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DESIGN AND DEVELOPMENT OF SEMI-AUTOMATIC CART

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ABSTRACT: *There are number of vehicles in today's life style which are used by traders, construction site worker, industrial workers and warehouse workers to transport material, domestic appliances, food and other supplies, daily tons of goods and products are produced and they are carried or transported from one place to another. some of the transportation aides are manual based like trolleys, carriage, and rickshaws etc., which require the manual help to pull or push them over the journey of the transportation.*

As per today's life style time is directly proportional to money, so time required to transport the product directly affects the profits margin and price of the product. Hence to achieve fast transportation at short time we have created a carrier/cart or trolley which is advanced and comfortable in handling. At present, the main focus is given on the time required, comfort, advancement, cost, and mainly manual work is aimed to be reduced as much as possible. The model we have created aims to reduce extra effort and tension applied by worker and it also aims to travels from narrow passages and fields. Further emphasis is given on the weight of the trolley so that the motion can be executed with ease and in less time period user can perform the work and the carriage/platform can also be tilt and rotate. Project is designed in Solidworks and analysis is done in ANSYS. MS and steel alloys material has been used for manufacturing

Key words: Trolley, Cart, Transportation, platform, Bevel Gear.

1. INTRODUCTION

In this new era of transportation varies load carrying vehicles are available which help to reduce the extra effort applied by worker but most of them have a problem of steering and height discomfort while transporting the material or loads whereas pushing and pulling increase the work of the worker. This Semiautomatic Electrically powered trolley also reduces time to reach the destination and increases profit. The problem of carrying heavy loads in a wheel cart or similar vehicles provide a vision to develop a trolley which can solve these problems. The new era of world demands an interactive and ergonomically suitable product like those, product which are affordable but should reduce human efforts best suited to environment, easy to carry and do not require maintenance. In this era there is a need of a cart which should be easy to handle and easy to control, hence whereas there are some cart and trolleys are already design and now they are in use for heavy loading/unloading of material and objects. We have design this cart with some semiautomatic features so it can helpful in that areas which have narrow passage and narrow alleys, our project has an advantage as the worker or labour who is transporting construction site material like bricks, aggregate, sand, cement etc. to a narrow passage the actual stress which will held on labour will be less as compare to old trolleys and carts and these carts may also use as gardening carts. Hence there is a need of semiautomatic carts as it can easily move in a narrow passage and alleys.

2. MATERIAL AND METHOD

In selection of material for the components of trolley various I.S{Indian standards} are used. Some of the components of trolleys are design with the help of DME design data and its design in such a way that the workers do not have to apply any extra effort or pressure which are required in normal trolleys and cart like rickshaw trolleys, metal trolleys, wooden carriage and may more. In material of components such as upper base and lower base mild steel square rods are used and whereas material for the axle shaft is hard steel. Miter bevel gear is made up of stainless steel and steel alloy material which are 90 degree straight and bearings have high carbon chromium steel material. Platform is the main part of the trolley so all the loads would have to bear by this part. So, the parameters of this part like strength, tensile strength, bending strength, hardness, toughness, young's modulus etc. should be consider first. To increase the loading capacity of this platform the material should be hard and ductile so mild steel material are used for the platform.

Properties of mild steel are:

1. Malleable

2. Ductile
3. Hard
4. Tough
5. Young modulus = 200 -240 Gpa.
6. Density of material = 6.89 g/cm^3

Methods which are applied to fabricate this project are metal arc welding, drilling, lathe operating, grinding, Machining and other many other methods.

3. PRINCIPLE OF OPERATION

Cart is a source of transportation of commodities from one place to another in small scale industrial areas. To evaluate the performance of different carts we have created this cart such that extra stress which is occurred on the human while transportation will be reduce. Our project will increase the efficiency of the trolleys and cart .This cart has special design that it can moves in any direction while loading and unloading .There are shaft and gear arrangement in this cart so we can move the assembly in upward direction .It can also perform lifting the assembly so we can say it is multitasking mechanical cart which we can use for various purpose and this will help the farmers, plant seller , small scale industrialist, construction workers , gardeners who uses the manual and conventional trolleys /carts.

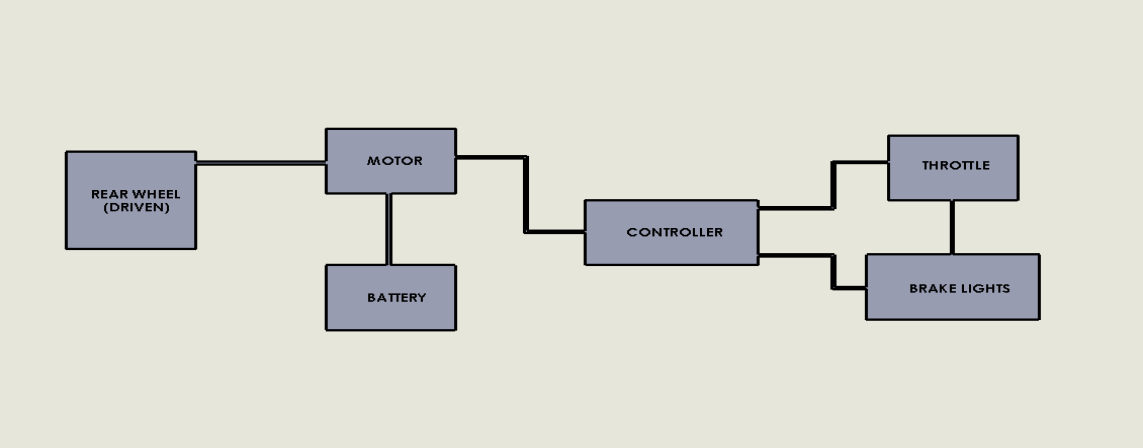
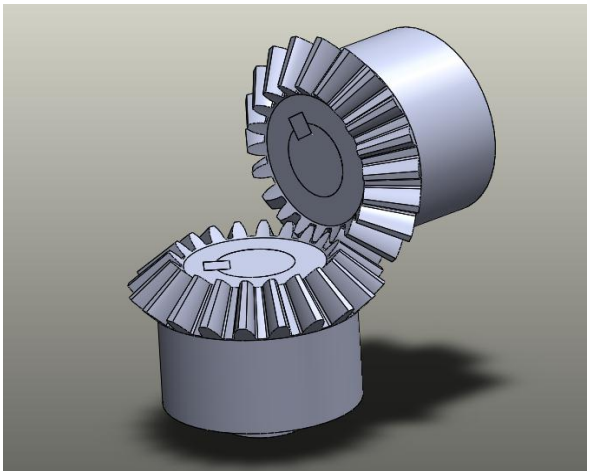


Fig.1 Block diagram of semiautomatic trolley.

4. Design and Calculation

4.1 BEVEL GEAR

Bevel gears and miter bevel gear are gears where the axes of the two shafts intersect and the tooth-bearing faces of the bevel gears themselves are conically shaped. Bevel gears are mounted on each other as such a way that it transfers the torque easily and the shafts are 90 degrees apart, but it can be design to work at other angles as well. In bevel gear the torque is depend upon number of teeth. Where the design calculation of bevel gear is given below. The cylindrical gear tooth profile corresponds to an involute which is a triangle wave projected on the circumference of a circle, whereas the bevel gear has octoidal tooth profile. Usually all the bevel gear are manufactured with octoidal tooth profile.



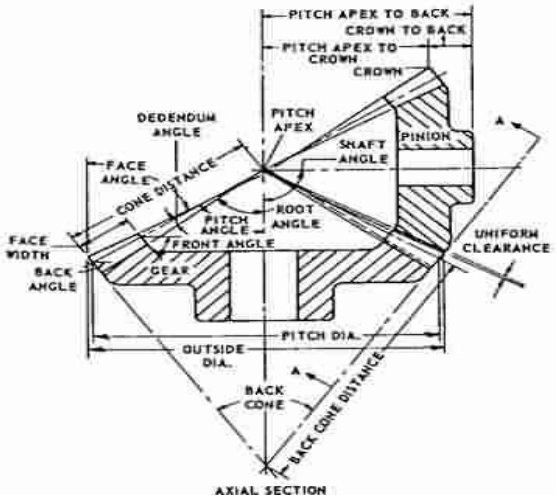


Fig.2Bevel Gear Fig.3 Bevel Gear Terminology

4.2 Design of bevel gear

Calculation of bevel gear:

Formulas for bevel gear calculations are:

1. Pitch Diameter:

D= N/P

Where N is the number of teeth and P is the diametral pitch.

2. Diametral Pitch:

P= N/D

3. Number of Teeth:

N=M/D

Where

4. Whole Depth:

Ht= 2.188/P+.002

Where Ht is the whole depth, P is the diametral pitch.

5. Addendum:

a= 1/P

6. Dedendum:

b= Ht-a and c= Ht-2*a

7. Circular Tooth Thickness:

T= PI/(2*P)

8. Pitch Angle:

Lp = atan(Np/Ng)

, and Lg= atan(Ng/Np)

9. Pitch Cone Radius:

Rcp= D/(2*sin(Lp))

and Rcg= D/(2*sin(Lg))

10. Face Width

F= min(C/3, 8/P)

11. Outside Diameter:

Dop= Dp+2*a*cos(Lp) and Dog= Dg+2*a*cos(Lg)

12. Back Cone Radius:

Rbp= Dp/cos(Lp)

and Rbg= Dg/cos(Lg)

13. Virtual Number of Teeth:

Vp= N/cos(Lp),

1. Stress analysis formula:

Velocity ratio of gears can be calculated using Equation 1 as given by [1]:

VR=N/n=t/T……{1}

where, N = Number of revolutions of driver bevel gear, n = Number of revolutions of driven bevel gear,

T = Number of teeth of pinion gear, t = Number of teeth of driven gear

Bevel gear given data :

Shaft angle (θ) = 90

Pitch angle for pinion (γp) = 45

Pitch angle for gear (γg) = 45

Where normal human can produce 300-600 watt of energy /power.

P_d = 500 watt = 0.5 kw

Tp = Number of teeth of driver gear =28

Tg = Number of teeth of driven gear =28

VR = Np/Ng=Tg/Tp 28/28 =1

1) **Pitch line velocity**:

$$Vp = \frac{\pi * Dp * Np}{60}$$

2) **Design power**;

Pd = Pr * Kl
Where Kl = 1.25 for steady and continuous load

Pd = 0.5 * 1.25
= 0.625 Kw

3) Tooth load :

$$Ft = \frac{Pd}{VP}$$

4) Bending strength:

Fb = So* Cv *Y*b*m*(1 –b/L)

Where,
Formative teeth on gear and pinion given as:
Tfp = Tp / cos γp

Tfg = Tg / cos γg
Where,
Yp = 0.485 – 2.87 / Tfp
Now,
Sop = Syt / 1.5 where material used is steel and steel alloy and its for eg. Syt = 680 N/mm2
Sop = 453.33 N/mm2
Sog = 453.33 N/mm2

i) Now, Sop * Yp and Sog * Yg can be found
Since pinion and gear has same material design further with respect to gear material.

ii) L = cone distance = 0.5 $(Dg^2+Dp^2)^{1/2}$

iii) Where module M = diameter of gear / Number of teeth on gear
M =Dg/Ng

Where b less than equal to L/3, Hence design is safe.

iv) Cv = (3 / 3+ Vp)

Where, Fb = So* Cv *Y*b*m*(1 –b/L)

Fb >Ft, hence design is safe

5) Dynamic load:

$$Fd = Ft + \frac{21\,VP*(Ceb+Ft)}{21VP+\sqrt{(Ceb+Ft)}}$$

C = deformation factor = 11800 with 20^0 full depth

e= 0.050

Fd can be found.

6) Limiting wear strength:

Fw = Dp*b*k*Q / cos γp

Where, Q = gear factor

Q = 2Tfg / Tfg + Tfp

From the above equation Fw can be found

Equate eq 1 = eq 2

Hence Fw > Fd

Hence design is safe.

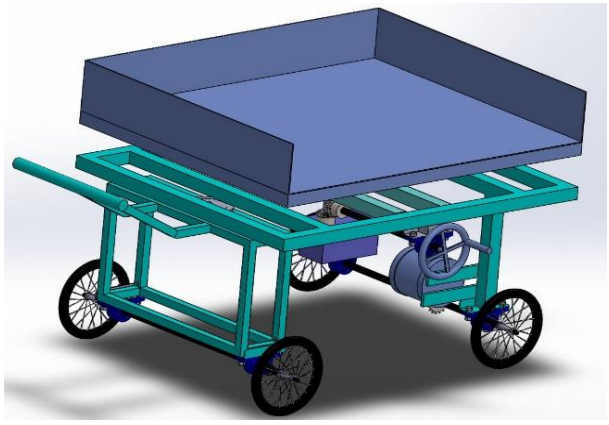


Fig.5 Authentic Model Fig.4 CAD Model

5. ANALYTICAL OBSERVATION: Following analysis is done in ANSYS 16.0.

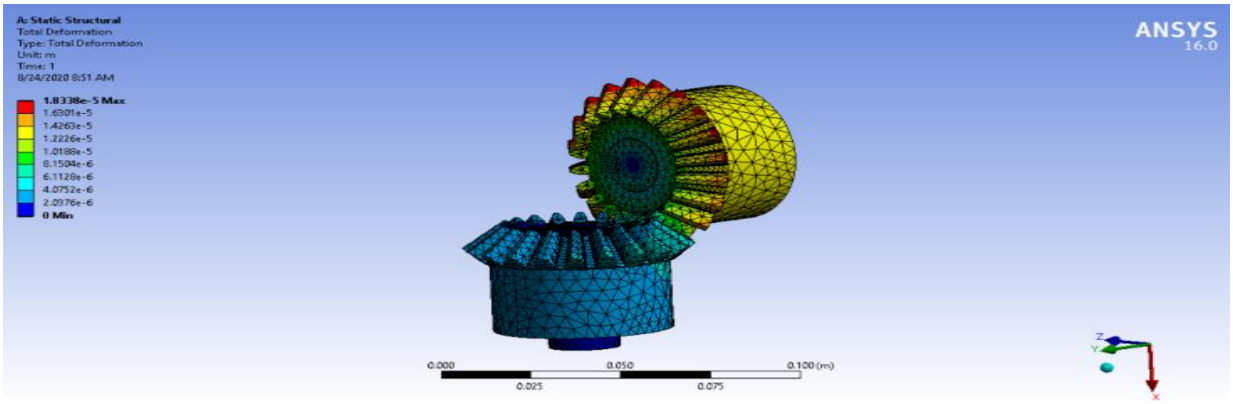


Fig.6 Total Deformation

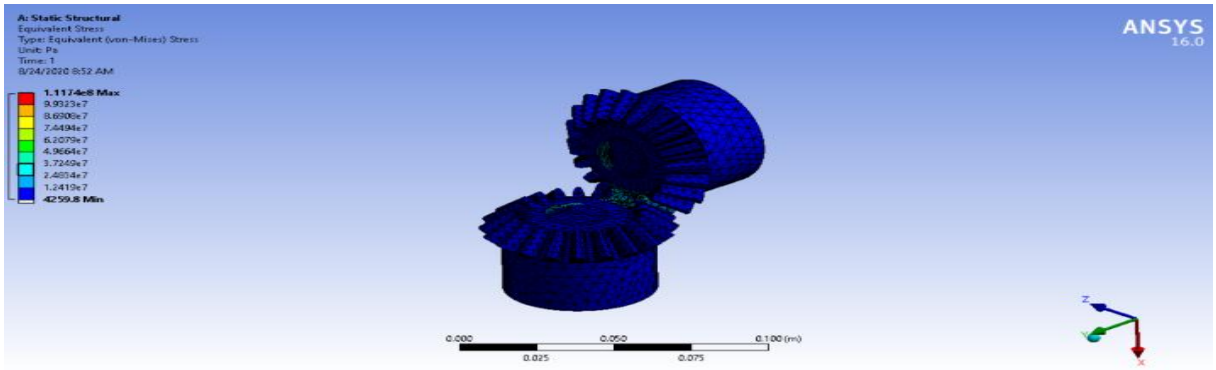


Fig 7. Equivalent stress (Von-Mises)

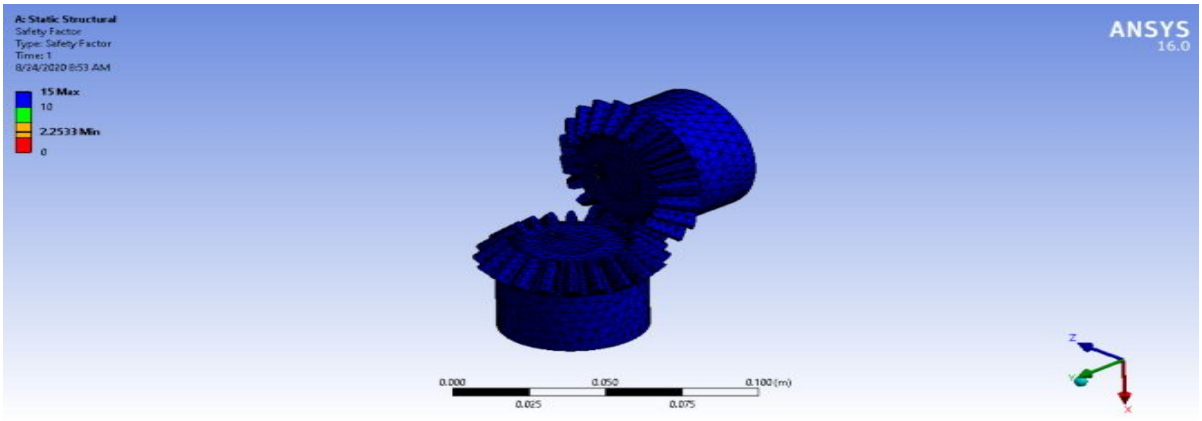


Fig 8. Safety Factor

Above analysis is found out to be safe, bevel gear is designed for maximum load carrying. Torque of 200Nm was applied on the teeth which has output safety factor of 2.53 which is excellent. We have found out that for even 400N of load has generated not more than 20Nm of torque. Keeping the same calculation for bevel gear high load carrying cart can also be manufactured.

6. OBSERVATION

Following two reading have been taken for main purpose to find effort required to operate manually. lifting is done with bevel gear as rotational motion is converted into linear, and tilting operation is performed with the universal coupling whose end side has thread which result into tilting operation**.**

T= F * R where R is the length of lever arm and F is the effort force acting at the end of the arm of handle in newton.

Serial number	Load [N]	Effort [N]	Torque [Nm]
1	98.4	19.62	3.56
2	196.32	39.43	7.69
3	296.3	60.82	11.94
4	392.43	84.36	16.18

Table.1 shows readings of lifting mechanism with the help of bevel gear.

Serial number	Load [N]	Effort [N]	Torque [Nm]
1	98.4	15.30	2.754
2	196.32	21.87	3.937
3	296.3	35.76	6.438
4	392.43	43.59	7.847

Table 2. Shows Readings of tilting mechanism with the help of universal coupling.

As load increasing gradually effort required is also increasing evenly but during tilting it is observed as increase of load effort is decreasing in percent than the previous.

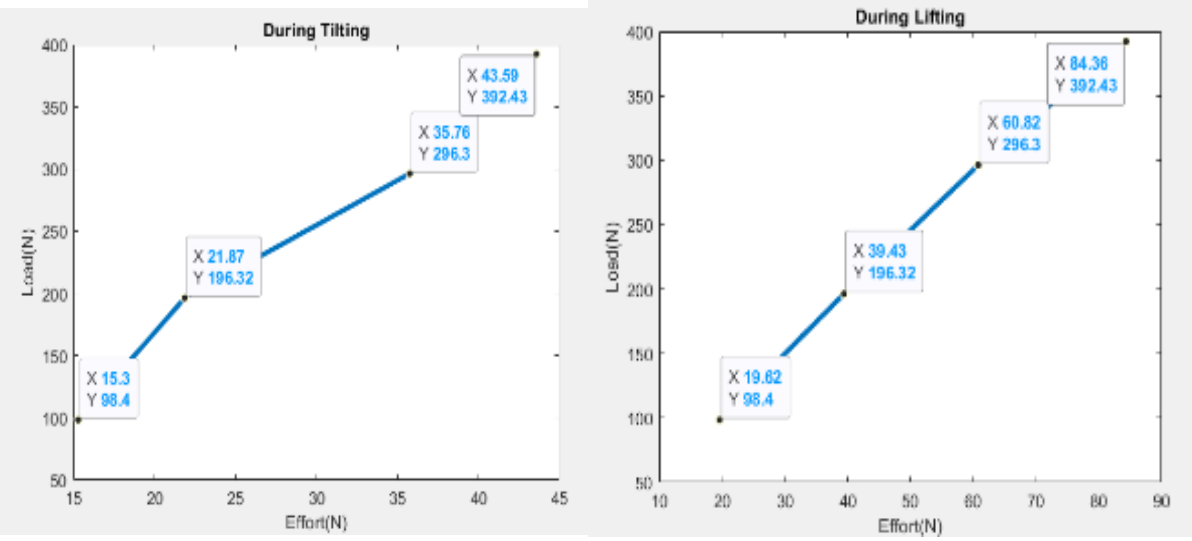


Fig.10. Load vs Effort during Lifting **Fig.10.** Load vs Effort during Tilting

7. FUTURE ASPECT:

1. Actuators can be used of for mechanical work as a replacement of gears.

2. Further development can enhance the load carrying capacity.

3. Project can be controlled with remote with automation tech.

4. One can also develop it as self-driving cart.

5. With some modification and weight distribution a seat can be provided for the driver.

CONCLUSION

Highest average Automatic trolley with all dimensional constraint is designed. Likewise, the 3D model of the trolley is designed in the solidworks Software with isometric view generated as well as with the rendered view. The trolley is designed consisting of the motors. Various drawbacks which were present in the existed models were removed like manual work was reduced as well as the steering mechanism was improved so that the worker would be easily able to perform the steering with ease. The experimental result shows that very little effort is required to unloading as compare to normal trolleys. the focus was emphasized on the cost and weight of the trolley which was maintained as per the requirement of an individual. Screw jack mechanism is also provided to adjust the height of the platform as per requirement.

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