Design and Manufacturing of Rotating Body Tool Holder

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ABSTRACT

An assembly operator performs repetitive work of tightening and loosening of bolts. If assembly area lags the ergonomic devices it provides the opportunity for injury and may cause additional cost on organization and may lead to early retirement of worker. High torque nutrunner creates reaction force on operator's hands. While studying ergonomics and some of experiments conducted, conclude how the torque reaction affects operator's hand. Torque reaction depends upon hardness of the joint, how the operator holds the nutrunner and reset torque of machine. The vibrations created and transmitted by machine is closely monitored and studied and how they affect operator is noted.

Keywords*: Hand and Arm vibrations, Grip force, Power hand tools, Reaction force, Angled nutrunner, torque analysis, handle displacement analysis.*

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1. INTRODUCTION

Angle nutrunners are both quieter and more precise than impact nutrunners, they are often used to tighten screw and bolt joints in the assembly industry, thus often replacing impact nutrunners. There is no fixed dividing line between single-handed and double-handed tools. It is suggested that an angled nutrunner with the capacity to tighten joints to a torque of over 30 Nm should be considered a double-handed tool, so as to not subject the operator's wrist to an extreme torque. Because the number of tightening per unit of time determines the load on the wrist, the workplace designer should always strive to find a good suspension system for the tool, particularly if one hand of the operator is providing the joint with screws or nuts.

1.1 MODEL DESIGN :

They have developed a dynamic mechanical model for right-angle nutrunner operation in the horizontal plane in which the longitudinal axis of the tool spindle was perpendicular to the ground.

Static hand reaction force at a given time can be calculated as torque at the spindle divided by the handle length: $F_{Hz} = T_{nut} / L_{Hy}$

Where F = force, H = hand, T = torque, and L = length, F_{Hz} = hand reaction force Using the equations of motion.

1.2 Design

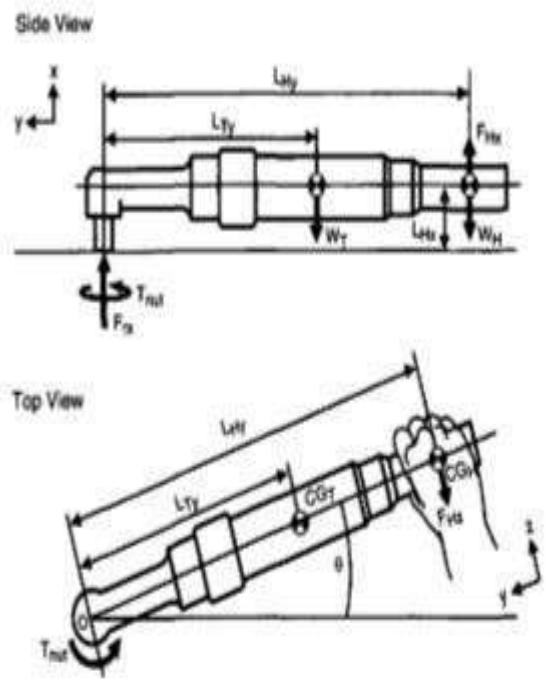


Figure 1. External co planar forces acting on a right angle power hand tool.

1.2 EQUIPMENT :

Hand reaction force (F_{Hz}) during tool operation was calculated, based on the mode described in Equation , by substituting geometric and inertial parameters of the power hand tool studied and using kinematic data collected in a investigation. A computer-controlled power hand tool was used to study hand tool operation in the laboratory. An Atlas Copco Tensor right angle was operated on an Indresco joint simulator. The tool contained a torque transducer and an angle encoder integrated into the spindle head, which outputted signals representing applied torque and angular spindle rotation. Data for only tool operation in a horizontal workstation where the longitudinal axis of the joint head was perpendicular to the ground were used for this study. in order to calculate angular velocity and angular acceleration, respectively. A digital low-pass filter with a cutoff frequency of 55 Hz was used to reduce signal noise. The average mass of the hand and lower arm was approximated as 1.6 kg. The tool CG was estimated as 0.21 m measured from the tool spindle . The mass moment of inertia of the tool (1'001) was measured using the quick-release method .[2]

1.3 DYNAMIC AND FORCE IN TOOL OPERATION :

$$F_{Hx} = 1/L_{Hy} (W_T L_{Ty} + W_H L_{Hy})$$

Several simplifying assumptions were made. It was assumed that forces could be summed along the handle without producing coupling moments. This assumption allowed hand force to be considered as a single point of application. The hand and lower arm mass was considered a point mass, and hand force was concentrated at the center of the grip, which coincided with the center of gravity (CG) of the hand. [2]This assumption enabled the moment of inertia of the hand to be zero at it's eG. Only hand force components reacting against torque (F_{Hz}) and supporting the tool (F_{Hx}) were considered in the model. The hand force in the y direction was assumed to be insignificant; furthermore, it was assumed that the hand does not create torque along the y axis, which means that there was no twisting motion by wrist flexion or extension during tool operation. Frictional forces were also ignored.

1.4 EXPERIMENTAL DESIGN :

The three-factor full-factorial experimental design included target torque (T), torque buildup time (B), and subject (S). Subject was considered a random variable, and torque and torque buildup time were fixed variables. All combinations of three target torques 25, 40, and 55 Nm and five torque buildup times 35, 150, 300, 500, and 900 ms were presented randomly to every participant. Ten replicates were made for each experimental condition, and the last five trials were used for data analysis in order to reduce learning effects. [2]Six inexperienced volunteers (three men and three women) participated. The participants' average age was 21 years (SD = 1.5 years), average stature was 167 cm (SD = 12cm), and average body weight was 72 kg (SD = 23 kg). Inertial torque was calculated from angular acceleration measurements and by inertia of the tool and hand. Inertial force was defined by the ratio of inertial torque and the tool handle length (0.48 m). The error between FHz estimated using the static mechanical model and the dynamic mechanical model.[2]

2 THE ANGLED NUTRUNNER :

In this experiment they have studied that how the nutrunner act on the hands of operator. Long expose to nutrunner toque may affect the health of operator and cause loss to organization .following are the basic thing which will affect the torque reaction:

1) Hardness off joint
2) displacement amplitude
3) holding posture of worker

2.1 Study No.- 1 [1]

Aim of this study to find out how the soft joint and hard joint affect the torque reaction. If the angle of torsion is less than 60 degrees then it can be consider as hard joint and more than 700 then soft joint

2.2 Method

Worker asked to perform the tightening of 2 set of 10 joint. One is soft joint with 40 degree and another is medium soft joint with 200 degree with same machine required to achieve 50 Nm torque. Traducer is attached to measure torque as function of time .

2.3 Result

As show in graph of torque vs time we can see that hard joint can achieve required torque faster than medium soft joint

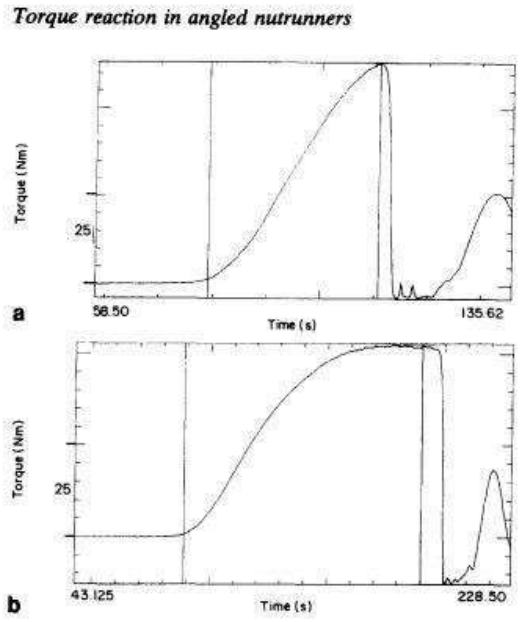


Fig2 a) hard joint b) soft joint

2.4 Study 2 [1]

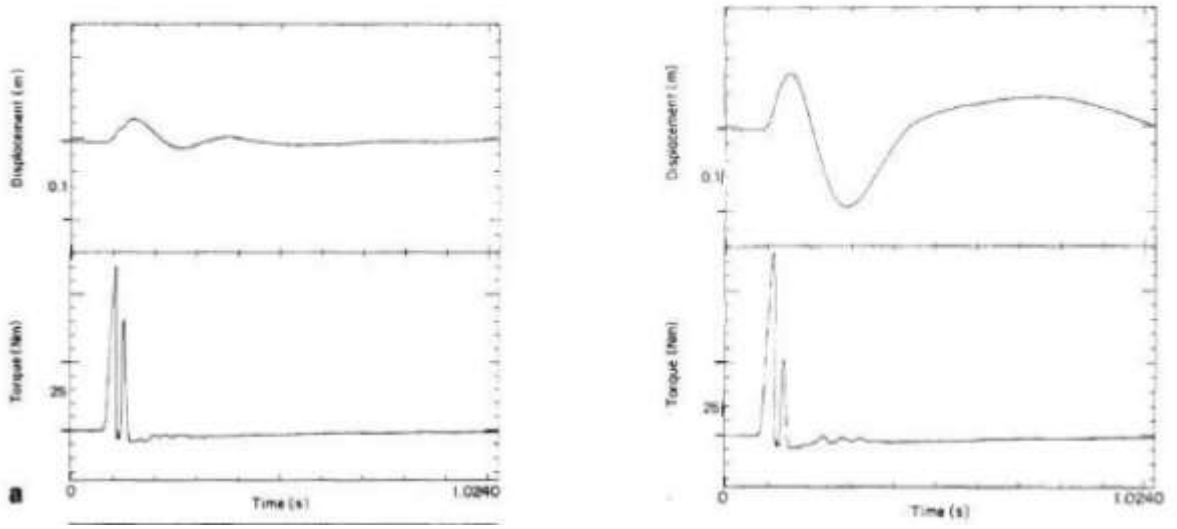
Same experiment I carried out to study how posture of worker affect the displacement and torque

2.5 Method

2 set hard joints of 10 bolts are tighten by same machine holding on 2 different position one is horizontal lower arm and another is vertical lower arm and recorded displacement and torque and plotted against time.

2.6 Result

As you can see horizontal lower arms displacement is less that of vertical lower arm taking the same amount of torque. So horizontal lower arm is more preferred while designing tool holder



b

Fig 3 Holding posture a) horizontal lower arm b)vertical lower arm

3. RESULTS :

It is possible to conclude the following from the various studies performed:

1) The arm posture influences the tightening sequence, particularly the displacement of the handle.

2) The subjective rating of operator discomfort is related to the handle displacement and the pre-set torque.

3) The maximum displacement of the handle during a tightening sequence can be used as a measure of operator discomfort during work place studies.

3.1SUMMARY:

We have studied research paper which deals with the ergonomics study also the torque acting on operators hand, how acting force can vary with holding posture ,preset torque, hardness of joint etc.

4.REFERENCES:

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