Human Factors Engineering
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Design of Manual Material Handling Tasks
Lecture - 20
Use of Material Handling Aids, Types of Material Handling Devices, Numerical Problems

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So, in the 5th lecture session, we will discuss about use of material handling aids, types of material handling devices and numerical problem.

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Now, the question is why do you need material handling. The material handling related body movements there are certain reasons and in almost all work places, any types of workplaces where you cannot avoid it.

The first purpose is the transportation. Transportation of parts/components/goods from one station to another and back in a production system. Transportation of different kinds of materials continually to an assembly workstation. Transportation of products/assemblies to packaging section and subsequently to a warehouse/store prior to their distribution to customers. Unloading of materials at the receiving department. Secondary transportation needs: removal of wastes and scraps, housekeeping.

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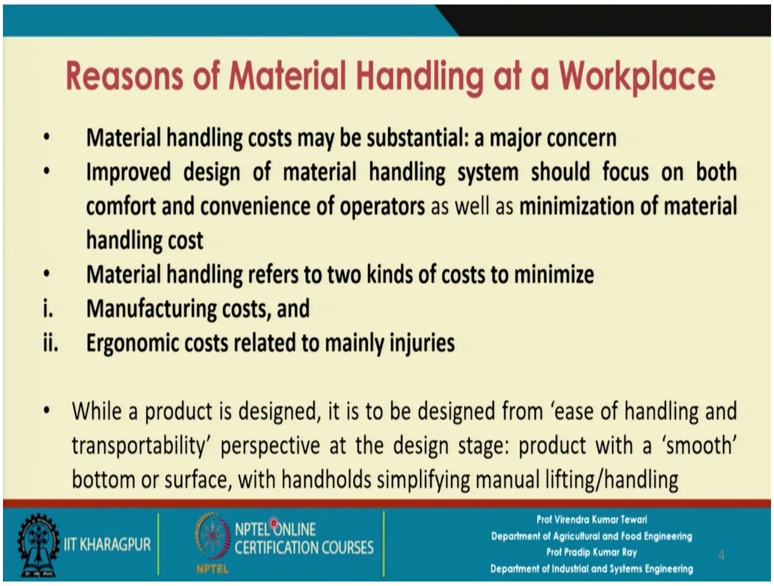

Now, one important factor is the material handling cost may be substantial a major concern. And, always you will find this is considered a hidden cost. Improved design of material handling system should focus on both comfort and convenience of operators as well as minimization of material handling cost. Material handling refers to two kinds of costs to minimize. Manufacturing costs, and Ergonomic costs related to mainly injuries. While a product is designed, it is to be designed from 'ease of handling and transportability' perspective at the design stage: product with a 'smooth' bottom or surface, with handholds simplifying manual lifting/handling

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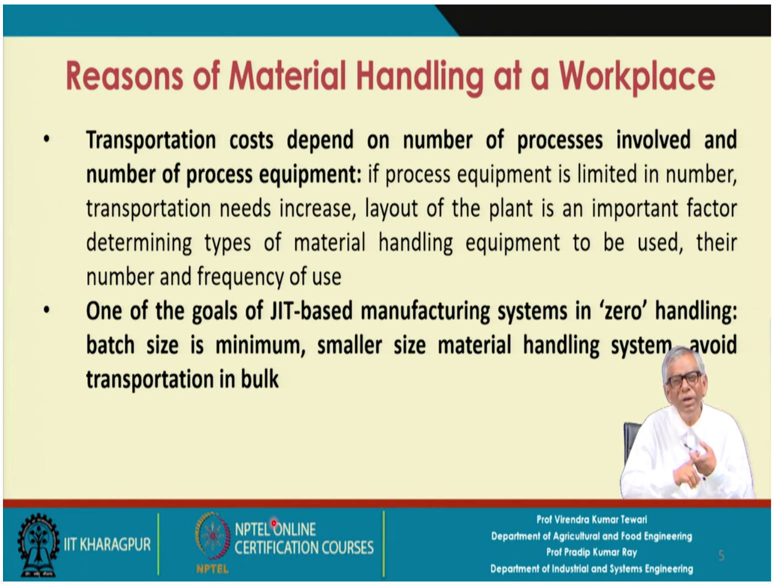

Transportation costs depend on number of processes involved and number of process equipment: if process equipment is limited in number, transportation needs increase, layout of the plant is an important factor determining types of material handling equipment to be used, their number and frequency of use.

One of the goals of JIT-based manufacturing systems in 'zero' handling: batch size is minimum, smaller size material handling system, avoid transportation in bulk.

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So, that is the basic idea. Now, material handling devices there are many types of material handling devices you come across. Over the years, with varieties of production/manufacturing system increasing, types of material handling devices increased.

These devices are used for different purposes: receiving, transportation, packaging, storing, testing, etc.

Transportation is very common: two types: vertical or horizontal

1. Rule-1: Vertical transportation should be avoided/minimum (from ergonomic design perspective: frequency of manual lifting should be minimum.

2. Rule-2: Minimize transportation in the horizontal direction: optimize plant layout.

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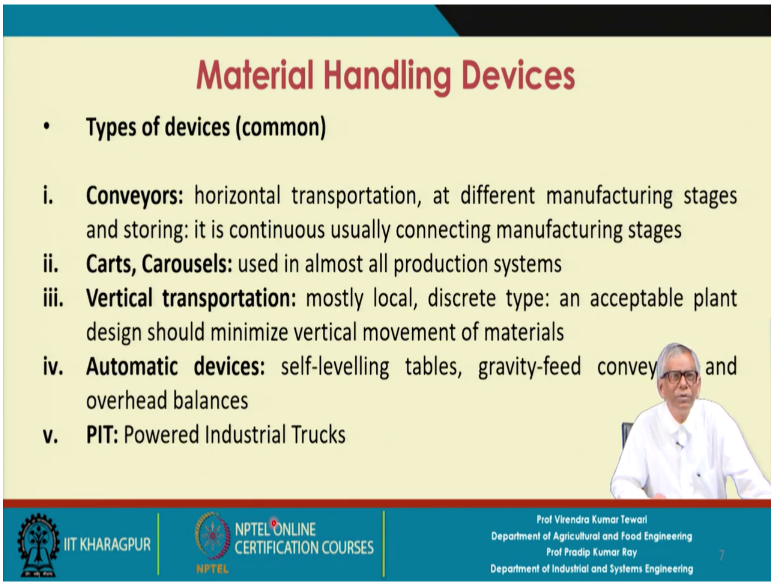

Now so, these are the two rules we have to follow. Now, what are the types of devices? Types of devices (common) are as follow:

Conveyors: horizontal transportation, at different manufacturing stages and storing: it is continuous usually connecting manufacturing stages.

Carts, Carousels: used in almost all production systems.

Vertical transportation: mostly local, discrete type: an acceptable plant design should minimize vertical movement of materials.

Automatic devices: self-levelling tables, gravity-feed conveyors, and overhead balances.

PIT: Powered Industrial Trucks.

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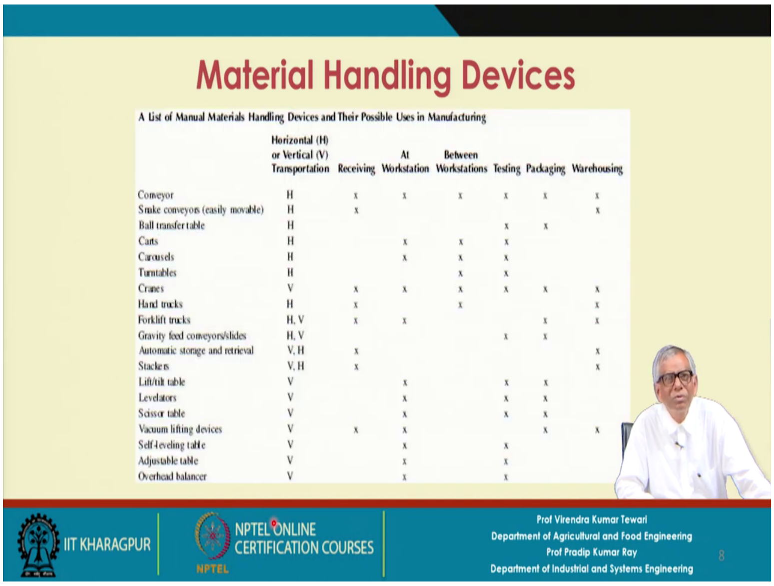

	Horizontal (H) or Vertical (V) Transportation	Receiving	At Workstation	Between Workstations	Testing	Packaging	Warehousing
Conveyor	H	x	x	x	x	x	x
Snake conveyors (easily movable)	H	x					x
Ball transfer table	H				x	x	
Carts	H		x	x	x		
Carousels	H		x	x	x		
Turntables	H			x	x		
Cranes	V	x	x	x	x	x	x
Hand trucks	H	x		x			x
Forklift trucks	H, V	x	x			x	x
Gravity feed conveyors/slides	H, V				x	x	
Automatic storage and retrieval	V, H	x					x
Stackers	V, H	x					x
Lift/tilt table	V		x		x	x	
Levelators	V		x		x	x	
Scissor table	V		x		x	x	
Vacuum lifting devices	V	x	x			x	x
Self-leveling table	V		x		x		
Adjustable table	V		x		x		
Overhead balancer	V		x		x		

So, this also you go through and this is the list of material handling devices. So, all these details are given. So, you go through and under what conditions one particular device you are supposed to use.

So, when you study this particular see this table, you get an idea. Like conveyor like say it is used for horizontal transportation. Some of the devices you can use both for horizontal as well as vertical like forklift trucks and the gravity feed conveys to the slide. So, horizontal transportation as well as vertical transportation. So, like for the lift or the till table vertical transportation.

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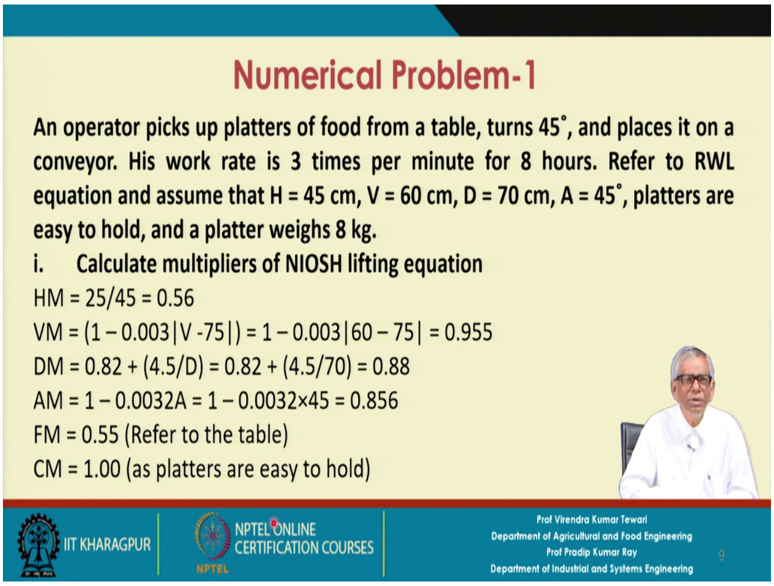

Now, let us discuss a few numerical problems, mainly related to NIOSH lifting equation as well as we have already the studied biomechanical modeling. So, related to biomedical modeling, one the typical numerical problem already we have discussed. So, here mainly we are considering we are concentrating on use of NIOSH lifting equation.

1.An operator picks up platters of food from a table, turns 45˚, and places it on a conveyor. His work rate is 3 times per minute for 8 hours. Refer to RWL equation and assume that H = 45 cm, V = 60 cm, D = 70 cm, A = 45˚, platters are easy to hold, and a platter weighs 8 kg. Calculate multipliers of NIOSH lifting equation:

$HM = 25/45 = 0.56$

$VM = (1 – 0.003|V -75|) = 1 – 0.003|60 – 75| = 0.955$

$DM = 0.82 + (4.5/D) = 0.82 + (4.5/70) = 0.88$

$AM = 1 – 0.0032A = 1 – 0.0032\times45 = 0.856$

FM = 0.55 (Refer to the table)

CM = 1.00 (as platters are easy to hold)

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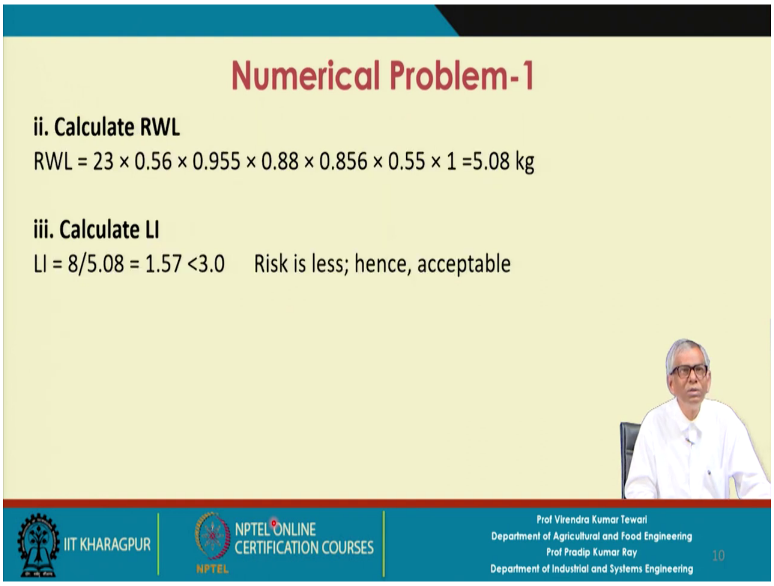

Now, ii. Calculate RWL

RWL = 23 × 0.56 × 0.955 × 0.88 × 0.856 × 0.55 × 1 =5.08 kg

iii. Calculate LI

LI = 8/5.08 = 1.57 <3.0   Risk is less; hence, acceptable

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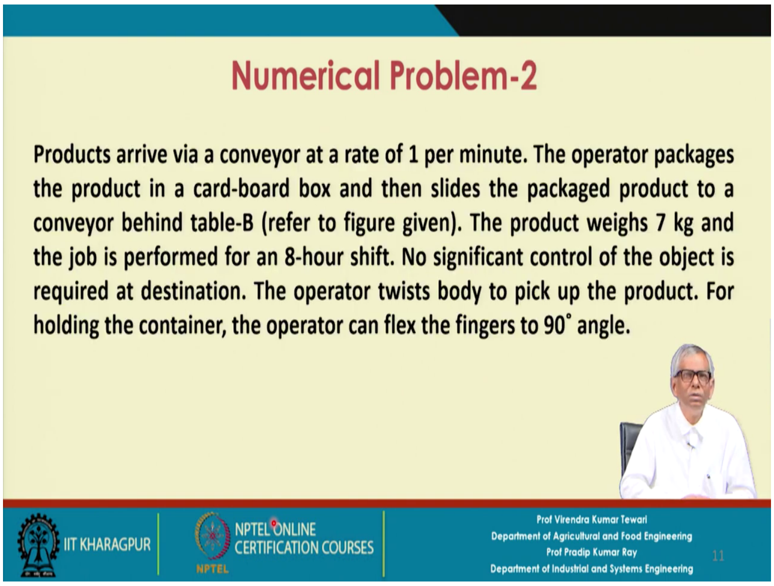

So, let us go to the second example or 2nd numerical problem. Products arrive via a conveyor at a rate of 1 per minute. The operator packages the product in a card-board box and then slides the packaged product to a conveyor behind table-B (refer to figure given). The product weighs 7 kg and the job is performed for an 8-hour shift. No significant control of the object is required at destination. The operator twists body to pick up the product. For holding the container, the operator can flex the fingers to 90˚ angle.

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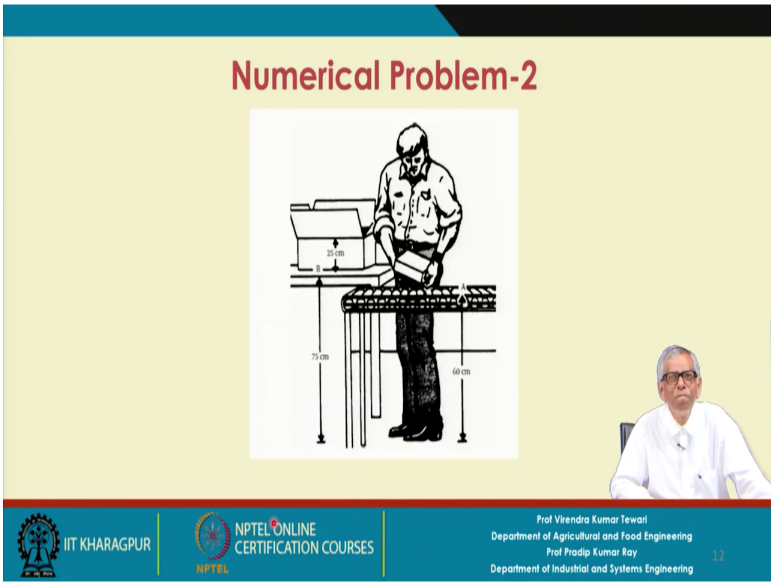

So, this is the figure. The sketch and you look at figure you will get an idea that how the person is carrying out the job. So, there is a conveyor, there is a box, there you are getting the item from the box and you are placing it on the conveyor. It is a running conveyor. So, from this the figure you can just get the value of H, get the value of D, get the value of the V.

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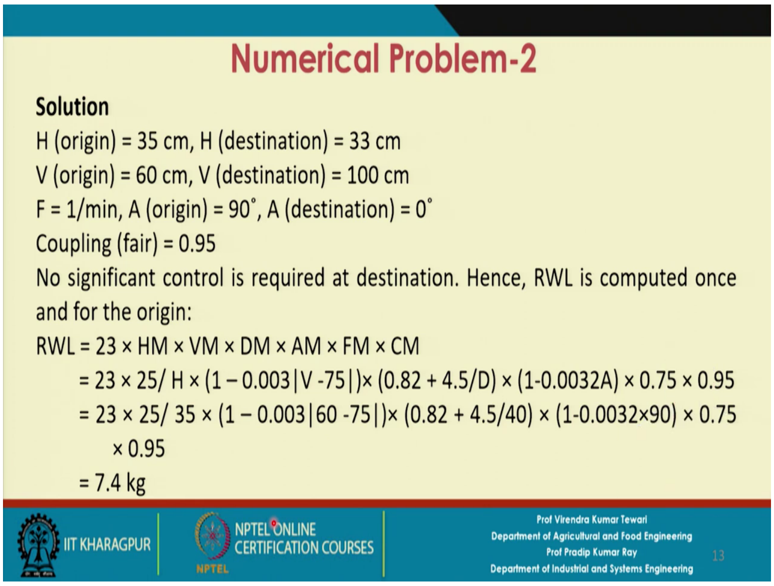

H (origin) = 57.5 cm, H (destination) = 57.5 cm

V (origin) = 38 cm, V (destination) = 160 cm

F < 0.2

At origin,

$RWL = 23 \times HM \times VM \times DM \times AM \times FM \times CM$

$= 23 \times (25/ 57.5) \times (1 – 0.003|38 -75|)\times (0.82 + 4.5/122) \times 1\times 1 \times 1 = 7.6$ kg

At destination,

$RWL = 23 \times (25/ 57.5) \times (1 – 0.003|160 -75|)\times (0.82 + 4.5/122) \times 1\times 1 \times 1 = 6.4$ kg

Hence, RWL = 6.4 kg

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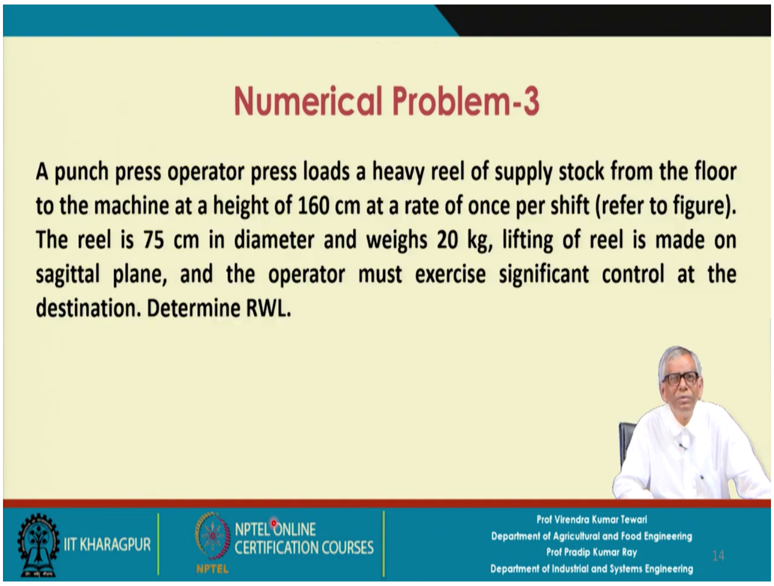

Next, the third problem. A punch press operator press loads a heavy reel of supply stock from the floor to the machine at a height of 160 cm at a rate of once per shift (refer to figure). The reel is 75 cm in diameter and weighs 20 kg, lifting of reel is made on sagittal plane, and the operator must exercise significant control at the destination. Determine RWL.

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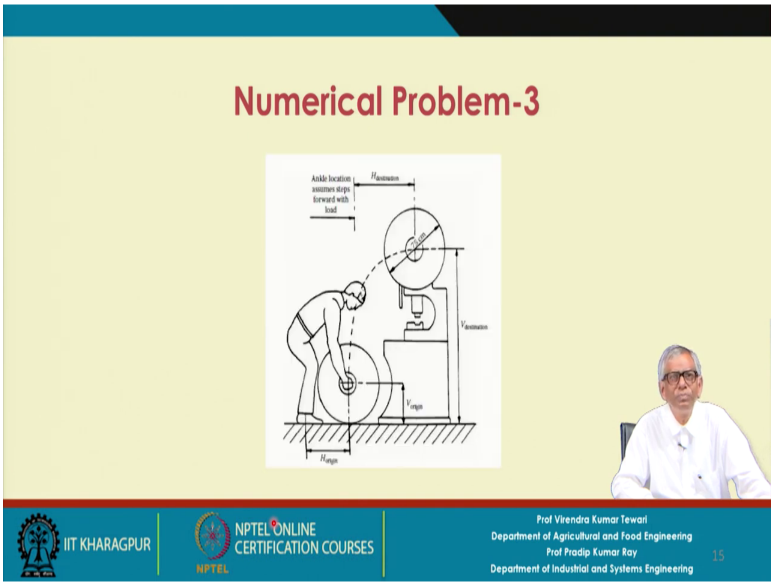

So, this is the figure, all these details are given over here. So, while you leave the load, you also move your body the front of the machine. So, that always is the natural posture. So, while you lift the load you assume the best possible in the natural posture is it, considering the constants. So, the V origin, V destination, H origin, H destination all these are marked.

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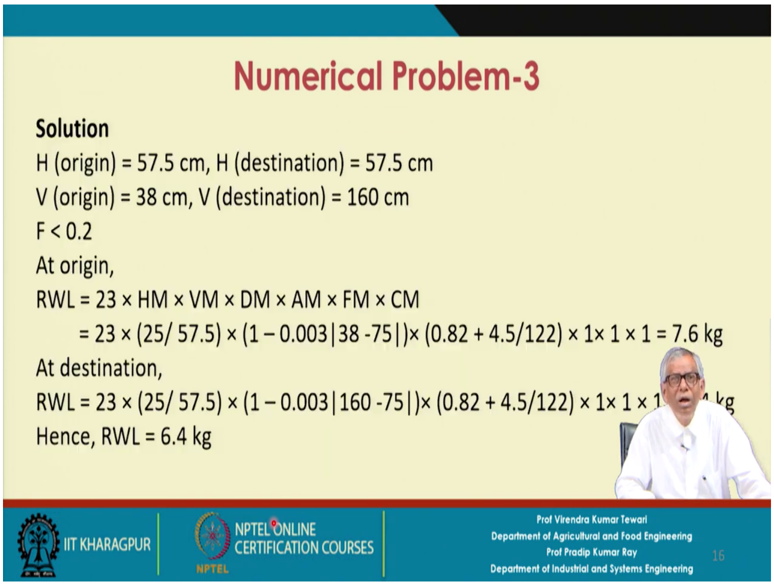

Solution:

H (origin) = 57.5 cm, H (destination) = 57.5 cm

V (origin) = 38 cm, V (destination) = 160 cm

F < 0.2

At origin,

RWL = 23 × HM × VM × DM × AM × FM × CM

= 23 × (25/ 57.5) × (1 – 0.003|38 -75|)× (0.82 + 4.5/122) × 1× 1 × 1 = 7.6 kg

At destination,

RWL = 23 × (25/ 57.5) × (1 – 0.003|160 -75|)× (0.82 + 4.5/122) × 1× 1 × 1 = 6.4 kg. Hence, RWL = 6.4 kg

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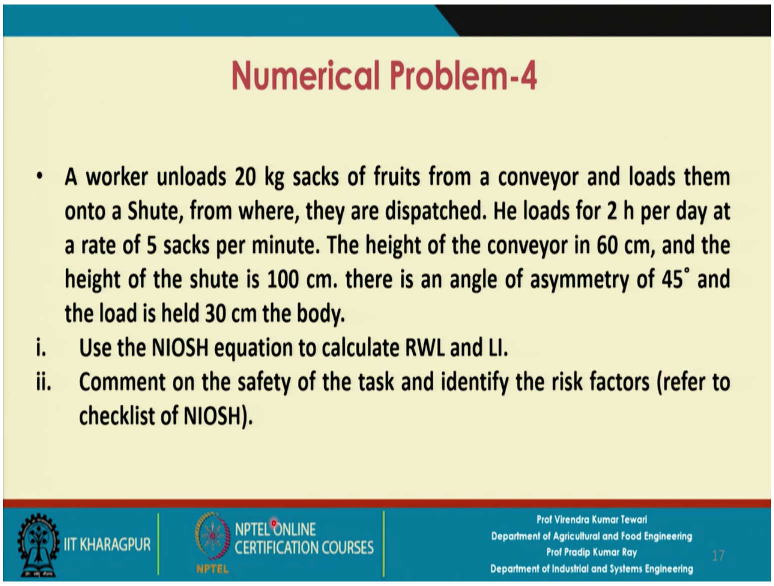

So, this is another example and the last example is the that is A worker unloads 20 kg sacks of fruits from a conveyor and loads them onto a Shute, from where, they are dispatched. He loads for 2 h per day at a rate of 5 sacks per minute. The height of the conveyor in 60 cm, and the height of the shute is 100 cm. there is an angle of asymmetry of 45˚ and the load is held 30 cm the body.

Use the NIOSH equation to calculate RWL and LI

Comment on the safety of the task and identify the risk factors (refer to checklist of NIOSH)

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List of Reference Textbooks

1. Sanders, M. S. and McCormick, E. J., Human Factors in Engineering and Design, McGraw-Hill, Sixth Edition

2. Bridger, R. S., Introduction to Ergonomics, Taylor and Francis Group, Third Edition

3. Helander M, A Guide to Human factors and Ergonomics, Taylor and Francis Group, Second Edition

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