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Design and Analysis of Physical Strength in Ergonomics

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ABSTRACT
Flexible Isokinetic strength assessment is a technique of assessing dynamic muscle function where the velocity of motion is constant. Numerous isokinetic devices are available on the market, most of which focus on quantifying strength about isolated joints or body segments. Devices that perform isolated joint assessment are typically quite expensive and may be well-suited to clinical and rehabilitative use. A different sort of isokinetic device has been used by some to measure whole-body lifting strength. These devices typically have a handle connected by a rope to a winch, which rotates at a specified isokinetic velocity when the handle is pulled.

Key words: Ergonomics, Manual material handling, MSDs, Model designing

INTRODUCTION

We have pleasure in introducing our new project "Design and Analysis of Strength in Ergonomics", Humankind's interest in measurement of human physical strength probably dates to the first humans. At that time, life was truly a struggle in which the fittest survived. To a great extent, fittest meant strongest. Interestingly, current interest in human physical strength in the workplace stems from 1970–1980s vintage research demonstrating that persons with adequate physical strength are less likely to be injured on physically demanding jobs. Survival in many modern workplaces may still be a case of survival of the strongest. There is, however, a flip side to this issue — that person with limited strength is more likely to be injured on "hard" jobs. To address this problem, we can apply what we know about physical strength to job design. "Hard" jobs can be redesigned to be within the physical strength capability of most people. Since physical strength is important to these jobs, we must find ways to quantify it through testing. This publication concerns human physical strength testing. Its purpose is not to recommend any particular type of testing, but rather to describe the types of testing available and their uses. It is up to each individual user of strength testing to decide which testing technique is most appropriate for his or her particular application. This booklet discusses four types of strength testing: isometric, is inertial, psychophysical, and isokinetic. Human strength before describing the different types of strength measurement, we must define the term "strength" and explain the concept of strength measurement. Strength is defined as the capacity to produce force or torque with voluntary muscle contraction. Maximum strength is defined as the capacity to produce force or torque with a maximum voluntary muscle contraction. These definitions include some key words that must be explained. A voluntary muscle contraction is "voluntary." When a person's physical strength is measured, only the effort the person willingly puts forth at the time is measured. Thus, when we test a person's "maximum strength," we are not measuring his or her actual maximum, but some lesser value representing what he or she is comfortable expressing at the time with the existing equipment and environmental conditions. Interestingly, when researchers startled persons being tested (e.g., by setting off a starter's pistol behind them), they have found significant increases in measured strength It has been hypothesized that the lower strength displayed during normal testing provides a margin of safety against overloading and damaging muscle tissue. The test equipment and the tested person's familiarity with the process also influence the "voluntary" strength output. The interface between the tested person and the test equipment is particularly important. A poorly designed interface induces localized tissue pressures that vary from uncomfortable to painful. In this situation, testers are measuring voluntary discomfort tolerance — not strength. It is important for strength researchers to keep the "voluntary" nature of their data in mind when they are designing their equipment and protocols. The definition of strength also involves force or torque. Strength researchers and users of strength data must understand this distinction. We commonly use the terms "muscle force" and "muscle strength" to describe the strength phenomenon. Technically, this is incorrect. In most human movements and force exertions, a group of individual muscles (a functional muscle group) actually works together to produce the observable output. In complicated exertions, a number of functional muscle groups work together to produce the measured output. Elbow flexion strength, for example, is the result of the combined efforts of the biceps brachii, brachialis, and brachioradialis; and a squat lift is the result of the combined efforts of the legs, back, and arms. In elbow flexion, each individual muscle's contribution to the functional muscle group's output depends on the posture of the arm when being tested. Thus, when we measure elbow flexion strength, we are measuring the strength of the elbow flexor muscle group, not the strength of any individual muscle. Furthermore, we are measuring (recording) the force created by the functional muscle group(s) against the interface between the person and the equipment (a set of handles, for example). Consider the elbow flexion measurement depicted in Figure 1. The force generated by the elbow flexor muscle group is shown by Fm. This force acts through lever arm "a." In so doing, it creates a torque about the elbow joint equal to Fm x a. The measured force (Q, R, or S) depends on how far (b, c, or d) the interface (force cuff) is from the elbow. Assuming that the exertion is static (nothing moves) in this example, the measured force (on the gauge) will equal the elbow flexor torque divided by the distance that the gauge's associated force cuff is from the elbow joint. That is, $Q = (Fm \times a)/b$ (1) or $R = (Fm \times a)/c$ (2) or $S = (Fm \times a)/d$ (3) As we move the interface (force cuff) from the elbow to the hand, the measured force will decrease. This example highlights four points. First, as Kroemer et al. wrote in the International Journal of Industrial Ergonomics, "muscular strength is what is measured by an instrument." Second, people publishing or using strength data must report or understand in detail how the measurements were done. Third, the differences in published strengths of the various body parts may be due to differences in the measurement methods and locations. Fourth, interface locations selected using anthropometric criteria will result in more consistent results across the population measured. In summary, a record of a person's strength describes what the instrumentation measured when the person voluntarily produced a muscle contraction under a specific set of circumstances with a specific interface and instrumentation.

LITERATURE REVIEW

Dr. Kottala Sriyogi Assistant Professor, Department of Industrial and Production Engineering, Institute of Technology, Guru Ghasidas Vishwavidyalya Bilaspur, (C.G) India October 2017 From ergonomics point of view carry bags has become a more convenient way to carry daily necessities and for packaging in small quantities. The well-known form of such bags is in the form of plastic bags. Despite of all known hazards of plastic pollution, it's prevalent and pervasive in India. Plastic bags are one of the worst and most unnecessary plastic polluters of the earth. Plastic bags are used on a large scale by retailers for a simple reason that plastic bags are much cheaper than paper, cloth or other eco-friendly bags. This paper presents the designing and development of a system to automate the procedure of paper bags production so as to make its production cost comparable to plastic bags and inherently increase its production rate so as to fulfil the ever-increasing demand. We have used micro-controller-based design approach which has kept the cost of the system significantly low as compared to PLC based designs and have automated the manufacturing process. Case Study: Several studies have been done and reported regarding the work-related health issues from different work field slice health care professions, agriculture, industries and etc. According to the studies, most of the employees claim to have painful posture experience from neck, shoulder, lower back, upper limb, leg and etc. due to lack of knowledge and awareness on the ergonomics in the workplace. These issues pose the workers the risk of Musculoskeletal Disorders (MSDs). A large number of steel and power production industries are situated in the state of Chhattisgarh where availability of raw material is plentiful and cheap. This paper reports the results of an ergonomic study in steel and power production plant situated in Chhattisgarh. The main objective of this paper is to evaluate the working conditions of the plant from an ergonomics perspective and recommended feasible solutions to management for implementation. The investigation was done by a questionnaire survey as well as by observations in the workplace as a single case study. The results indicated that the plant conditions were stressful, with poor safety, weak interfacing with work equipment as well as physical workplace layout design. The results also revealed that noise, vibration, climate, illumination, and working posture were not an acceptable limit as ergonomic perspective. However, major positive research finding was conducive condition in the work environment resulting low absence rate among employees due to illness. AIP Conference Proceedings 1883, 020034 (2017); https://doi.org/10.1063/1.5002052 Assessment methods two types of assessment methods followed by researchers main a] rapid upper limb assessment (RULA) b) rapid entire body assessment (REBA) RULA evaluates the risk factors like movement, posture, exertion force, repetition, and work duration of several body parts which include upper arms, lower arms, wrist, neck, trunk, and legs by using the RULA employee assessment worksheet REBA shares the same principle as RULA with regard to the procedure on the evaluation of risk factors and designated body parts for assessment. REBA shows better results in the ergonomics evaluation of health care and service industries professions Hope E Johnson, Maury A Nussbaum AIHA J (Fairfax, VA) Nov-Dec 2019 Physical Strength - MSD - Ergonomics Evaluation Physical ergonomics deals with the physical load on the human body when performing activities like work, sports, jobs at home or dealing with products. With regard to the exposure to physical loads and its potential effects on the human body, the presented framework is helpful. Purposes of Strength Measurement in Ergonomics People may want to collect human strength data for a number of reasons. One common reason is to build an anthropometric database of population strength data that can be used to create design data for products, tasks, equipment so forth, as well as for basic research into the strength phenomenon. This publication focuses on two common uses of physical strength assessment in worker selection and placement and job design. MSD (Muscular Skeleton Disorder) Ergonomics point of view, manual material handling is a high-risk activity that could cause spinal injuries. From physiology perspective, manual material handling requires high amount of energy and strength. Hence, all activities, if carried out inaccurately, could cause inflammation at the nerves and muscles. MMH activities that require high physical demands, continuous bending, crouching and hip twisting could disturb the musculoskeletal system. The main source of this problem is enduring static loads frequently for long duration, which causes tensions or disruptions on the joints, ligaments and tendons. These are known as Musculoskeletal Disorders August 2020 BioMed Research International 2020(4): DOI:10.1155/2020/9212587 Strength and subjectively determined exertion limits are used widely for ergonomic evaluation. Although compilations of such data for the hand and finger exist, several important limitations include the use of inexperienced participants and constrained postures. In this study both strength and maximum acceptable limits (MAL, 2-hour duration) were obtained from both industrial workers and inexperienced volunteers in 10 simulated hand-intensive automotive assembly tasks. To expand the applicability of the results, the effects of hand-dominance were also determined. Results were compared with existing recommendations (by Kodak and the American Conference of Governmental Industrial Hygienists threshold limit value for hand intensive activities), and showed that across the diverse tasks the former yields value slightly below the 1st percentile of MAL, whereas the latter values are slightly higher than the 25th percentile. MALs were found to be approximately 50% of strength, consistent with earlier reports, and suggesting that acceptable limits are strongly influenced by physical capacity. Substantial differences (approximately 30%) in strength and MALs were found between the two participant groups, emphasizing that participants should resemble the target population. Hand dominance effects were statistically significant though of moderate size (approximately 5%). Strength and MAL distributions are provided that can be used for evaluation and design of a variety of hand-intensive occupational tasks. According to nurses, the limitation of the application of ergonomic principles of work may contribute to the occurrence of numerous dangerous behaviours, improper eating habits, or deficiency of systematic physical activity. The most common consequences are nutritional disorders and musculoskeletal system dysfunctions. This prospective observational study was aimed at evaluating selected parameters of the body composition of professionally active nurses and at determining work-related risks during nursing activities. The study group consisted of 37 active nurses (38.38±11.33 years). The research tool was a device for bioelectrical impedance analysis (BIA). In the present study, it was shown that all average values of the tested nurses' body composition parameters were within the normal range

DESIGNING

The following data should be provided about the subject population when

- reporting strength testing results:
- Gender;
- Age distribution;
- Relevant anthropometry (height, weight, etc.);
- Sample size;

Method by which sample was selected and who it is intended to represent;

Extent of strength training done by participants, and their experience with isometric testing; and Health status of participants (medical exam and/or health questionnaire recommended). Any form of physical exertion carries some risk. The directions for the person undergoing an isometric test specifically state that the person is to slowly increase the force until he or she reaches what feels like a maximum, and to stop any time during the exertion if discomfort or pain is experienced. The directions also expressly forbid jerking on the equipment. Isometric testing per formed in this manner is quite safe to administer because the tested person decides how much force to apply, over what time interval, and how long to apply it. The only known complaints relating to participation in isometric testing are rare reports of some residual soreness in the muscles that were active in the test.

Isometric strength is defined as the capacity to produce force or torque with a voluntary isometric (muscles maintain a constant length) contraction the speed of motion is held constant in isokinetic exercise, the resistance experienced during a contraction is equivalent to the force applied throughout the range of motion. For this reason, the technique of isokinetic exercise has sometimes been referred to as accommodating resistance exercise.

This type of exercise allows the muscle to contract at its maximum capability at all points throughout the range of motion. At the extremes of the range of motion of a joint, the muscle has the least mechanical advantage, and the resistance offered by the machine is correspondingly lower. Similarly, as the muscle reaches its optimal mechanical advantage, the resistance of the machine reaches its optimal mechanical advantage, the resistance of the machine increases proportionally. It must be understood, however, that while isokinetic devices control the speed of the exertion, this does not assure a constant speed of muscle contraction.

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It is clear that isometric strength testing cannot substitute for dynamic strength assessment when examining highly dynamic occupational job demands.

Most isokinetic devices available on the market focus on quantifying strength about isolated joints or body segments,

Strength of arm And Leg may be the limiting factor in an individual's lifting strength. For this reason, machines that measure isokinetic strengths of isolated joints or body segments should not be used as a method of evaluating worker capabilities related to job demands in most instances

Ddynamic isokinetic lifting devices designed to measure whole-body lifting strength. These devices typically consist of a handle connected by a rope to a winch, which rotates at a specified constant.

Certain precautions have been suggested to reduce injury risk in performance of isokinetic musculoskeletal evaluations:

1. Warm-up and stretching of the involved muscle groups.
2. Performance of 5 to 10 submaximal trial repetitions to assess proper alignment, subject comfort, and subject familiarization with the test requirements.
3. Postexercise stretching.
4. Ice/compression/elevation any time postexercise effusion or swelling occurs.

Devices that perform isolated joint assessment are typically quite expensive and may be well-suited to clinical and rehabilitative use.

PROBLEM DEFINATION

Wrong assignment of job without considering. The strength of an individual leads to long term MSD (Muscular Skeleton Disorder).

OBJECTIVE

1) To find the various issues related to MMH (Manual Material Handling) and its effect of WRMSD (Work Related to Muscular Skeleton Disorder)
2) To do life survey to find the scope of application of the object.
3) Design and fabrication the model for strength measurement.

4) To do the experimental analysis for various takes involved in MMH.
5) To do at least 2 case studies in the domain of MMH in unorganized sector.
6) Result and discussion.

CONCLUSION

In spite of advances in measurement techniques and an explosive increase in the volume of research, our understanding of human strength remains in its introductory stages. It is clear that muscle strength is a highly complex and variable function that depends on a large number of factors. It is not surprising, therefore, that large differences in strength exist not only between individuals, but even within the same individual tested repeatedly on a given piece of equipment. The issue is compounded by the fact that correlations of strength among different muscle groups in the same individual are generally low, and tests of isometric strength do not necessarily reflect the strength an individual might exhibit in a dynamic test. As a result of these and other influences, great care needs to be exercised in designing, evaluating, reporting, and interpreting muscular strength assessments

It should be clear from this publication that muscular strength tests are tools that can be used to prevent occupational musculoskeletal disease. However, if these techniques are to be applied successfully, it is imperative that they be applied with a clear understanding of the advantages and limitations associated with each strength assessment procedure

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