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Power Screw Operated Automated Gate

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Abstract: ***This project is to design and develop low cost and high speed automatic opening and closing of gate for industry purpose. Automatic gate is one of the most preferable and necessary thing for industry. Time required for open and close the gate manually is more. Also to open and close the gate again and again by hand required much power and hence it can exhaust the power of worker and he gets bored, so automatic gate is required in industry. There are some mechanisms to operate a gate such as a sliding on screw or on rack and pinion, piston operated, rotary. The main objective of our project is to reduce the operating cost of gate and increase the life of mechanism which open and close the gate. We use the power screw to open and close the gate, which is low in cost and also more durable than other mechanism. A power screw is a device used in machinery to change angular motion in to linear motion and, usually, to transmit power. It is smooth and noiseless in working and has ability to carry heavy loads with high efficiency so if gate weight is more then also it will not affect the working of mechanism. Power screw is operated by means of motor. We also use sensor to open and close the gate so workers work will reduce.***
Keywords: Automatic gate system, power screw, motor, nut and sensors

I. INTRODUCTION

Gates are used at residential areas and industrial areas. A gate is a point through which one can enter to a space enclosed by walls. Gates prevents or controls entry or exit of vehicles and human crowd to a particular area. The necessity for automatic gates has increased in recent times. The gate prevents or controls entry or exit, or they may be merely decorative. The mechanism described here the actuator to control the movement of the gate automatically. The automatic gate described here automates the entry to parking lots of residential homes, organizations, automobile terminus, and public car parks & many more. It does not use a remote control convenience to less the stress of manually opening and closing the gate and decreasing a requirement man power. Normally gate works with many features like movement in forward direction, reveres direction, automatic stop when problem occurs and on sensing a movable parts around it. These gates come with different types of mechanisms such as sliding, swinging, folding, and barrier gate. These mechanisms have their own working principle and features but, automatic gate design seem limited at the local market. Most of the product is supply by outside provider. Which cost is higher and not in budget. Cost study and new mechanism design, can be Marketable toward customer at lower cost and new innovation of auto gate mechanism can enhance local design capability.

II. WORKING OF THE GATE

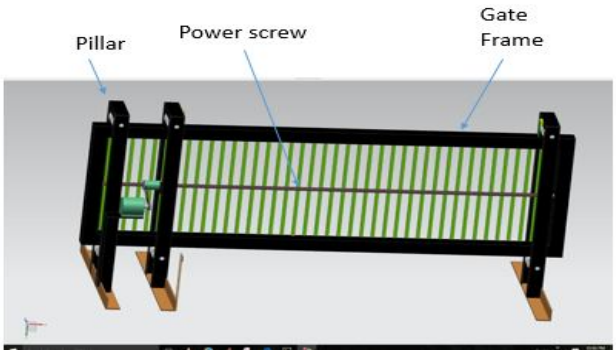


Fig 1.CAD Model of the Gate

Before discussing the finer details of gate and automatic openers, let's take a quick look at the major components of a typical system and how it operates. The gate is securely mounted to tough posts that are set in concrete and buried deep into the ground. Gates can also be mounted to brick pillars or stone columns.

1) The power screw is bolted to the gate frame.
2) For opening and closing of gate we have cable connections with push button system separately for forward and backward motion.

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A. Opening of gate

1) When the automatic switch is pressed, the current will pass to the motor to move the gate towards left or right.

2) The gate will touch the limit switch as it reaches to the end.

3) As the gate touches the limit switch, a current is send to circuitry to stop the motor which causes stopping of the gate.

B. Closing of Gate

1) The gate will automatically close after a specified time delay if sensor doesn't sense any object.

2) As the gate touches the limit switch, a current is send to circuitry to stop the motor which causes stopping of the gate

III. CASE STUDY



Fig 2.Automatic gate case study

Pravara Rural Engineering College's North campus gate has length of 6000mm and width of 2000mm and weight of 125 kilogram is under consideration for case study.

IV. DESIGN CALCULATIONS

Our design is based on the above case study.

Material used for screw = C50 … (Design data book Page No. - 1.4)

Material used for nut = bronze

S_{yt}=380 N/mm^2

Factor of safety = 4

W=10000 N

Length of screw = 6000 mm

Modulus of elasticity (E) = 2.04*105 N/mm^2 … (Design data book Page No. - 1.1)

Design of screw

$\sigma_c = S_{yt}/FOS$ =95 N/mm^2

$\tau = 0.5*\sigma_c$ = 47.5 N/mm^2

$\sigma_c = [W/ (\pi/4*d_c^2)]$

$95 = [10000/ (\pi/4* d_c^2)]$

d_c=13 mm

Considering additional stresses due to bending and shearing we consider the safe diameter of the screw as

d= 28 mm, pitch (p) = 5 mm … (V.B.Bhandari Table No. 6.2)

$d_m = d-0.5*p = 28-0.5*5 = 25.5$ mm

$d_c = d-p = 28-5 = 23$mm

Considering the trapezoidal threads and double start threads

l=n*p=2*5=10mm

$\tan(\alpha) = (l/\pi*d_m)$

$= (10/\pi*25.5)$

$\alpha = \tan^{-1}(10/\pi*25.5)$

α=7.110

The maximum value of coefficient of friction between steel and bronze is 0.18

So we are considering the value of μ=0.15

$\tan(\phi) = \mu$

ϕ=8.530

For the trapezoidal thread

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Θ=150 ... (V.B.Bhandari Page No. 195)

Torque required to raise the load is calculated as follows:

M_t= (W*d_m/2) [(μ sec (θ) + tanα)/ (1-μ*sec (θ)*tanα)] ... (V.B.Bhandari Page No. 196)

M_t=36402.87 N.mm

Design of nut

Considering the bearing pressure (S_b) = 6.5 N/mm^2 .. (V.B.Bhandari Table No. 6.4)

z= [4W/π*S_b*(d^2-d_c^2)]

z= 7.68

So consider the numbers of threads are 8

Length of nut = z*p

Length of nut =8*5

Length of nut = 40mm

S.P.P.U

Length of nut $\leq$ 1.5*d .. (V.B.Bhandari Page No. 208)

40 $\leq$ 42

Hence this condition is satisfied so the design is safe.

Consider the thread thickness is 0.5*p

Thread thickness = 2.5 mm

τ_s= (W/π*d_c*t*z)

τ_s=6.32 N/mm^2

τ_n= (W/π*d*t*z)

τ_n= 5.684 N /mm^2

As both τ_n & τ_s both are less than the permissible τ.

Hence the design is safe.

Linear speed of screw:

We are using a motor of 2 HP

= 1.5 kW

KW= (2*π*n*M_t/60*106)

n=393.38 rpm

V= (π*d_m*n/103)

V= 31.2 m/min.

V= 0.52 m/s.

V. ADVANTAGES

A. Working speed of the mechanism is quite high.
B. More durable.
C. Maintenance cost is low.
D. Weight sustain ability of mechanism is high.
E. Having simple in mechanism hence it is easy to operate.

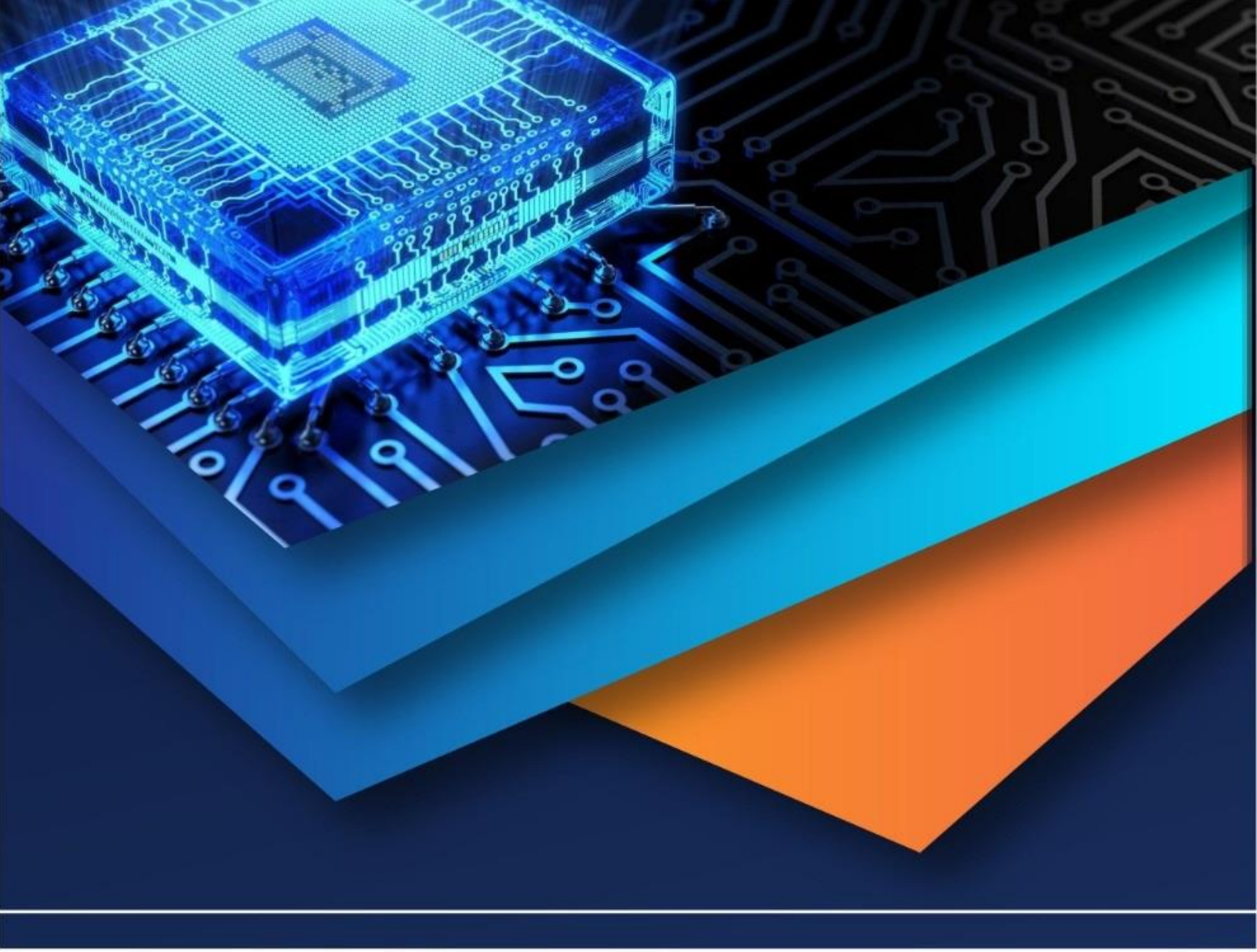
VI. CONCLUSION

The paper introduces a new mechanism for opening and closing of gate using Power Screw. It has advantages of being operated without manual interference, high load carrying capacity, high speed, long life. The gate is simple in construction and easy to manufacture. Use of remote control is eliminated and opening and closing of the gate is totally automatic.

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