-	1.260	NA
6	WHEELS	-	0.300	0.040	NA
7	RINGGEAR	-	0.920	0.040	135
8	HANDWHEEL	-	0.500	-	NA

Table 3-Dimensions for Concrete Mixer Assembly

2. DESIGN

Design of the Drum –

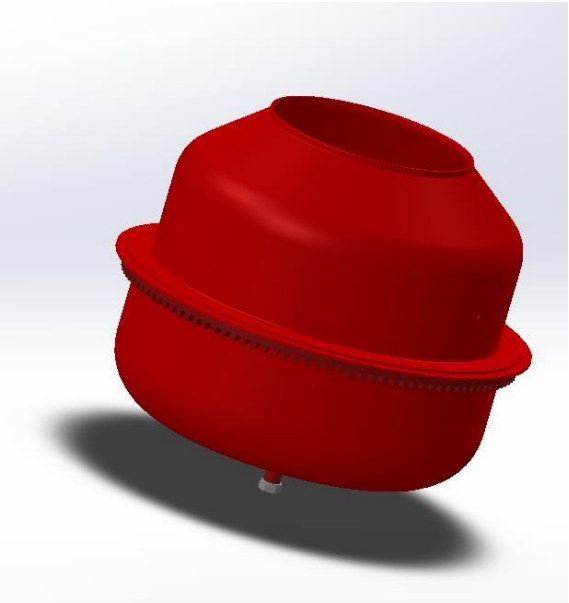

Figure 1-Design of Drum (1)

Figure 2-Design of Drum (2)

Main Frame Assembly –

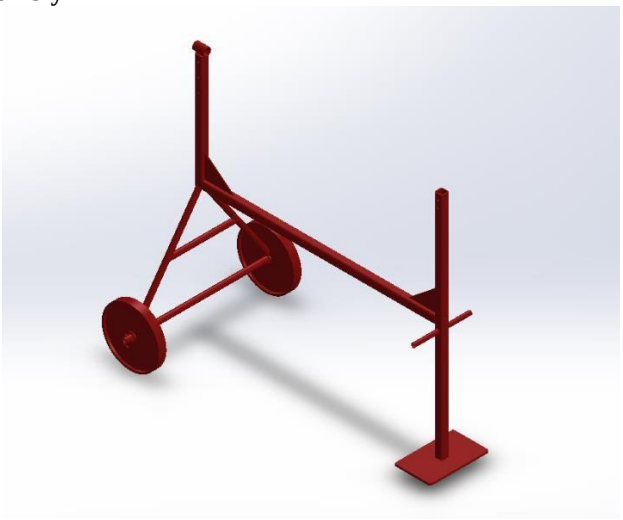

Figure 3-Main Frame Assembly (1)

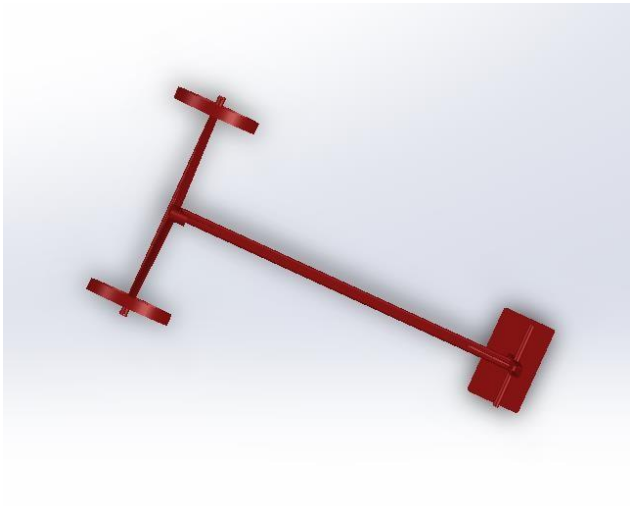

Figure 4-Main Frame Assembly (2)

Design of Yoke -

Figure 5-Design of Yoke

Motor assembly -

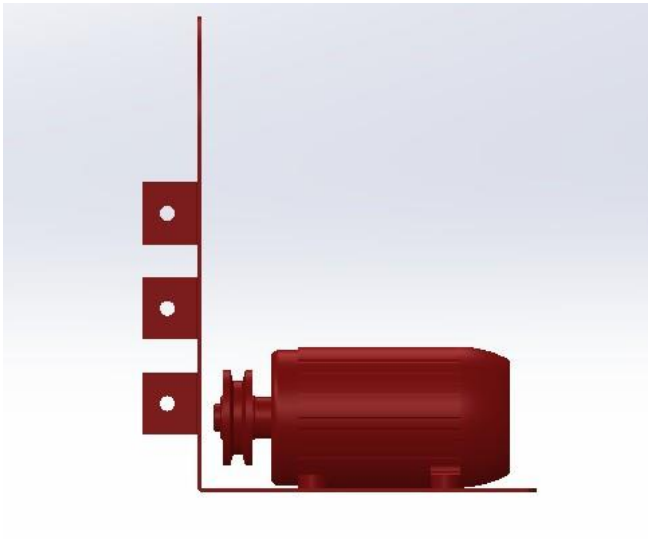

Figure 6-Motor Assembly (1)

Figure 7-Motor Assembly (2)

Design of Motor Casing -

Figure 8-Design of Motor Casing (1)

Figure 9-Design of Motor Casing (2)

Design of Blade –

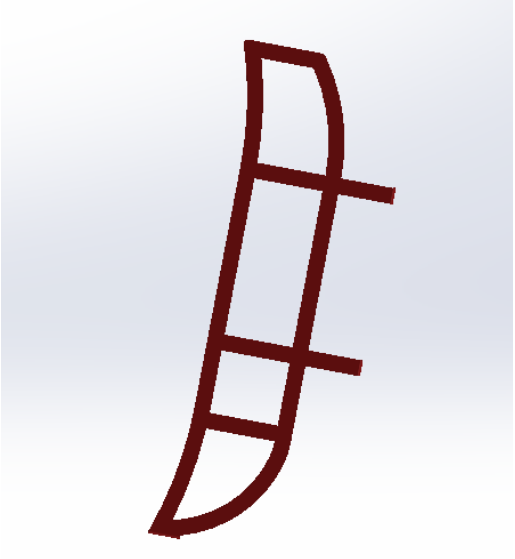

Figure 10-Design of Blade (1)

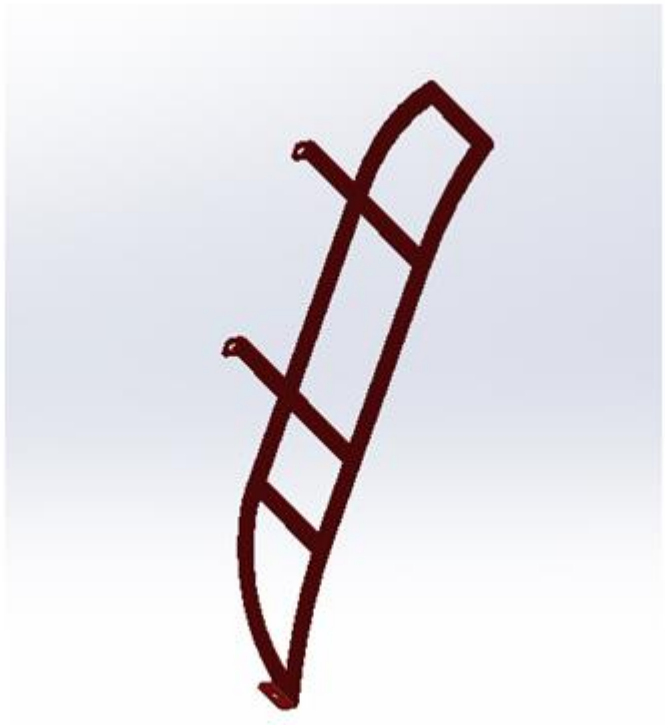

Figure 11-Design of Blade (2)

Complete Assembly of Portable Concrete Mixer –

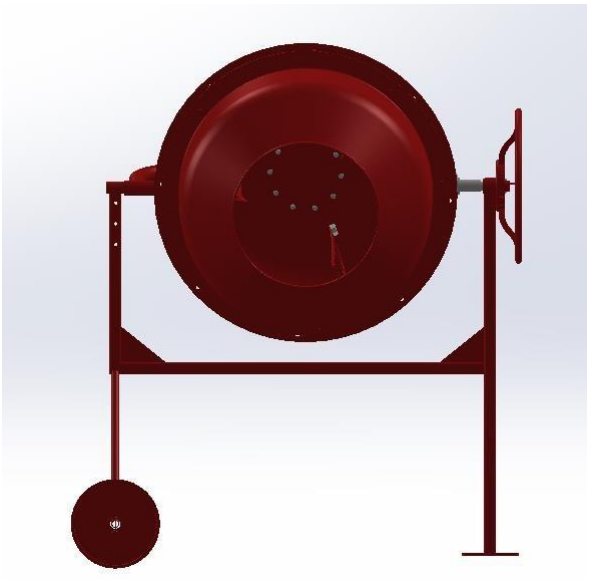

Figure 12-Assembly of Portable Concrete Mixer

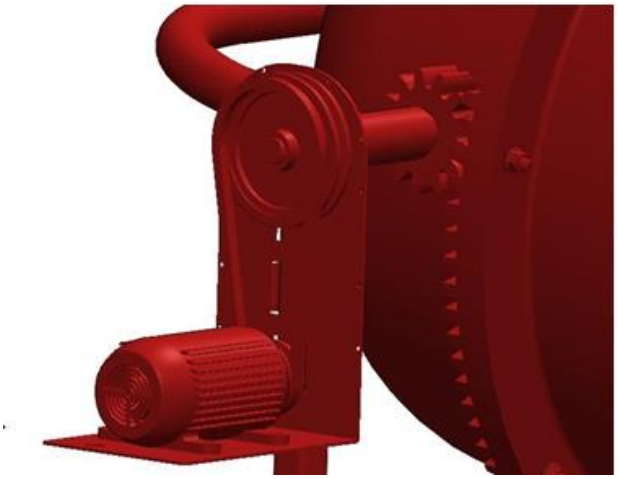

Figure 13-Assembly of Portable Concrete Mixer (2)

Figure 14-Assembly of Portable Concrete Mixer (3)

2. ANALYSIS

Analysis of Yoke -

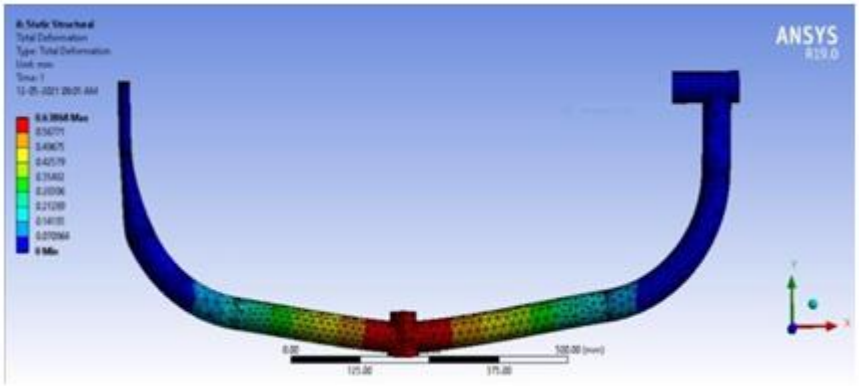

Figure 15 Yoke

Maximum Deformation Observed = 0.63mm

Analysis of Blade -

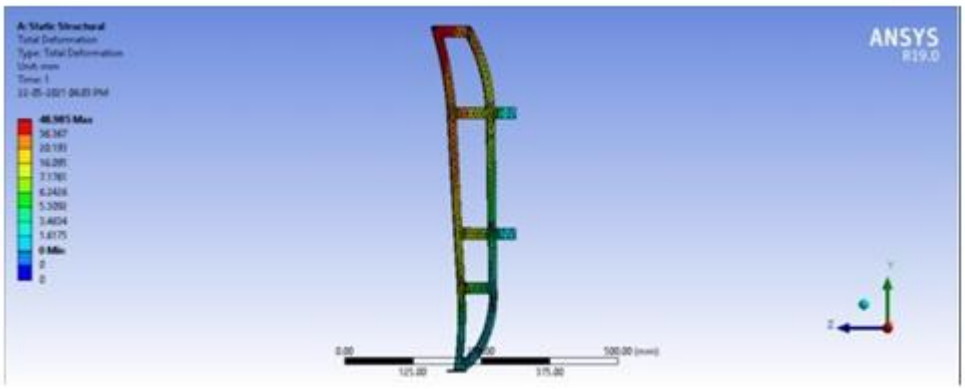

Figure 16 Blade

Average Deformation Observed = 4.8mm

Analysis of Main Frame –

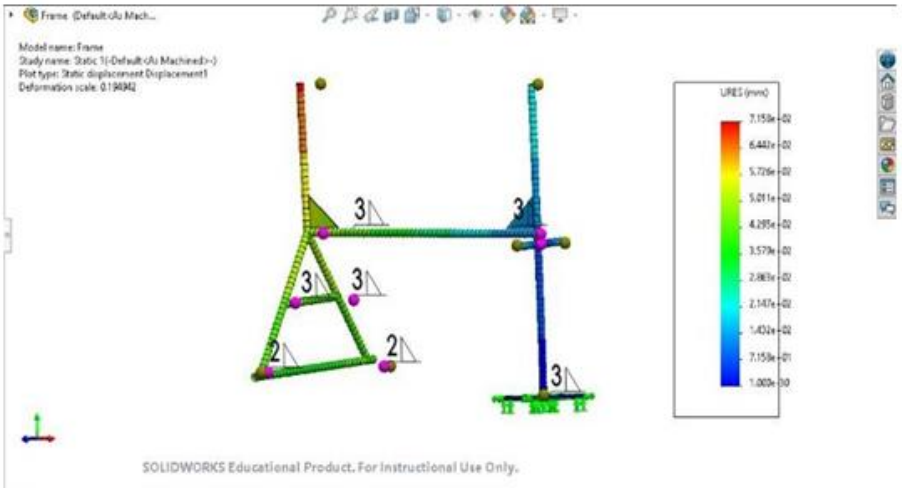

Figure 17 Main frame

Maximum Deformation Observed = 7mm

Analysis of Drum –

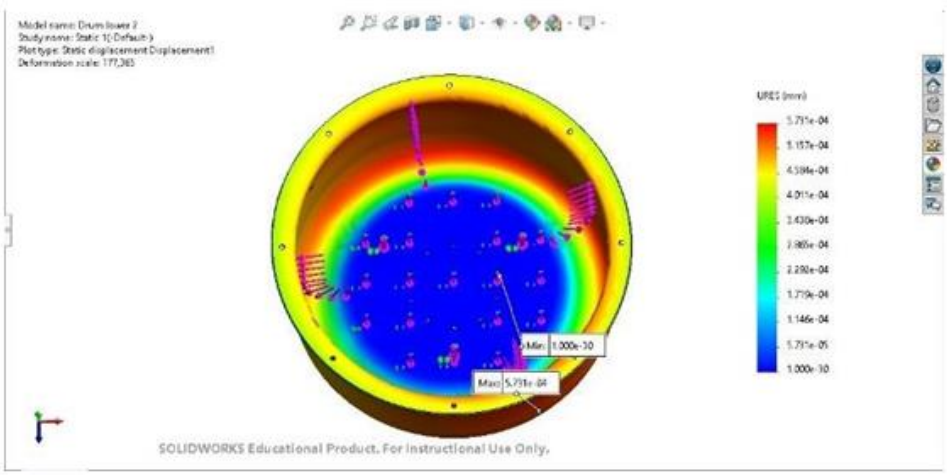

Figure 18 Drum

Maximum Deformation Observed = 5mm

III. CONCLUSIONS

Concrete has a continuously growing demand especially in developing countries. There is a constant requirement of concrete no matter how big or small the construction project is. To fulfil this demand in the fast-paced world we are living in, mechanization of the process is required. After considering all the calculations, a portable concrete mixer was designed to fulfil the requirement of forming the M10 grade concrete. The design is completely safe as the deformations in the parts observed were within the limits and because of which the assembly would not fail. Mixing is a complicated process because of which we have to take into consideration factors like duration, loading method and energy of mixing. As a result, stainless steel was selected as the material for blade with which the design overcomes factors such as strength or corrosion.

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