

Design and fabrication of sand collector for construction site.

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Abstract- This project aims to design and fabricate the sand collector applicable to construction sites, dams etc. Mainly at construction sites the material such as sand, debris remains, stones are generally carried with the help of large JCB and bulldozers which increases fuel consumption and overall cost of the project. To overcome this problem, we designed a machine that collects soil, debris remains and stone with the help of blade attached to the front of machine. The collected soil will be transferred over the conveyor belt which further transfer soil to be stacked in the container located behind of machine. This design reduced the effort made by mechanized heavy machines as well as helps in human fatigue.

Key words-

Introduction

Construction industries play a key role in overall GDP of the nation and socio-economic development of the country. Now a day's construction industries are rapidly growing to meet the growing demands of people such as home, private constructions, government construction projects etc. The growth in construction industries also have adverse effect such as significant increase in pollution and waste generation [1]. Many researchers and practitioner address this issue emanates during construction stage [2]. Debris remains, sand collection and transportation are a major issue currently faced at construction site [3]. Management of these requires either heavy machineries such as JCB, excavator, and bulldozers or manual intervention to carry it. Extensive use of machinery for collection and transportation of debris and sand put addition cost in overall project cost. To overcome this problem, we have designed and develop the small-scale machine to collect the waste from construction site and this collected material is being conveyed over the conveyor mounted over it and collected at rear end collector.

Working Principle:

Soil collector machine comprises three parts namely blade part, conveyor part and rear tank as a collector. Firstly, the C shaped blade attached at front of the machine is attached with windshield wiper motor with the help of welded links. When power is given to the motor, it produces a torque which lifted up the sand and drop the sand on conveyor belt. Conveyor belt which is attached to Gear motor of 10 RPM with help of small pulleys and PVC pipes gives a rigid support to the belt and transfer the soil into the stack tank at the rear position. The sand collected in the stack tank can drop at the desired location. The whole elements such as conveyor and blade(collector) are mounted on a frame which is fitted with shaft and wheels for the movement of the prototype. The power supply for the whole system will be controlled by RC board.

Prototype design and dimensions

Length of prototype – 71.2 cm, Width of prototype – 46.5cm, Length of conveyor belt – 34.2 cm, Stack tank dimension – as per requirement, Blade length – 31.3 cm, Blade diameter– 16.6 cm

Material Used

Stack tank material – Mild steel, Prototype material – Mild steel, Conveyor belt material- polymer, Roller material – polymer.

COMPONENTS USED

MS square pipe (Mild steel) – 25 mm, 2 mm thickness, 2 windshield wiper motor – 12 volt, 1 DC gear motor – 12 volt, 4 cycle toy wheels – 30 cm, 12 volt battery, Sheet metal – 2 mm thickness, 4 small wheels, shaft – 25 mm, 2 UC bearing, PVC pipe, synthetic rubber, RC board, Chain drive, Sprocket gear, Nuts & Bolts

SPECIFICATIONS

Mild steel (AISI 1018): As we are fabricating a prototype of sand collector machine which is to be withstand high strength, elasticity and durability we choose mild steel as it is most commonly used in industries and automotive and every day usage. This is because due to its properties. Mild steel is not brittle and obtained high yield and ultimate tensile strength.

Windshield DC wiper motor: 12-volt high powered DC wiper motor used for wiping purposes in automotive which is having torque of ranging from 7 to 24 N/m and power being 120-watt, motor speed of 45-55 RPM. Motor is suitable for various land robots and high-powered project which is best suitable to move this prototype and torque capability to lift up the sand as shown in Fig 1



Fig 1: Windshield DC wiper motor

Gear motor (10 RPM): 10RPM 12V DC motor with gearbox having torque 12 kg cm is used for conveyor mechanism to transfer the sand at very constant rate into stack tank.



Fig 2: Gear Motor

12V UPS battery: 12 V- 7 MAH SMF Battery for UPS use, compact in size and Big on power and equipped with a rechargeable sealed acid, makes it more efficient.

Cycle wheels: Small 30 cm diameter synthetic cycle wheel where the whole prototype body is mounted on it and gives a free movement to run with help of motor

UC bearing: UC bearing were attached to the rickshaw shaft mounted on frame which withstand static misalignment of the shaft and easy to be inserted.

Assembly of Prototype and CAD model

The final assembly of sand collector prototype is shown in Fig 3



Fig 3: Final Assembly of Sand Collector



Fig 4: CAD Model

Analysis

Length of the C shaped blade –31.3 cm, Diameter of the C shaped blade –16.6 cm

$$\begin{aligned} \text{Volume of the C shaped blade} &= 3.14 * r * r * h / 2 \\ &= 1.5707 * 0.083 * 0.083 * 0.31 \\ &= 0.0033528 \text{ m}^3 \end{aligned}$$

Torque required for motor to lift up the blade = $F * r$, Let's assume 2 kg of sand is being lifted up and weight of blade be 3 kg then total weight is 5 kg is to be lifted then,

$$\text{Force (F)} - 5 * 9.81 = 49.05 \text{ N}$$

Length of the distance i.e. perpendicular distance (r) is 44.3 cm

$$\text{Torque require for motor} = 49.05 * 0.443 = 21.7 \text{ Nm}$$

Power supplied to the wiper motor of 12 V to run (P) = V * I

$$\text{Current (I)} = 10 \text{ A}$$

$$\begin{aligned} \text{Max Power} &= 12 * 10 \\ &= 120 \text{ watt} \end{aligned}$$

Bending moment on shaft

Bending equation

$$M / I = \sigma / y = E / R$$

Assume stress (σ) of whole load acts on shaft not to exceed 100 N/m²

and $y = r / 2$, where diameter of shaft is 25 mm

$$\begin{aligned} \text{Moment of inertia (I) for solid shaft} &= \pi / 64 * d * d * d * d \\ &= \pi / 64 * 0.025 * 0.025 * 0.025 * 0.025 \\ &= 1.9174 * 10^{-8} \text{ m}^4 \\ y &= 0.00625 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Bending moment} &= 1.9174 * 10^{-8} * 100 / 0.00625 \\ &= 3.067 * 10^{-4} \text{ Nm} \end{aligned}$$

Conclusion

Construction industries play a key role in overall GDP of the nation and socio-economic development of the country. Now a day's construction industries are rapidly growing to meet the growing demands of people such as home, private constructions, government construction projects etc. The growth in construction industries also have adverse effect such as significant increase in pollution and waste generation. The designed prototype is very useful at construction site to reduce the cost and human effort.

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