Ergonomics Research Techniques

Urmi Ravindra Salve

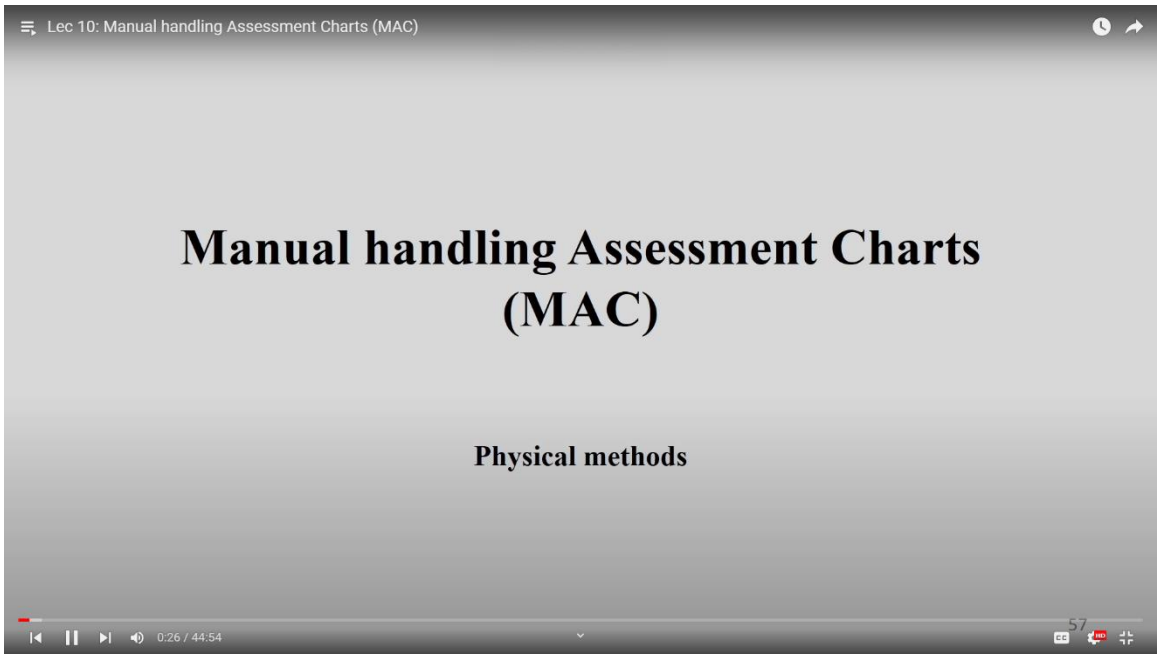
Department of Design

Indian Institute of Technology (IIT) Guwahati

Week – 03

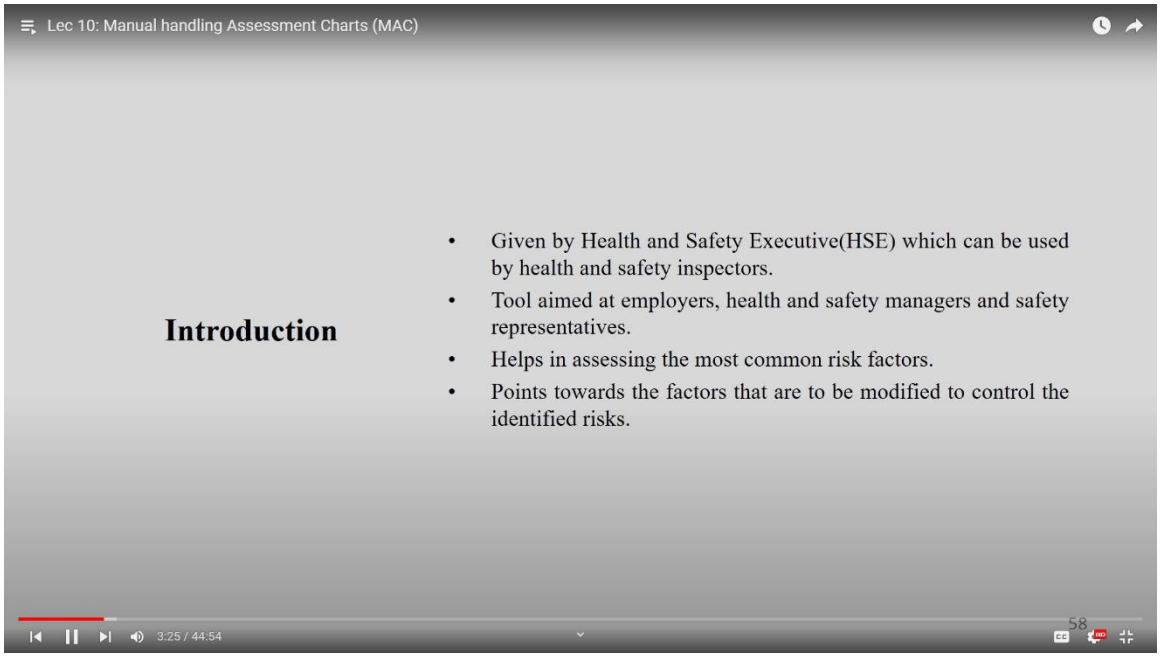
Lecture - 10

Lec 10: Manual handling Assessment Charts (MAC)



welcome back to the next class which is physical methods and today we will be talking about manual and handling assessment chart. So from this name, we can understand it is an assessment. So here we will not have any kind of indexing. We will get an understanding about the physical hazards and availability of risk in any kind of manual handling. In this particular technique, we mainly consider lifting, carrying, and if something is happening in teamwork. So lifting, carrying, and team handling.

So these are the three things we will be discussing and what kind of musculoskeletal risks are available while doing such a job we will try to assess using this particular technique.



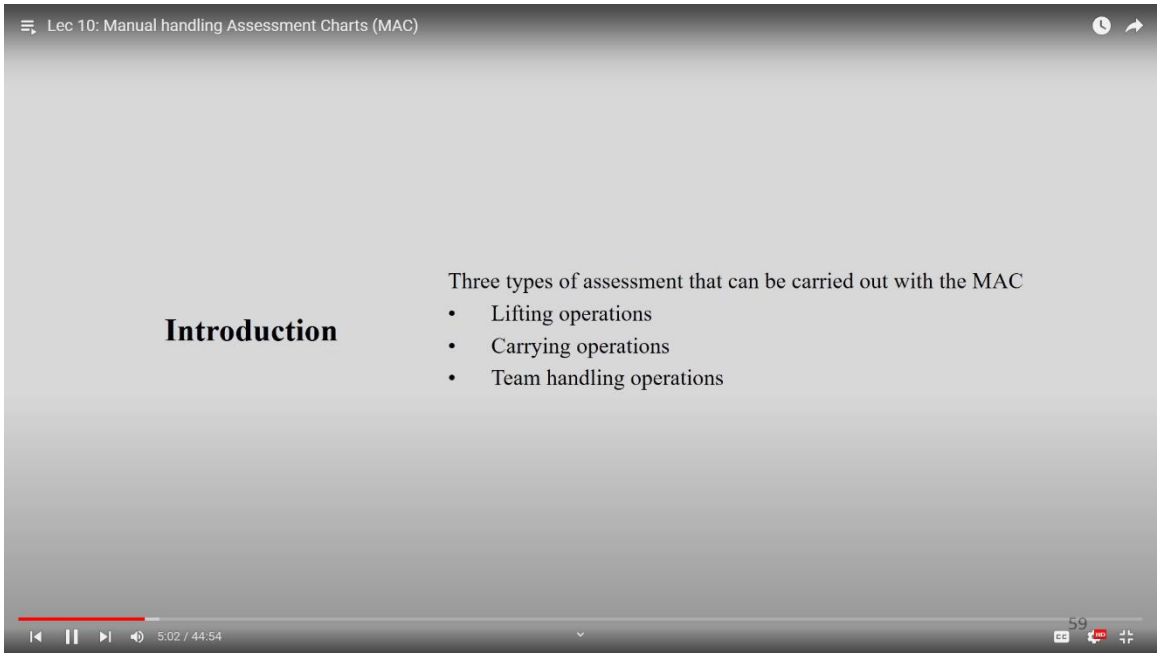
So first let us understand in detail that what this tool is all about and how it has been invented or it came into existence and in practice. So this particular tool is given from the HSE that is the Health and Safety Executive. All of us know what is this is a body that is taking care of different types of ergonomics issues in industry.

So this particular tool is given by them for health and safety inspection. So all the health and safety inspectors normally use this particular tool to assess the risk of musculoskeletal disorder while handling things like lifting, carrying and something in team. So this particular tool is aimed at employers, health and safety managers, and safety representative. So it is very much connected to the safety officials who are engaged in taking care of the health issues in any kind of such industry. So manufacturing industries, construction industries automobile industries many cases this particular tool is very much connected.

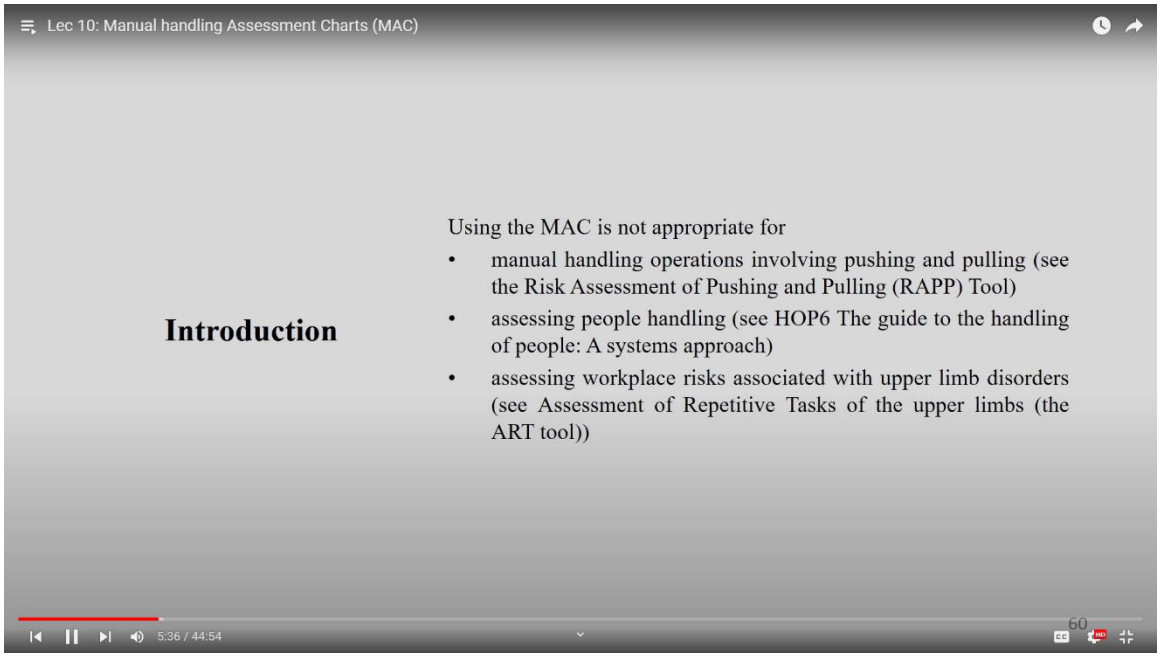
Even if we talk about agriculture they are also such tools are very useful. However, agriculture being an unorganized sector we may not have any safety officials. However, you can use this particular tool for your own research analysis. This particular tool helps in assessing the most common risk factors. So several risk factors will be there in a particular work station or workplace we will be able to identify it.

So here we have several factors as we go on we will understand there are several factors which we are actually considering in this particular tool. Points towards the factor that are to be modified to control the identified risks we will evaluate and we will take measures accordingly. For this tool, I would like to mention we will not get any kind of index only some pointers only some indication of where the risk is lying and where we can do the modification. Where is the feasibility or possibility to do modification to enhance the situation. Now here for this particular tool is very beneficial when we do kind of intervention in any workplace or workstation and we would like to see is there any improvement or not.

So before after the experiment and comparison of the results of such intervention, we will be able to use this particular tool. As we go on we will understand how we are going to do this.



So mainly as I mentioned in earlier slides also that we will be taking care of lifting operation, carrying operation and team handling operation. Here team handling means two or three members handling a particular job. So that we can take care of it.



So using this MAC the MAC Manual Activity Assessment System. So here is not appropriate for certain cases. So where we cannot use this particular tool we should know this because otherwise, we may use it at the wrong place. So these are the places where you cannot use a manual activity assessment tool chart. Where manual handling operations involve pushing and pulling only lifting and carrying.

So pushing and pulling we have some other tool we should use that. So here one example of how to understand pulling and pushing is the risk assessment of pushing and pulling. This is a different tool altogether you can use that particular tool but not the MAC. This tool also is not possible to use where people handling like people handling. So human handling.

So those cases also you cannot use that particular tool. So you should go for HOP 6 that guideline and you should handle that system approach you have to take. Also, you cannot use this particular tool while assessing the workplace risk associated with upper limb disorder. So where something is specifically to upper limb disorder you cannot check or cannot use this particular tool. So these are the cases you cannot use MAC.

So one is pushing and pulling, people handling, and if something is very specific to upper limb disorders. So these cases you cannot use this tool. So you should remember only carrying, lifting, and load handling you can use this particular tool.

So let us understand what is the varieties of risk level we are going to get from this particular tool. This color itself shows how we are going to get the differentiation.

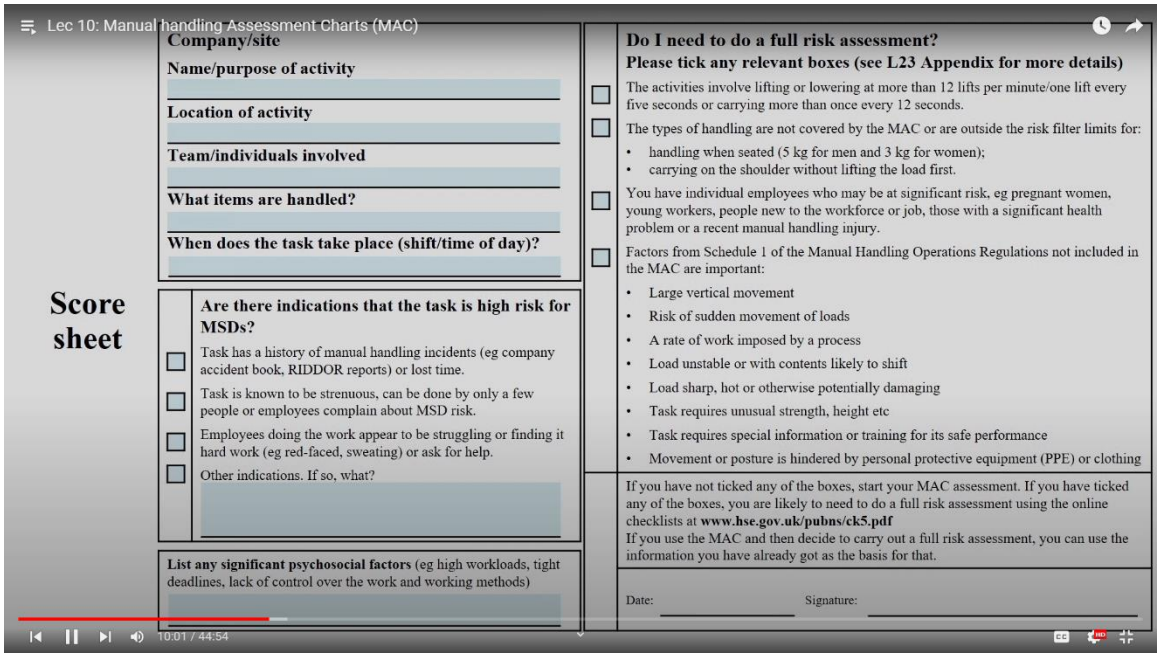
So if it is green we will come how do we read these values. So if it is green then it is a low-level risk you need not worry much. However, there is some risk but it is not that to consider.

A represents the amber so it is a medium-level risk you can examine the task closely. If it is red then it is high-level risk.

So prompt action need to be taken and this may expose a significant proportion of the working population to a risk of injury. So here you are actually getting into the alert zone. So red zone talks about the high level of risk. So you are saying that a lot of people are significant amount of number of people are exposed to the risk of injury. The last one is the purple which is an unacceptable level of risk.

An unacceptable level of risk means if you find any such risk in the workplace you should immediately stop that particular action. So that is unacceptable level of risk. So such operation may represent a serious risk or injury and need to improve it immediately. There is no question as soon as you find it you have to take measure. So there are four colors green, amber, red, and purple.

Now these all are predefined colors and as we go on in the tool we will say there are numbers associated with and those are already pre-computed numbers. Now let us understand how we use this particular tool.



Now this is the basic score sheet that we are going to use for this assessment. This is just taken from HSC. So this is the worksheet.

I have divided this particular worksheet into two forms. This is the first and this is the second component. Let us understand what is the importance of this worksheet. So when we are talking about worksheet we should have a record right proper record that where and how we are going to assess it. So company name or the site where you are actually assessing.

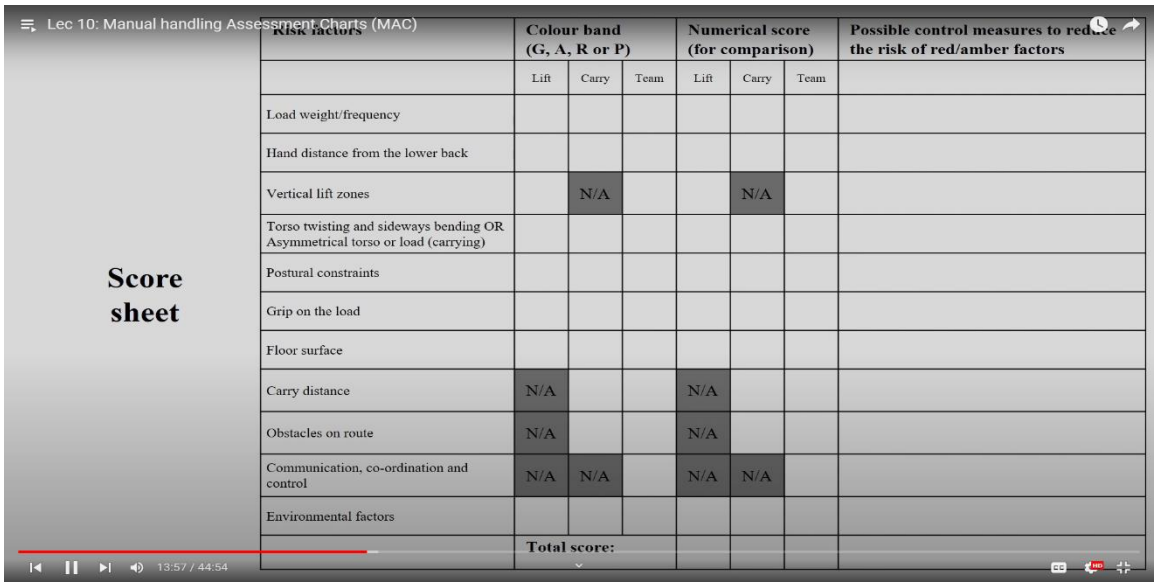
So for your case, as this is industry-based based that is why it is written company or site for your case depending on the cases depending how do you give the nomenclature. So if you would like to say workstation number 1, workstation number 2 that is also fine or you can say workplace of this or section A, section B whatever is your wish. So that way you can give the nomenclature. So location, team, or individual involved. So here if it is lifting and carrying it is individual.

If it is team then it is like two or three members of activities right. What items they are handling? Here it is very important. What item they are handling? Is it a bag? Is it a box? Is it you know something metallic? What is that? So item description is very important okay. So that you are going to enter in this. And then when does the job or task take place? Actually, we want to describe here that what is the varieties of shift they are occupying.

So is it morning work or maybe you know evening or whole day or you know sometime in a shift there is no specific time what it is okay. So that will give us a better understanding that what is the impact is going to have on the musculoskeletal system. This will help you in the analysis part. This information is going to help you in the analysis. Also in the second part where we are talking about that are there indication that the task is high risk for MSD.

So here we have four options you have to check for it. And also something related to some other information. So that once you have the complete analysis with these variables these are also some variables. Here also you have some variables. So with these variables you can understand that how you are going to analyze your data.

Here important thing is that this is for industrial practice. So here date when you are collecting and who collected, that is important. However, for your research purpose, you are the person who is collecting data, or if you are taking help from your peer so you can get a signature from them to get some authenticacy okay. So these two things are not that mandatory. However, this information are very very important for further analysis of our data.



Score sheet

Risk factors	Colour band (G, A, R or P)			Numerical score (for comparison)			Possible control measures to reduce the risk of red/amber factors
	Lift	Carry	Team	Lift	Carry	Team	
Load weight/frequency							
Hand distance from the lower back							
Vertical lift zones		N/A			N/A		
Torso twisting and sideways bending OR Asymmetrical torso or load (carrying)							
Postural constraints							
Grip on the load							
Floor surface							
Carry distance	N/A			N/A			
Obstacles on route	N/A			N/A			
Communication, co-ordination and control	N/A	N/A		N/A	N/A		
Environmental factors							
	Total score:						

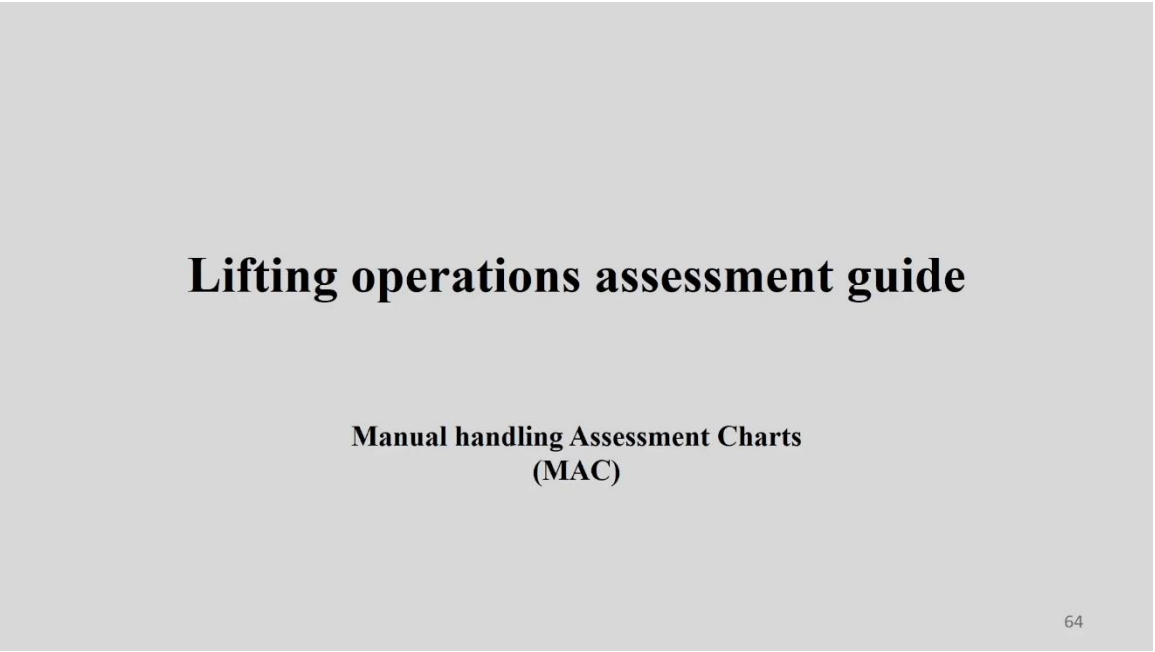
Now let us understand what is the kind of data sheet we have for data collection. So we can see that two specific portion one is the color band another is the numerical score. As we go on we will understand what how it works. And there are all lists it is a full list of risk factors. So we have 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11.

11 risk factors are associated. Also, we have a blank column over here which talks about possible control measures to reduce the risk of red and amber factors. We will get those values. So we will understand how do we get these possible risks. Now this is a reporting item. So this is as it is being used in the industry it is a reporting format.

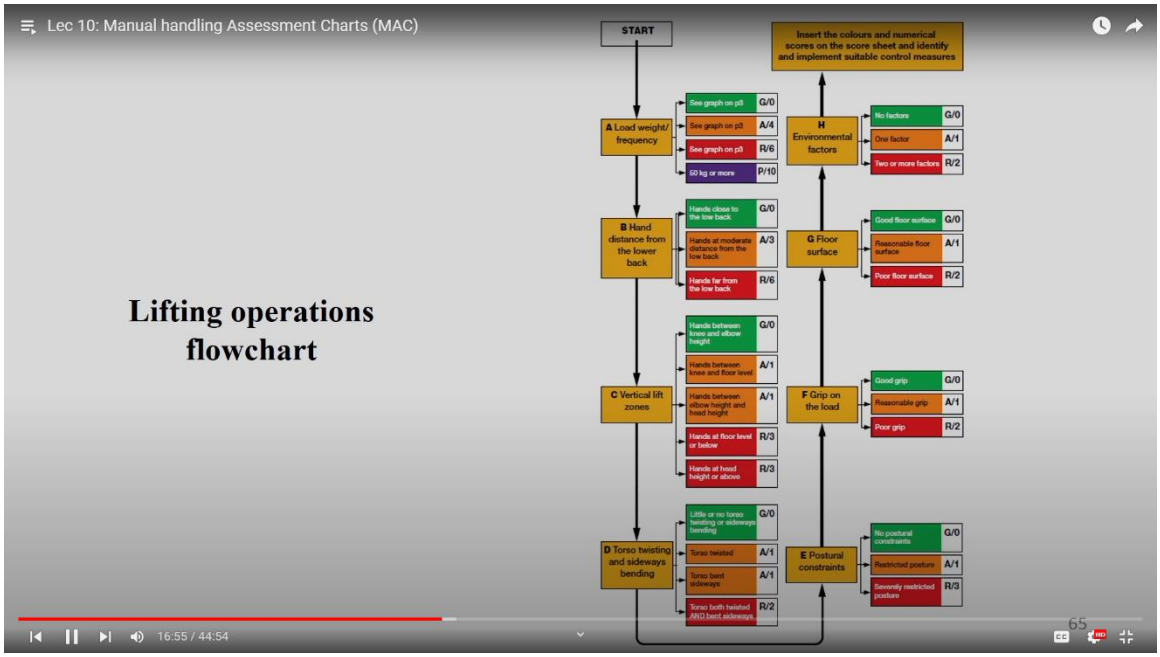
But for us when we are doing research on this particular part maybe we can take it later. Now here you can see many cases NA, NA, NA what does that mean? If you are talking about lift carrying distance is really not applicable to Obstacle on the route because you are not moving you are just lifting it. So that wherever these questions are not valid we will have NA. So we need not to uncertain. And once we get all these things so every color has some number numerical number we will get those numbers in further charts.

So once we get those number we can add them over here. So this is the total score. These total score is going to help you in further analysis. Colors will help you to take decision that where the intervention can be. Numbers will help you in analysis that what is the kind of improvement or what is the kind of changes you have done through your intervention.

So this is the importance of this particular score sheet. Now let us go ahead with each activity lifting separately, carrying, and teamwork.



So let us start with the lifting operation.



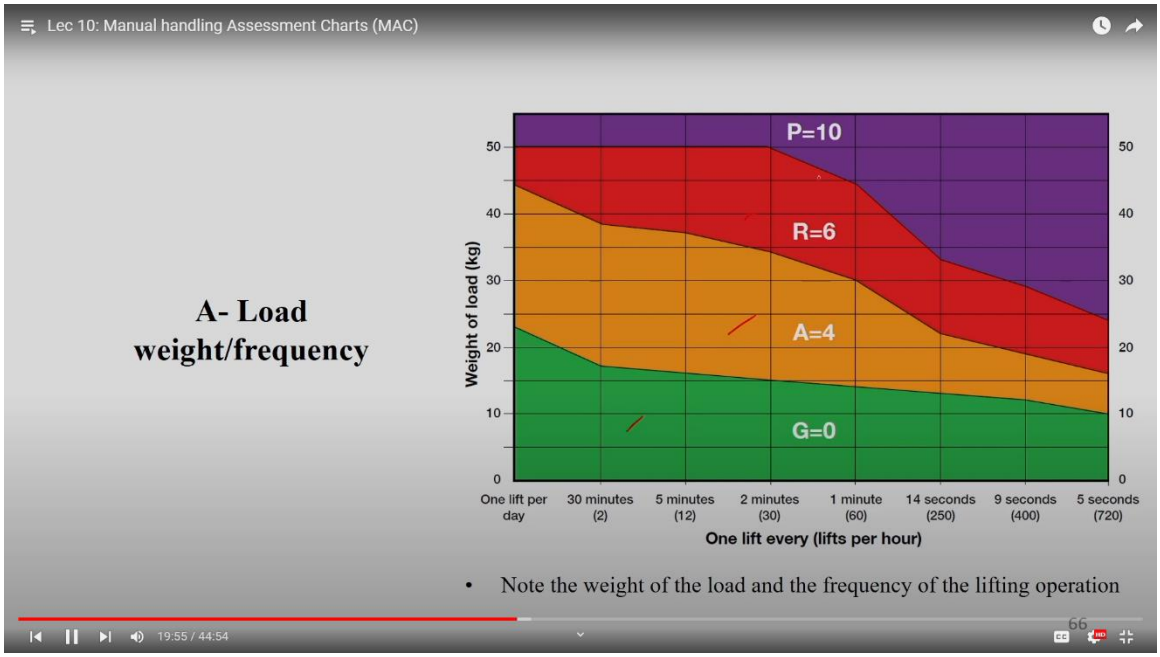
This is the only chart that we are going to get through and this is the flow process of whole activity. Now what we are going to do if it is a lifting we are going to have this information.

So total 8 answers we are going to get and from 8 answers we have some flags, green flags, amber flags, red flags, and purple flags. So using those flags definitely we are going to get some understanding the how risky this job is and what is the causal factor of that particular risk. So A, B, C, D, E, F, G, H. So these are the numbers like alphabetic representation of load and weight frequency is for A hand distance from the lower back that is B vertical lift zone is C, torso twisting and sideway bending, torso twisting and sideway bending that we did in RULA, REBA and all right.

So twisting and bending. So this is D postural constraint. So where you are there is a difficulty in movement you have restrictions in the movement. So maybe you have some PPE or the position is such that that you cannot move so that is the postural constraint. Grip on load on the load so how you are holding it because actually, you are talking about lifting right. So what is the kind of grip you have on the load that is F and floor surface what is the position of the floor surface if it is slippery or it is difficult to step in all those things and the environmental factors.

So these are the few things we are going to understand. Now let us understand each individually you can see for each component you have numbers and colors. For each component you have numbers and colors. Now here you can see that everywhere you do not have purple. So it is assumed that most of the cases in industry these purples are impossible to present.

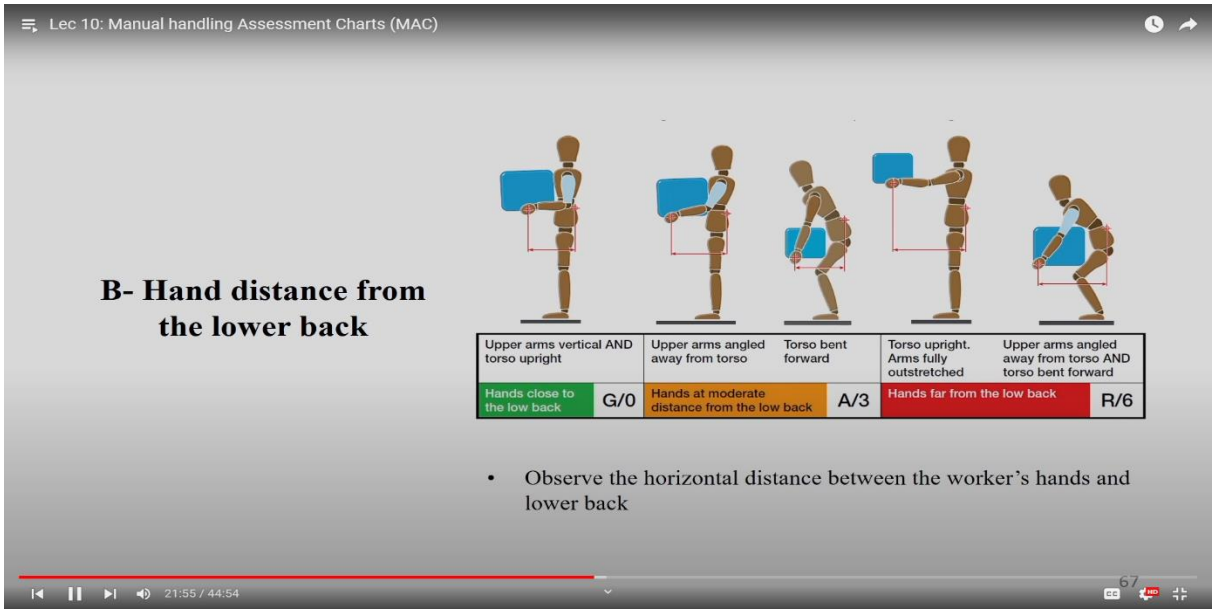
Mostly it is up to red zone okay. Only the load handle or load weight and frequency have a purple color. Now let us go in detail for each sector.



So this is for A that is the load weight and frequency. So you can see this is green zone, amber zone, green zone, amber zone, red zone, and purple zone. So here you have weight in the y-axis and lift per hour in the x-axis.

So based on your scenario, you will try to find out where your risk is available. So is it 30 per minute? Then you are and if it is 10 then it is you are here. However, if the weight is 30 and in the same case you are here. So depending on the availability of risk you will be marking your risk zone related to load weight and frequency in this particular chart and accordingly you will get the numerical value. So G is for green which is the representation of your color whereas this is G equal to 0 which is the numerical number.

So for A, it is 4, for R it is 6 and for P it is 10 and these numbers all are pre-computed. These numbers came from different experimental studies while developing this particular tool. So let us move ahead with the next variable. The next variable is so here you have the definition that what is the kind of weight you are handling and how frequently you are handling the load So based on that what is the kind of risk you have in load handling.



Now hand distance from the lower back. As you know if your hand is moving away from your body with a load definitely the whole CG is going away and it is going to tax your back. Because to hold that posture for some hours your trunk muscles need to work more. So that is why it is very important for us to understand where the load is. If it is close to your body so your see the whole CG will remain on the neutral position, near to neutral position. If it goes away from your body your CG also will move and when your CG is moving away from your body there is always a chance that you miss the balance and you fall right.

To prevent that what will happen your postural muscles which are responsible to hold those postures will be active and they will keep on working and which is going to cause some fatigue and slowly the accumulation of that fatigue may cause musculoskeletal disorder okay or musculoskeletal discomfort. Therefore it is very important for us to understand that how far it is from your body. So here we have 4 or rather we say 5 varieties which is possible. Of course, these possibilities are only from the industrial perspective. The first one here you can see there is no purple only green, amber, and red.

So purple is very rare case okay which is really sometimes it is not possible in industry. So purple is not here. What we are saying in green upper arm is vertical and torso upright. So it is the best posture right. The upper arm is vertical so you are not going to take this upper arm away from your body.

So the upper arm is vertical and you are holding your torso upright. So there is no bending, no twisting, no side bending nothing is available. So in that case also you need to see the hands are close to the lower back. So you are looking for the best possible option.

Your hands are very close to your lower back. So you can refer this picture. Similar picture if you get from your case then you can assign it as G okay and G means it is a 0 green. Now coming to the next part which is the amber zone. Amber zone may have 2 varieties.

One is upper arm has some kind of angle away from the torso. So you know you are moving forward. Or the torso is bent forward. Two cases. Either your upper arm is moving forward and you are holding it or you are bending from your torso towards the forward direction.

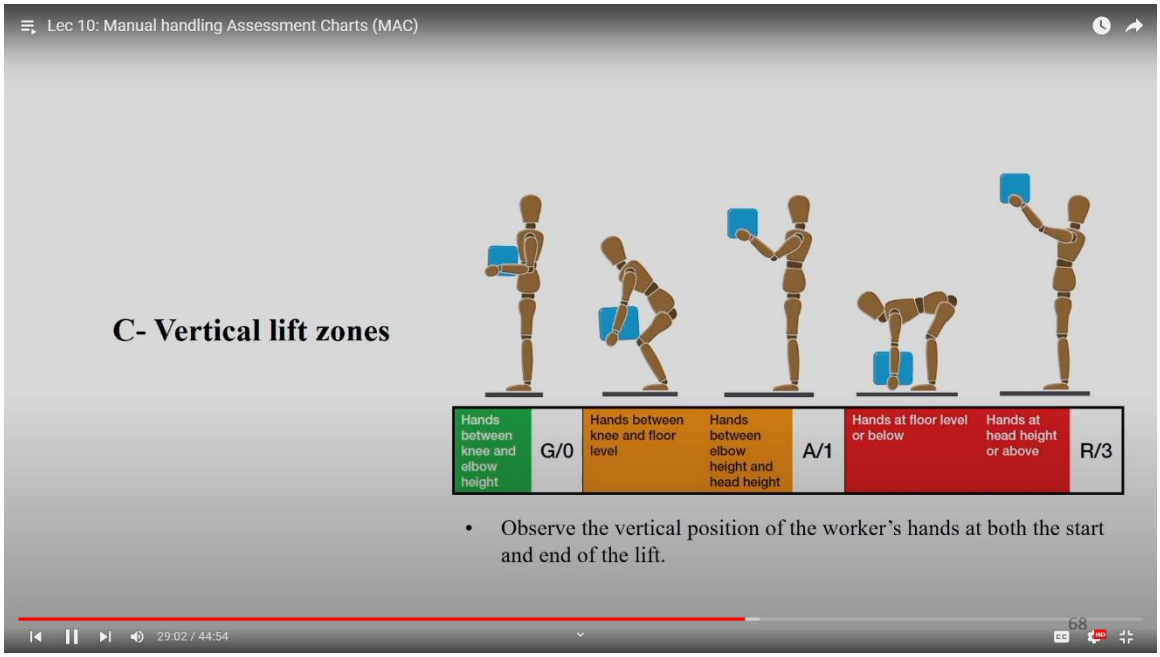
So representing this figure or this figure. Also hands at moderate distance from the lower back. Now how do you define this moderate distance? Now these are the experiences okay. So as you keep on practicing you will understand what you can say moderate or which one you can say lower. Now there may be some kind of argument that this is not moderate, this is high or low. However as in this particular tool there is no specific degree mentioned by them.

It is from your experience you have to gather. You can take the view from the expertise So if it is in the amber zone then the color is A whereas the number is 3. Now moving forward for this particular part that is the high risk that is the rate you may have 2 varieties of option or in between these 2 varieties. What it is? Torso is upright, arm is fully outstretched like this you are holding it. So you can understand how the whole CG has gone so far.

It is a weight that you are holding away from your body. So in that case it is very difficult for you to hold it. You will get a lot of stress on your shoulder and arm and neck muscles right or the upper arm is angled away from the torso and torso is bent forward. So here the bending is not that much whereas in the red zone it is quite more okay. It is little more and hands far from the lower back. Here hands is in moderate distance where here hands are little far from the body, more far from the body.

So in that case you can assign them as R that is the color and the score is 6. So we may have 3 varieties of score for hand distance from the lower back. One is 0, another is 3 and the last one is 6. So observing the horizontal distance between the workers hand and lower back is the major area where you have to have the data collection. So for all these cases, I would suggest you take a working video and you come back to the laboratory for analysis.

Do not take decision on the spot while working. There may be lot of ambiguity if you know the decision was correct or not. So better if you collect the video and do the analysis after coming back to the laboratory. So these are the 2 factors.



Now let us move ahead with another factor which is the vertical lift.

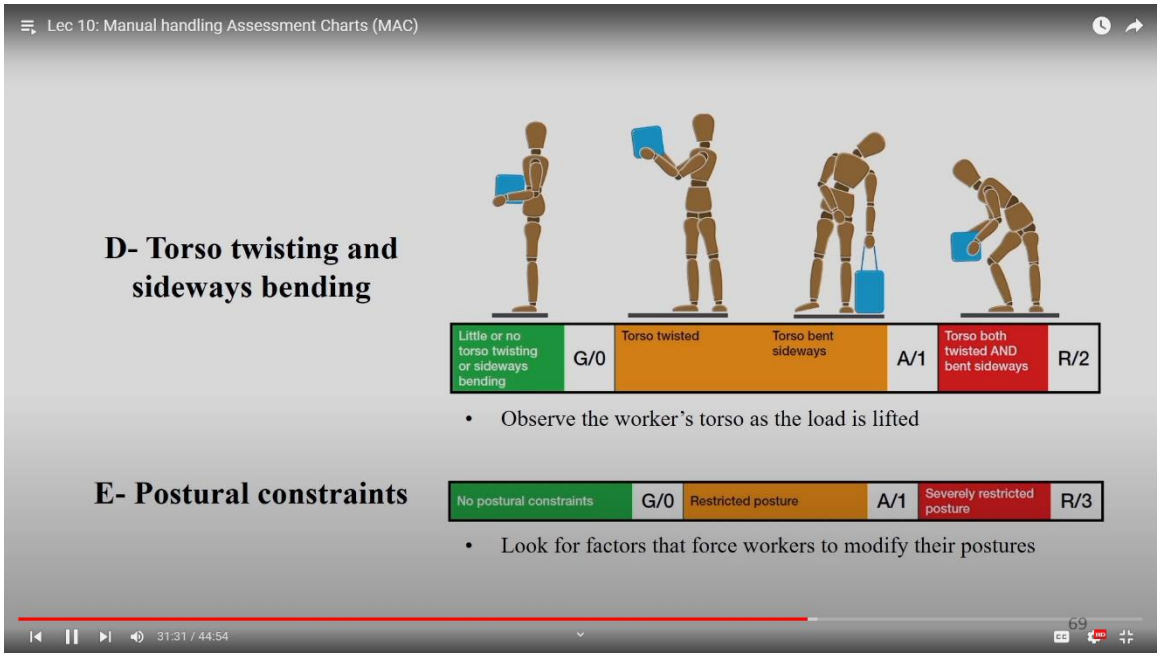
We are talking about lifting. So lifting means you are holding it, you are lifting it right. So you have to talk about lift. What kind of lifting is happening? So what do you need to do? Observe the vertical position of the worker's hand at both the start and end of the lift.

So where it was and where it became. So that changes right. So when we are talking about G that is 0 green zone, hands between knee and elbow height. So it is a comfortable position then green is 0. If it is amber then hands between knee and floor level, between knee and floor level or hands between elbow height and head height. In both cases, it is A knee and floor either or elbow to head.

So those cases you are actually not stressing your trunk so much right. So these cases A, you can give the color coding as amber, and number will be numerical value will be A 1. The next part which is rate it says hands are at floor level or below that. You are actually bending from your trunk too much. So representing this particular figure. So you can say the problem may come in the lower back, problem may come in the neck, even in knee, shoulder every place okay.

So this is very risky activity. So that is why it is R or red zone and hands at height or above your head okay. So you are working somewhere here. So those cases you can assign red that is value numerical value is 3.

So you understand. So you have the charts with you accordingly you should tick them.

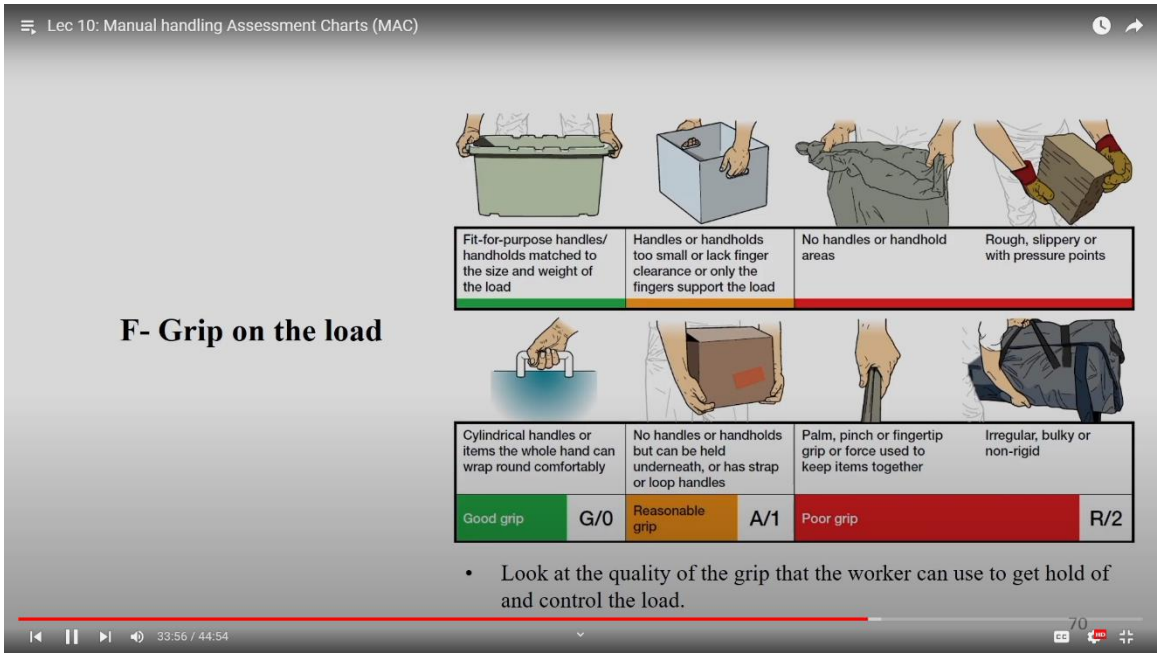


Now next two factors that is the torso twisting and sideways bending. So torso twisting and sideways bending, green is little or no torso twisting or sideways bending so not much, little bit. And now this little bit there is no degree of definition, degrees definition. So based on your experience, you have to take action.

G is the green zone and the value is 0. The torso is twisted and torso is bent sideways. For both cases it is amber and the number is 1. Torso both twisted and bent sideways, both are present. Twisted also bent also. So in that case it is red, red zone, color is red and value is 2.

Now you should remember these numbers you cannot change. These are the pre-computed numbers. So for this case, R is 2. Postural constraint, if no postural constraint then it is a green zone or we can say value numerical value is 0. If it is little bit of restriction then amber 1 severely restricted where you really cannot move. You have handles, you have constraints on the shoulder movement, neck movement, lot of constraints So this case you have to give a value of R like a value of 3, and the color is R.

So here you have to look for factors that force workers to modify their posture. So from this particular understanding if you see that you know your value is coming in the red zone you really need to see what are the things available in the workplaces which is actually forcing the worker to hold such posture. So that is the particular variable which is called postural constraint. Moving forward grip.



Grip is very very important because we are talking about lifting and in lifting without grip we cannot move ahead.

So we have a lot of varieties here. So what do we need to do? We need to look at the quality of the grip. We need to look for the quality of the grip that the worker can use to get hold of and control the load. First is how they are holding it and how they are controlling it from falling okay. So if you are holding something all of a sudden due to disbalance it has fallen it is going away.

So you have to hold it, you have to control it. So these factors you have to take care. Now let us understand what is green, amber, and red for grip on the load. We have specific definition. First is green that is G0. You say fit for purpose. It is actually for the purpose it has been designed that handle has been designed which is actually desirable.

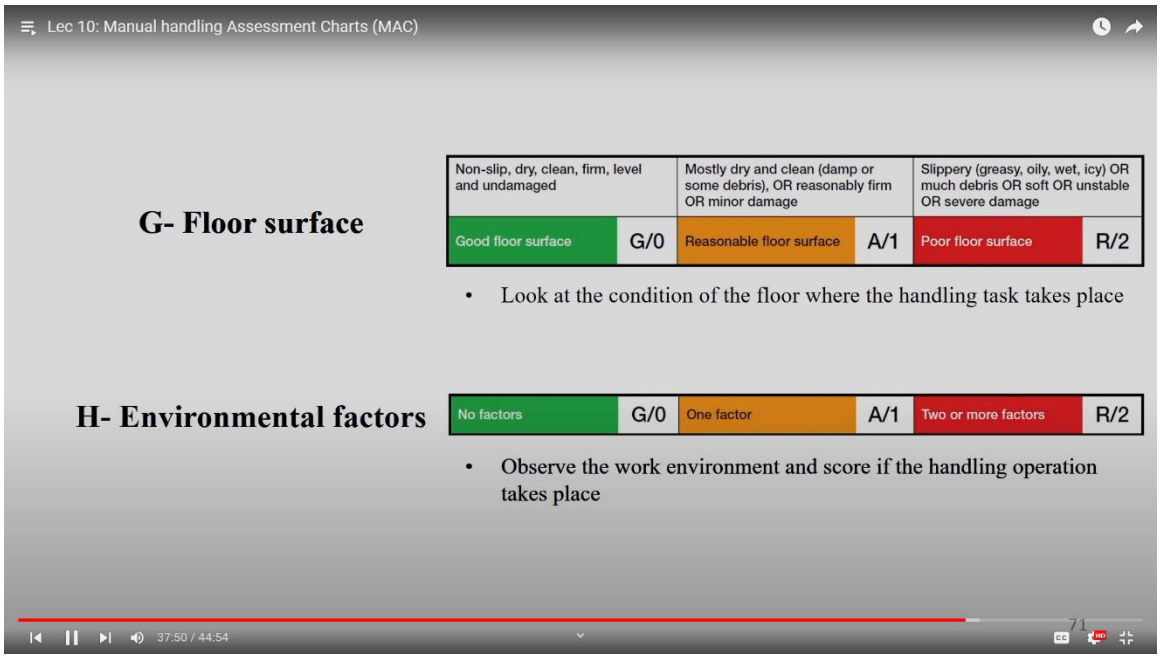
Handholds match to the size and weight of the load okay. So it is actually matching. Then it is green or we can say good grip or we can say cylindrical handle or items the whole handle can wrap around comfortably how we hold our suitcase and any other things So those cases it is good grip. We can say the color is green and the value is 0. Now coming to the next part which is amber we have a definition. We can find out similarities and we can put it in this particular category that is handles or handholds too small.

The earlier one was actually perfect. Here it is too small however it is there it is not that it is not there. It is there but it is small or lack finger clearance or only the fingers support that particular load. On such cases it is amber or if you do not have any handle or handholds but can be held underneath or the strap or the loop handle.

In those cases, you can have amber or reasonable grip. So A1. The next part which is poor grip no handle or handhold areas nothing is there depending on your comfortable you are holding it. Rough, and slippery with no pressure points because it is falling it is very slippery it is

slipping from your pump. So what you have to do you have to put more pressure. For such cases pump, pinch or fingertip grip or force used to keep the items together. So you have to hold it very tight you have to put it like this or something like that that cases also is it is red.

Irregular, bulky or non-rigid for such cases also it is red. So you have pictorial depiction of such grip so you can try to match where in your case where the grip is. So accordingly you can mark them good grip, reasonable grip or poor grip. So if it is green then 0 if it is reasonable then amber and the value is 1 and if it is poor then it is red and value is 2.

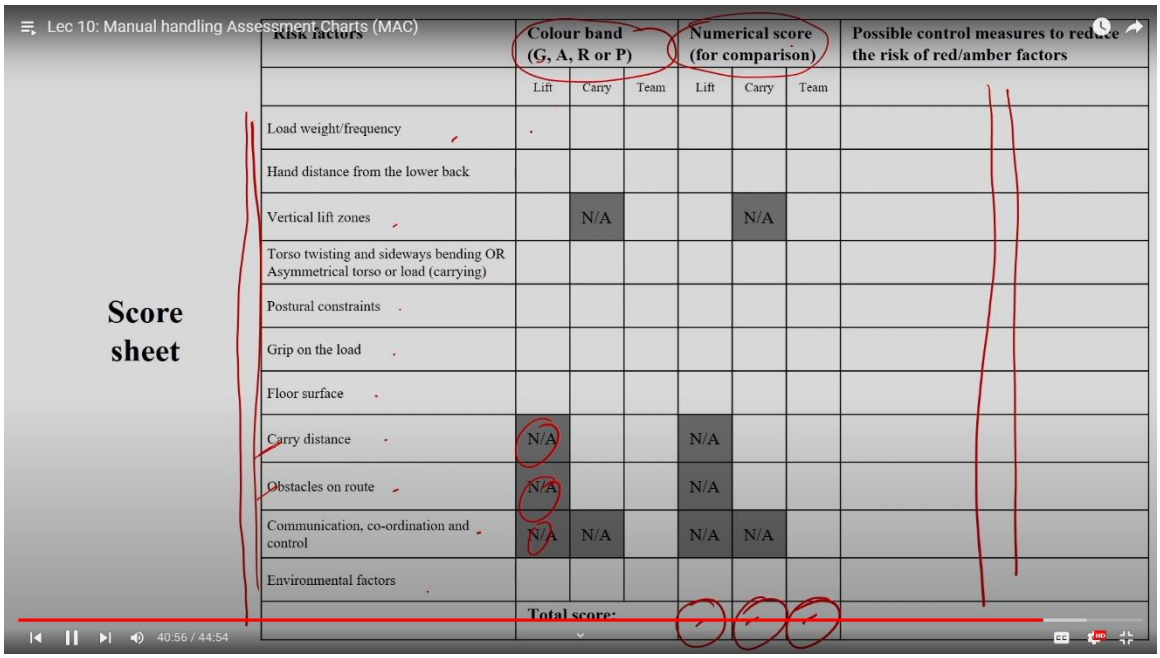


Let us move for last two factors that is the floor surface and environmental factors. Floor surface is very important why because if you are standing and doing the job and floor surface is not comfortable for you to work then what will happen there will be a chance to fall right.

So look at the condition of the floor where the handling task take place exactly where it is happening so that place. So there are no slippery things dry, clean, firm, level, and undamaged. For all such, cases you can give a good floor surface green and the value is 0. The next one is mostly dry and clean damp or some debris is there or reasonably firm or minor damage is there.

So those cases it is reasonable floor surface and you can give the color band as A or amber and the number is 1. Slippery where you have greasy, oil, weight, icy lot of difficulties especially it happens in the processing industry fish processing, meat processing those cases food processing industries those cases you will get such flooring or much debris or soft very soft or unstable and severe damaged area. Suppose you are in a construction area lot of debris is there and standing on that they are doing some kind of load handling. Of course, if there is a disbalance you will fall with that load. For such, cases it is a poor floor surface and you will get a value of 2 and the color is red.

The last factor is age which is the environmental factor. No factor so you are not having any impact of any environmental factors like noise, illumination, and all those things, if you have one impacting factor then 1 if 2 or more then it is 2. So green, amber, and red are fine. So what you have to do observe the work environment and score if handling operation if that particular cases if you have any environmental factors. So what you will do now let us go back to this particular score sheet.



What will happen for all these factors for all these factors for example let us take for we are talking about lift.

So here suppose I have red, I have amber, I have G, I have again Z, I have again A, A, A and some let us assume that A fine. So for each case, I have some numerical values that we discussed sorry for these cases you do not have any values because these are not applicable. Now you have a total number assume, assume this value comes as n assume okay I need to really refer and then you should get that value. So assume here you have a value of 10.

Now you look at these places so this is the place where you start your intervention. After intervention this R became somewhere A, A became G, G you need not to change this also you could not change need not to change. Here you have option to change however maybe due to the design, due to the position, due to the job demand you could not change so it still remain A, and so on. Then you have one more value over here so earlier it was 10 now probably it became 8. Now you have a chance to compare and prove that how this 8, 8 is lesser than 10 right so definitely there is an improvement.

Now statistically you have to take some statistical test to prove that this is significantly different. This is the use of this particular tool for lifting. Similarly, we have carrying, we have team handling. We will discuss that in next class. So before we go for the next class in carrying take this printout of this worksheet go and check any carrying lifting activities happening around you. Take some these measures and try to find out how do you or from your side what

is the possibilities of changes or modifications are possible to improve that particular workplace and how you help the worker to avoid such risky work activity and how you can assess the risk of that particular work activity.

So if you find I do not think you will find any difficulties to use this particular worksheet. However, if you find any difficulties let us discuss it in the next session. Also what I will do as a whole what are the advantages and disadvantages of this particular tool we will discuss once we complete the carrying and carrying activity and teamwork. So altogether we will discuss about the advantages and disadvantages of this tool. So we will start the carrying activity in next class. Till then thank you.