ERGONOMICS – DOMAIN II (SHE Engineering)

Definitions

- Ergonomics (Human Factors Engineering) - the study of human characteristics for the appropriate design of the living and work environments. Basically, it is the study of man's relationship to his work environment. Ergonomics utilizes several subdivisions: Engineering, Psychology, Physiology and Biomechanics. Ergonomics offers a reasoned, systematic approach to the design and construction of things and surroundings in accordance with human capabilities and limitations, with the end goal of increased efficiency, fewer errors and accidents, and improved emotional or physical comfort.
- Psychology - Study of behaviors
- Anthropometry - Study of reach and distance
- Biomechanics - Study of body mechanics
- Cumulative Trauma Disorders:
  1. Carpal Tunnel Syndrome - Inflammation of the channel in the wrist through which pass the arteries, nerves and tendons of the hand; OR compression of the median nerve.
  2. Tendonitis - Inflammation of the tendon
  3. Tenosynovitis - Inflammation of the connective sheath around the tendons.
  4. DeQuervains Disease - Specialized form of tenosynovitis occurring in the thumb.
  5. Raynaud's Syndrome - Numbness, tingling and loss of feeling in the fingers, associated with hand held vibrating tools.

Formulae:

$$RWL(kg) = (23)\left(\frac{25}{H}\right)\left[1-\left(.003\left|V-75\right|\right)\right]\left[.82+\left(\frac{4.5}{D}\right)\right](1-.0032A)(FM)(CM)$$

$$RWL(lb) = (51)\left(\frac{10}{H}\right)\left[1-\left(.0075\left|V-30\right|\right)\right]\left[.82+\left(\frac{1.8}{D}\right)\right](1-.0032A)(FM)(CM)$$

$$LI = \left(\frac{L}{RWL}\right)$$

NOTE: The two RWL formulas are much the same. However, one is based on metric units (kg) and the other is based on US units (lb). Be sure to read the question carefully to determine the units and use the proper formula.

- RWL = Recommended Weight Limit (maximum weight to be safely lifted)
- H = Horizontal distance from the torso of the lifter to the load
- V = Vertical distance of the load from the floor at start of the lift
- D = Vertical distance object is to be moved (the difference between height V to the height at the end of the lift)
- A = Angle of Asymmetry (How many degrees must the lifter move the load around the axis of the lifter's torso between the beginning of the lift and the end of the lift? If the lift was straight up, the A would equal zero. If the load starts in front of the lifter and ends at the lifter's side, the A would equal 90 – for 90 degrees)
- FM = A calculated value from the Frequency Multiplier Table (given in the exam handout). To select a FM from the table, you must know how many lifts per minute are done and for what duration in hours.
- CM = Coupling Multiplier is calculated from the table given in the exam handout.
- L = Actual weight of lifted item(s) or the "Load"
- LI = Lifting Index
- $\left|whatever\right|$ = the absolute value of whatever (whatever the value is inside the symbols, the result becomes positive)

NOTE: All distances are in cm and all weights are in kg for the metric equation. All distances are in inches and all weights are in pounds for the standard equation.

Questions:

(Domain 2 : Responsibility 1)

1. A job involves lifting from below knuckle height where H = 20cm, V = 40cm, and D = 100cm, and the loads are lifted at the rate of six per minute throughout a 7.5 hour work day. The boxes weigh 13 kilograms, and the lifts go straight up. The boxes are dry and have handles cut in the sides for handholds. What is the RWL for this job?

   a. 26 kg
   b. 16 kg
   c. 6 kg
   d. 0.6 kg

2. Work stations from the previous question are redesigned so that the lifting occurs at V = 75cm and D = 25 cm. All other data remains the same. What is the new RWL in pounds?

   a. 17 lbs.
   b. 12 lbs.
   c. 10 lbs.
   d. 5 lbs.

3. A lift must be made at a rate of four per minute over two hours (of an eight hour shift). There is a 45 degree angle of twist involved between the original location and the final location of the object. The coupling is rated as "fair." Given an H of 25cm, a V of 75cm, and a D of 70cm, what is the RWL?

   a. 5.5 kg
   b. 10.5 kg
   c. 11.5 kg
   d. 12.5 kg

4. Ma Grubb is tired of tossing lumps of lard at the Grubb meatpacking plant! She's been doing it now for 25 years, and wants to hire some young fool to do it for her. As the 55# lumps of lard drop off the conveyer belt, Ma picks them up, pivots 90 degrees, and drops them into the wrapping machine hopper. The lard lumps are lifted from a pan one foot off the floor. The inlet hopper for the wrapping machine is four feet from the floor. Ma holds the lumps a foot out to get them into the inlet belt, and two lumps per minute must be lifted for four hours out of each day. What is the RWL? What is the Lifting Index? Hint: Don't tangle with Ma!

   a. 17.38 at LI of 3.16
   b. 18.65 at LI of 2.95
   c. 19.30 at LI of 2.85
   d. 20.52 at LI of 3.10

Answers

1. "C":

$$RWL(kg) = (23)\left(\frac{25}{20}\right)\left[1-\left(.003\left|40-75\right|\right)\right]\left[.82+\left(\frac{4.5}{100}\right)\right](1-.0032\bullet 0)(.27)(1.00)$$

This simplifies to:

$$RWL(kg) = (23)(1.25)\left[1-(.003\bullet 35)\right](.82+.045)(1)(.27)(1)$$

This simplifies to:

$$RWL(kg) = 28.75\bullet .895(.865)(.27) \;=\; 6.01 \text{ kg} = \text{RWL}$$

Note that the FM was calculated from the table with six lifts per minute, more than two and less than eight hours duration, and a V of less than 30 inches (75cm). Note that the FM table given in the exam handout lists V in inches only! You must convert to cm if you're using the metric equation. Fortunately, the 30" = 75cm conversion is given in the CM table next to the FM table in the exam handout. The CM, from the table in the exam handout should be "Good" because of the dry boxes with hand cutouts.

2. "A":

$$RWL(kg) = (23)\left(\frac{25}{20}\right)\left[1-\left(.003\left|75-75\right|\right)\right]\left[.82+\left(\frac{4.5}{25}\right)\right](1-.0032\bullet 0)(.27)(1.00)$$

This simplifies to:

$$RWL(kg) = (23)(1.25)(1)(1)(1)(.27)(1)$$

This simplifies to:

7.76 kg which converts to 17 pounds = RWL

3. "D":

$$RWL(kg) = (23)\left(\frac{25}{25}\right)\left[1-\left(.003\left|75-75\right|\right)\right]\left[.82+\left(\frac{4.5}{70}\right)\right](1-.0032[45])(.72)(1.0)$$

This simplifies to:

$$RWL(kg) = (23)(1)(1)(.884)(.856)(.72)(1) \text{ or } 12.53 \text{ kg}$$

4. "B":

$$RWL(lb) = (51)\left(\frac{10}{12}\right)\left[1-\left(.0075\left|12-30\right|\right)\right]\left[.82+\left(\frac{1.8}{36}\right)\right](1-.003290)(.65)(.90)$$

Notice that the CM had to be deduced from the language of the problem. Since the lard lumps are probably slippery, a "Poor" coupling multiplier was selected. This equation simplifies to:

$$RWL(lb) = (51)(.833)(.865)(.87)(.997)(.65)(.90)$$

Thus, RWL = 18.65 pounds. Since $LI = \left(\frac{L}{RWL}\right)$, in this case $LI = \left(\frac{55}{18.65}\right)$ or 2.95.