© 2014 IJEDR | Volume 2, Issue 1 | ISSN: 2321-9939

Operated Rack In and Out Unit Development and Structural Analysis of MAST

[1]T.Sri Sivakanth, [2]J.Senthil Kumar
[1]post graduate student [2]Assistant professor
Dept of Mechanical & Production Engg., Sathyabama University, Chennai-600119.
[1]sivakanth52@gmail.com ,[2]j.senthilkumar1981@gmail.com

***Abstract*— Due to safety requirement, electrical unit like should be withdrawn from 20 feet away. Also, torque more than 10 N-m is required to withdrawn the unit due to continuous power supply to the electrical unit. Rack-in/Rack-out unit should be easily removed or fitted with the electrical unit which should racked-out or racked-in into the panel. Same remote operated unit can be used to change the LMV (like car/van) vehicle wheels also.**

Nomenclature used:
1. RRU –Remote Racking Unit
2. CW & CCW – Clockwise & Counter Clockwise
3. BOM – Bill of Material
4. RS – Requirement Specification

I. INTRODUCTION

Due to the safety purpose in industries while rack in and rack out purposes of circuit breaker normally many small and large scale industries by removing circuit breaker manually there is a chance of occurring short circuit so in order to overcome this problem here we are using rack in and rack out by worm gear this helps to do function from 20 feet away Mounting remote racking unit will be made on 2 mounting studs on the secure connect unit door Duty cycle CW-CCW-CW, continuous CW/CCW operation should not be performed twice 100 Lbs-inch is the required torque to operate the secure connect unit shaft Secure connect unit shaft has to be operated 90º CW/CCW within 3 seconds Alignment of Remote operator shaft which needs to engage with 2100 secure connect unit operating shaft needs to match orientation and shaft will rotated 90° CW for connect and 90° CCW for disconnect condition. This will be achieved by rotating operating shaft. So operating shaft should not be rotated beyond 90° , over travel will damage stab assembly So, Limit switch and stopper arrangement will be used and the design of Limit arrangement and stopper should meet the requirement of avoiding the shaft over travel above 90º .

The stepper motor shaft has to be coupled with worm gear shaft using a coupler and hence a step (flat surface) is required on the motor for assembling the coupler with set screw.The cables which will primarily function here are the red, green and white cable These cables must be crimped with a pin type lug/terminal to connect with the 6 pin connector. The cable length required is same as the power cable, 18 inches. "Design of mounting arrangement should have F.O.S 1.5 to keep design is safe and should be capable of handling axial load to avoid accidental release of the unit during operation" The second are single-throated worm gears, in which the worm wheel is throated. The final types are double-throated worm gears, which have both gears throated. This type of gearing can support the highest loading [1]. An enveloping (hourglass) worm has one or more teeth and increases in diameter from its middle portion toward both ends[2]. Double-enveloping worm gearing comprises enveloping worms mated with fully enveloping worm gears. It is also known as globoid worm gearing [3]. A left hand helical gear or left hand worm is one in which the teeth twist counterclockwise as they recede from an observer looking along the axis[4].

II. EXPERIMENTAL DETAILS

A. Worm and worm gear

1:20 gear reduction is required for the application with a smaller size. The selected worm & worm gear is capable of delivering the required torque

B. Stepper motor

Precise control with proper timing at desired torque is required for the application. Excitron stepper motor is controlled with a remote control from a distant location, and the function can preprogrammed in the stepper motor. Even at power failure the controller has the capability of resuming the remaining movement when the power is back. The total motor and controller set up is at better cost.

C. DEEP GROOVE BALL BEARING

The provided proper axial load and radial load balance without vibrations we need to provide a bearing on the other side of the worm shaft. On the stepper motor side already a bearing is present inside the motor.

III. METHODOLOGY

A. Material Selection

Mechanical properties of the materials are required for finite element models. Brass and Steel are used for the finite element analysis. Table 1 describes few material properties used for analysis.

Table 1: Material properties used for the Analysis

Property	Bronze	Steel
Young’s Modulus	96-120 GPa	200 GPa
Poisson’s Ratio	0.34	0.30

B. Finite Element Modeling

Finite Element Modeling involves in pre-processing stage, processing stage and post processing stage. Pre-processing stage involves details of mesh, load & boundary conditions. An appropriate finite element analysis was used to represent necessary structural details to obtain correct structural behaviour of system

WORM AND WORM GEAR

<u>**Efficiency calculation**</u>

EFFICIENCY= E = Tanγ(1-ftanγ)/f+tanγ

Where =worn lead angle
F=coefficient of friction

Max. Coefficient of friction= 0.05
Worm lead angle= 4°46”
η = 60% (For safety we take 50%)

If the motor provides a min. of **7.5** in-lbf torque,

If we required 100 in-lbf as output, with the current worm and worm wheel drive, the output torque will be 150 in-lbf. Suppose if we need 100 in-lbf as output. we will get 7.5 in-lbf torque from stepper motor shaft so the selected gear is 1:20 then 7.5 in-lbf is converted as150 in-lbf and gear losses is considered and gear loss is 0.75% den 150*0.75 and we will get 112.5 in-lbf torque so required torque is 100 in –lbf torque1

TORTIONAL STRESS ON THE WORM SHAFT				FORMULA	TORTIONAL STRESS ON THE WORM GEAR SHAFT			
DIAMETER OF WORM SHAFT	d_w	0.475	in	$I_P = \pi d^4/32$	AVERAGE DIAMETER OF WORM GEAR SHAFT	d_{avg}	0.385	in
RADIUS OF WORM SHAFT	r_w	0.237	in		RADIUS OF WORM GEAR SHAFT	r_g	0.19 23	in
POLAR MOMENT OF INERTIA	I_p	0.005	In^4	$\tau = (T*r)/I_P$	POLAR MOMENT OF INERTIA	I_P	0.002	In^4
SHEAR STRESS IN THE SHAFT	τ_w	832	psi		OUTPUT TORQUE	T_O	100	In lbs
					SHEAR STRESS IN THE SHAFT	τ_g	8929	psi

BENDING STRESS ON THE WORM SHAFT				FORMULA	BENDING STRESS ON THE WORM GEAR SHAFT			
DIAMETER OF WORM SHAFT(MIN)	d_w	0.475	in	$I= \pi d^4/64$	DIAMETER OF WORM GEAR SHAFT	d_g	0.5	in
RADIUS OF WORM SHAFT	r_w	0.237	in		RADIUS OF WORM GEAR SHAFT	r_g	0.25	in
MOMENT OF INERTIA	I	0.002	In^4	$\sigma= (M*r)/I$	POLAR MOMENT OF INERTIA	I	0.003 068	In^4
MAX BENDING MOMENT	M	44.54	In lbs		MAX BENDING MOMENT	M	207.49	In lbs
BENDING STRESS IN THE SHAFT	σ_w	4,234	psi		BENDING STRESS IN THE SHAFT	σ_g	16,908	psi

Worm-worm gear of 1:20 gear ratio is selected and safe


Fig 1: Manually operated to rack in and out

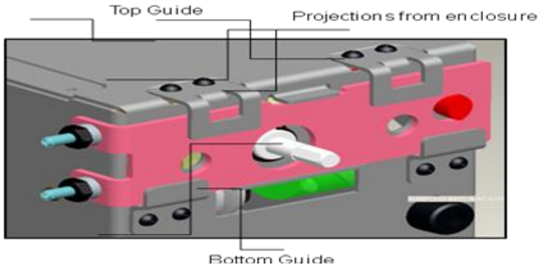

Fig 2: Automatic operation through remote racking

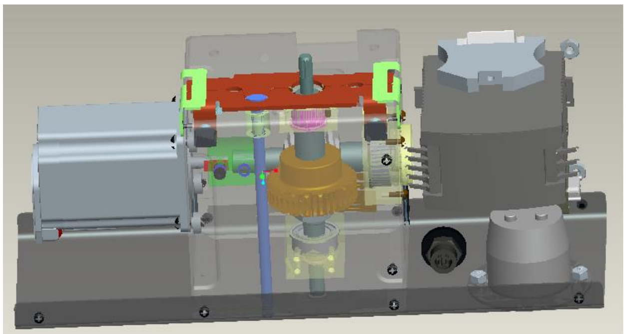
Fig 3: Proposed model for remote racking

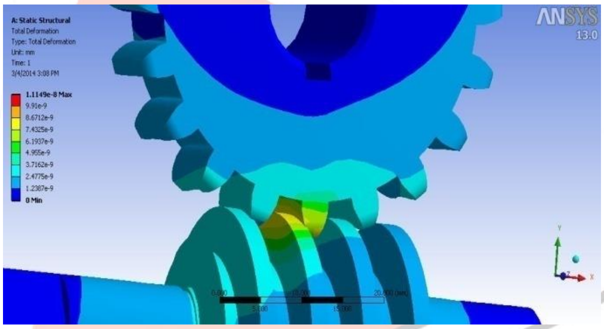

Fig 4: Total deformation

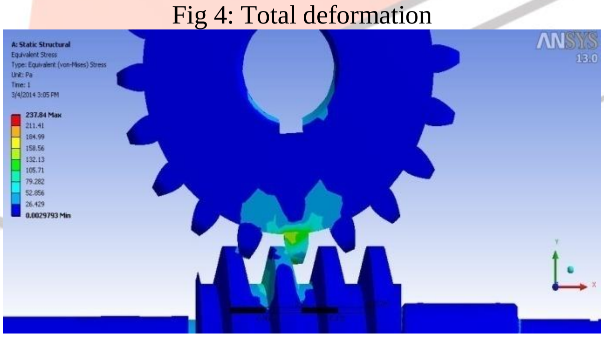

Fig 5: Equivalent stress

IV. RESULTS AND DISCUSSION

This total setup is drawn in pro E and gear calculations where done .so this setup helps to solve this fire accidents while racking in and out .This setup helps to rack in and out safely from 20 feet long so the operater will be safe at the other end and the maximum deformation and stress is shown in the above figure

V. CONCLUSION

- It avoids fire accidents while racking in and out of circuit breaker and increases safety measurements
- It helps car/van etc for lifting vehicle for changing tire purposes
- Secure connect unit shaft has to be remotely operated away from 20 feet

REFERENCES

[1] Worm Gears Retrieved 2009-05-01.
[2] Gear Nomenclature, Definition of Terms with Symbols. American Gear Manufacturers Association. p. 3. ISBN 1-55589-846-7. OCLC 65562739. ANSI/AGMA 1012-G05.

[3] Gear Nomenclature, Definition of Terms with Symbols. American Gear Manufacturers Association. p. 4. ISBN 1-55589-846-7. OCLC 65562739. ANSI/AGMA 1012-G05.
[4] Oberg 1920, pp. 213–214.