Rock Mechanics and Tunneling
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Lecture 08
Rock coring (Continued)

Hello everyone. I welcome all of you to the module 2 of lecture 2. So, in our previous lecture, we have started discussing about the method of rock exploration and under that we have tried to understand what is rock coring? I hope that the basic idea has developed by this time.

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Today, we will continue our discussion on core logging first and finally we will start the core orientation.

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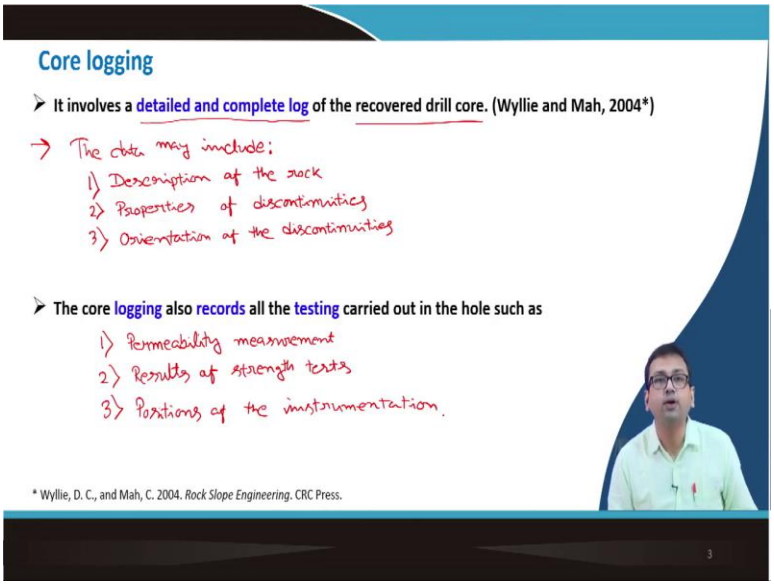

What is core logging? It involves a detailed and complete log of the recovered drill core. So, under that what are the data we collect basically?

The data may include:

1. Description of the rock
2. Properties of discontinues
3. Orientation of the discontinuities

Apart from that, some of few more thing, like the type of testing carried out in the hole (i.e., permeability test, strength test). So, those informations also should be noted somewhere in core logging.

Therefore, the core logging also records all the testing carried out in the hole such as

1. Permeability measurement
2. Results of strength tests
3. Positions of the instrumentation etc.

These informations are also important we should record them.

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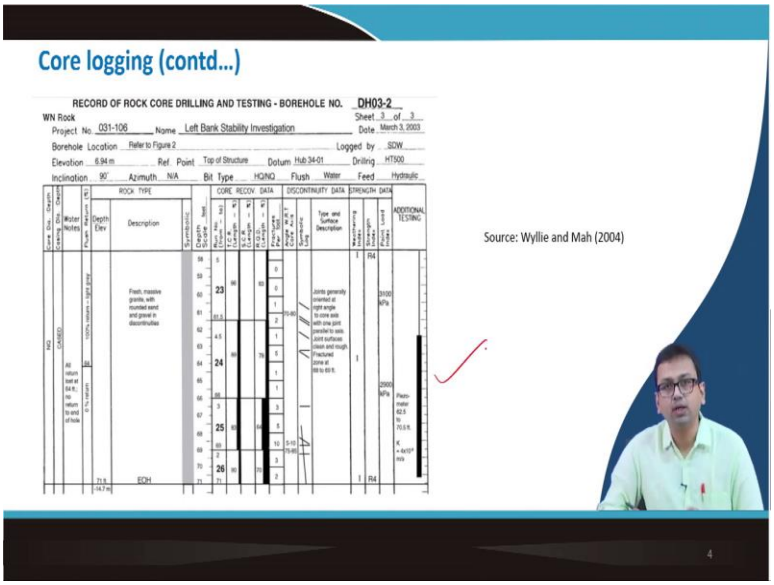

Refer to slide 4, this is a typical core log. It contains several things like orientation of joints, fractures, the tests conducted in the field. We will learn later, in field what types of in-situ tests can be performed.

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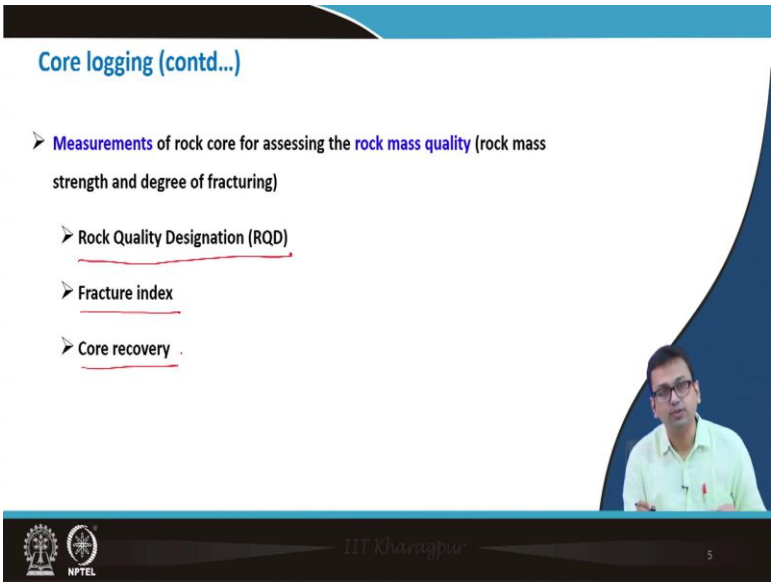

Now, some of the important terminologies need to be learnt first. For assessing the rock mass quality, measurement of rock core will be discussed now. For that, rock mass strength and degree of fracturing can be identified by three quantities.

1. Rock Quality Designation. (RQD)

2. Fracture index

3. Core recovery

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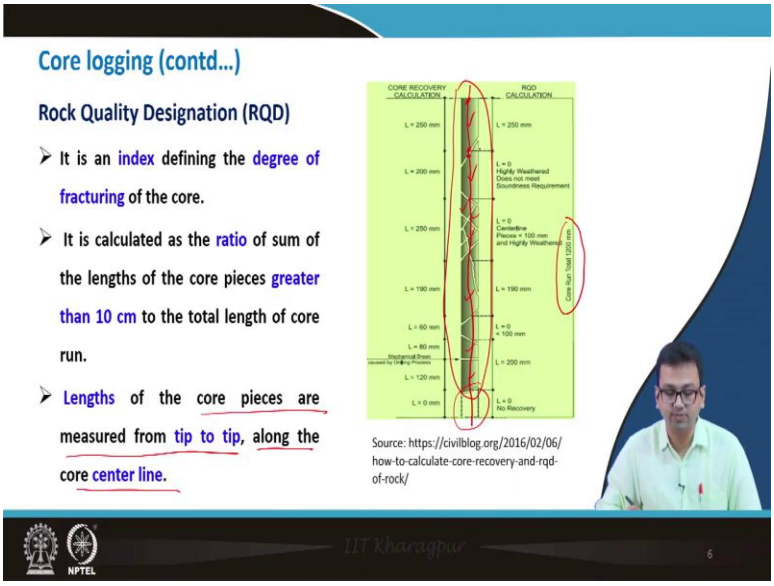

RQD is very important for rock mass classification. We will see later when we will discuss about the rock mass rating system under the rock mass classification. There, we will see its direct usage. Based on RQD also sometimes, rock is divided under different categories.

First, what is rock quality designation (RQD)?

It is an index defining the degree of fracturing of the core. Further, it is calculated as the ratio of the sum of length of core pieces greater than 10 centimeter to the total length of core run and lengths of the core pieces are measured from the like tip to tip along the core center line.

From Slide 6, you can notice over there that the core runs is 1200 millimeter. Now, out of that, some part of the core is recovered and other part could not be recovered. It can be identified that there are several core pieces.

So out of these pieces, we have to measure the lengths of these individual pieces and we have to find out the pieces having length greater than 10 centimeter. So, we have to imagine a center line and the core pieces are measured from tip to tip along the center line. We have to identify whether that piece is more than 10 centimeter or less than 10 centimeter.

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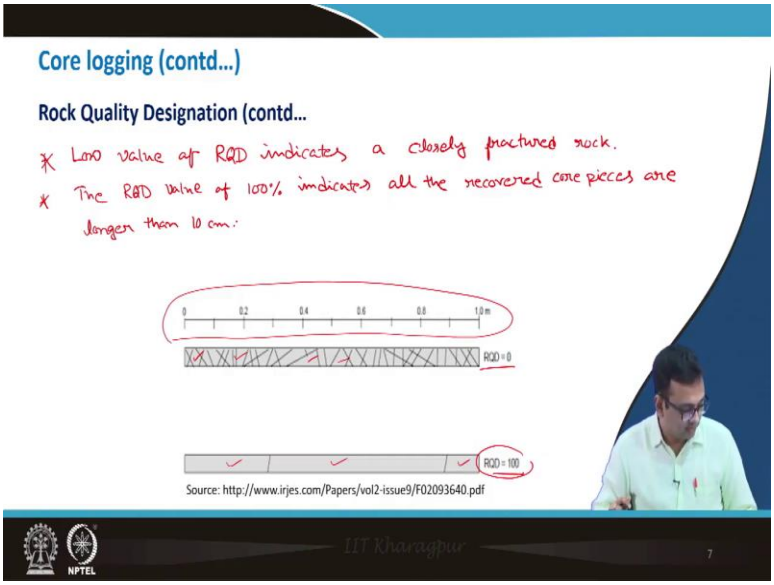

From the first core in slide 7, we can see RQD is 0. Here, none of the pieces are more than 10 centimeter as per the given scale. Whereas, in the second core, there are only three core pieces and only two fractures are present. In addition, all the three pieces are more than 10 centimeter in length. So, RQD is 100%.

So, what this low value of RQD indicates?

We can now understand that low value of RQD indicates a closely fractured rock. Therefore, if the RQD is close to 0, it indicates that none of the pieces are more than 10 centimeter. It is obvious that strength of the rock will be definitely very low. Therefore, the low value of RQD indicates a closely fractured rock.

Similarly, we can say that if all the pieces are greater than 10 centimeter, RQD will become 100%. Therefore, the RQD value of 100% indicates all the recovered core pieces are longer than 10 centimeter.

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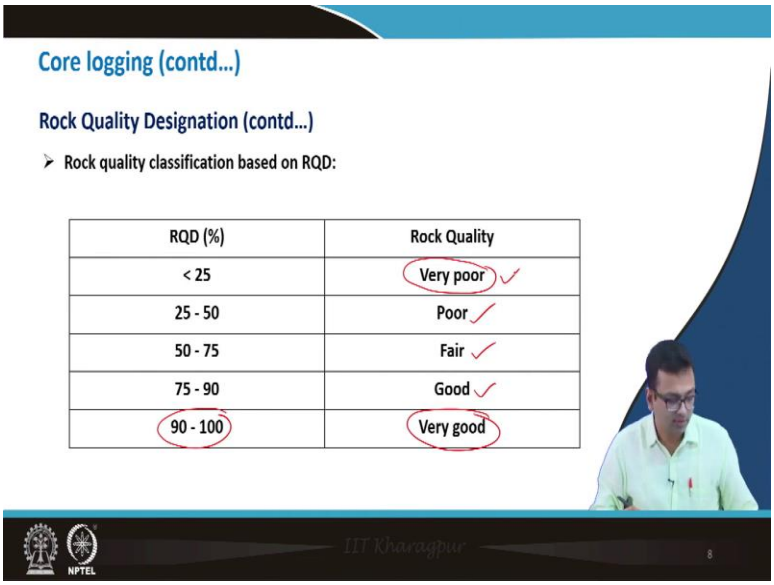

Based on RQD, the rock quality is classified in this table. From this table, if the RQD is less than 25%, it can be indicated as very poor quality rock. On the other hand, if RQD is 90 to 100, it is very good quality rock. The intermediate RQD values of 25 to 50 indicate poor and 50 to 75 indicate fair. If RQD values between 75 and 90, it is good quality rock. So, these are different ranges provided in Slide 8 to understand about the rock quality. So, less than 25 of RQD value is very poor rock.

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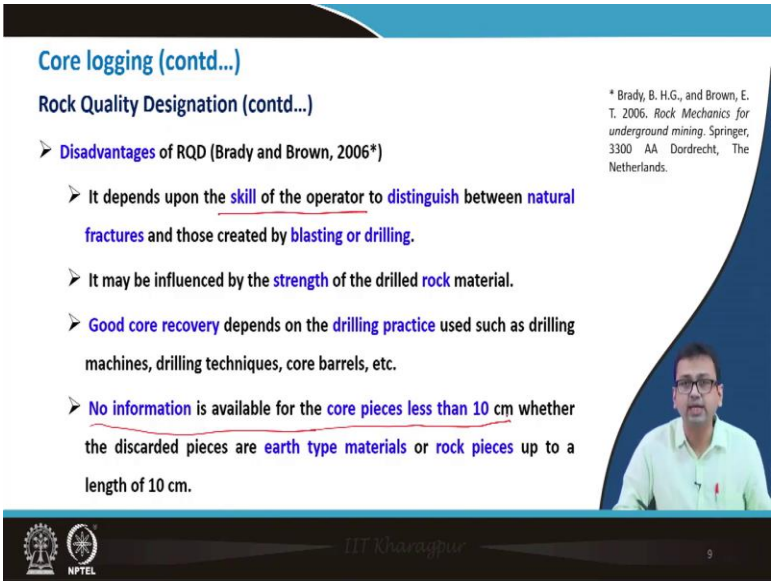

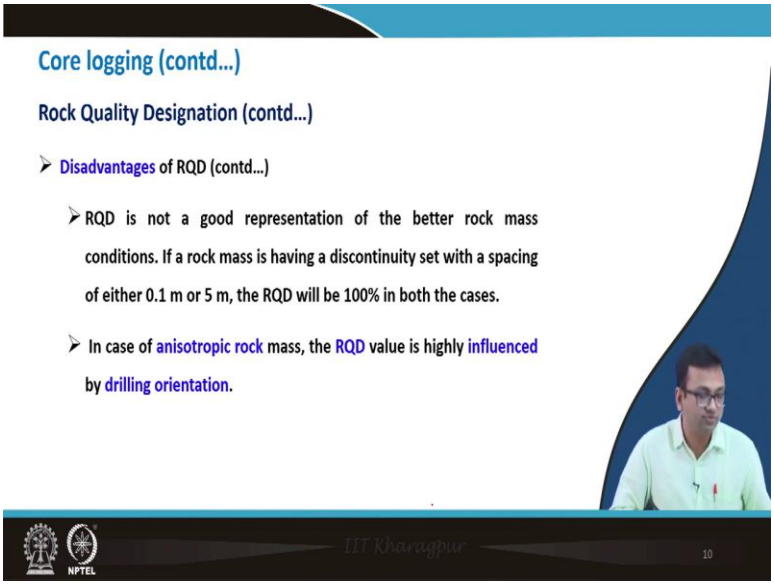

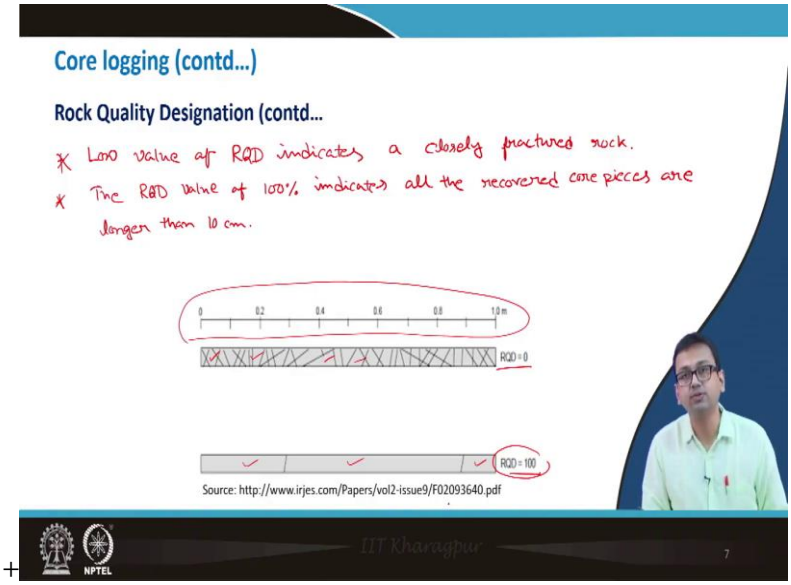

Now let us discuss about some of the disadvantages of RQD system.

To measure RQD, the individual length of the pieces is checked. If it is more than 10 centimeter, the length of that piece are considering for the summation. So now based on these philosophy, the disadvantages of RQD can be described.

The RQD value depends upon the skill of the operator to distinguish between the natural fracture and the manmade structures (those created by blasting or drilling). So if the operator unable to understand whether that fracture is due to manmade fracture or natural fracture, the RQD value will be erroneous. So, it depends on the skill of the operator. It is important for RQD determination.

Then it may be influenced by the strength of the drilled rock material. Good core recovery depends on the drilling practice used such as drilling machines, drilling techniques, core barrels etc. So, it is quite independent on instrumentation part.

Most importantly, no information is available for core pieces less than 10 centimeter. For example, there may be some pieces of length 9 centimeter or 8 centimeter which are not very less than 10 centimeter. Therefore, no information is available in RQD system for the core pieces less than 10 centimeter. Mostly, the discarded pieces are earth type material or rock pieces up to a length of 10 centimeter. So, actually we don't have any information.

So, below 10 centimeter, whether the piece is 9 centimeter or it is like soil or small particles, nothing can be said regarding these.

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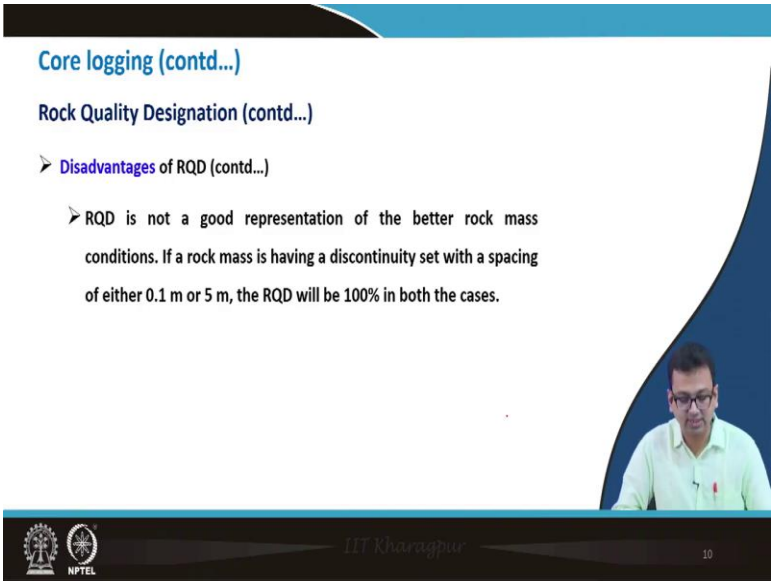

In addition, RQD is not good representation of the better rock mass condition. If a rock mass is having a discontinuity set with a spacing of either 0.1 meter or 5 meter, RQD will be 100% which we have discussed two slides back.

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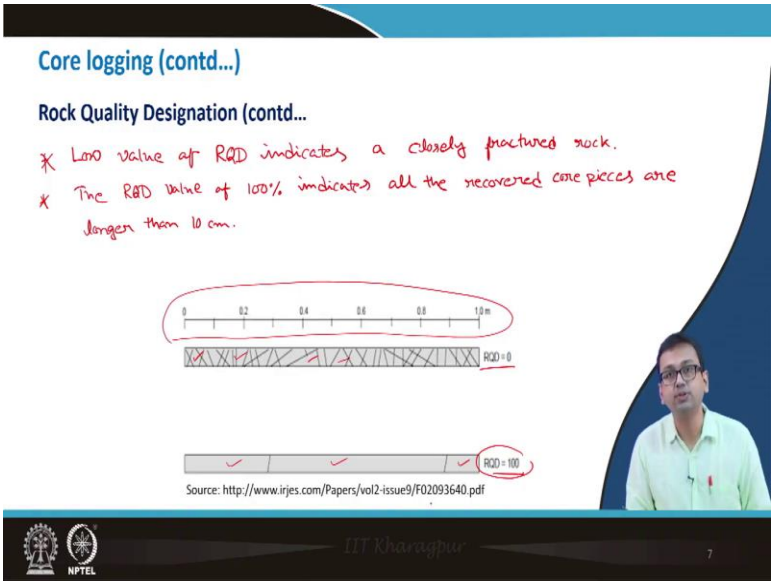

From slide 7, in second rock core, it can be one piece only or may be the full length. Then, the obtained RQD for one piece or three pieces is 100%. So, it does not gives full information regarding discontinuity.

In case of anisotropic rock mass, the RQD value is highly influenced by the drilling orientation. Obviously RQD value will change with the rock orientation and its anisotropic nature.

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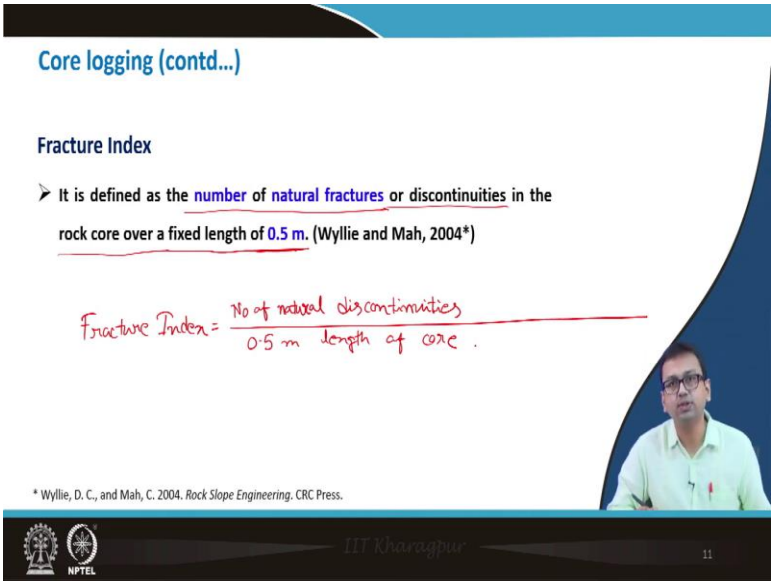

We will discuss a new term, which is known as fracture index. It is defined as the number of natural fractures or discontinuities in the rock core over a fixed length of 0.5 meter.

$$\text{Fracture index} = \frac{\text{the number of natural discontinuities}}{0.5\ \text{meter length of core}}$$

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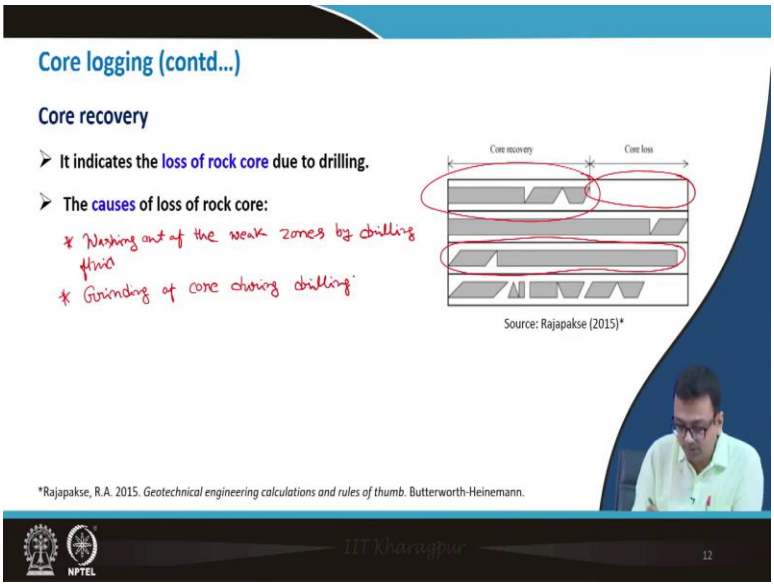

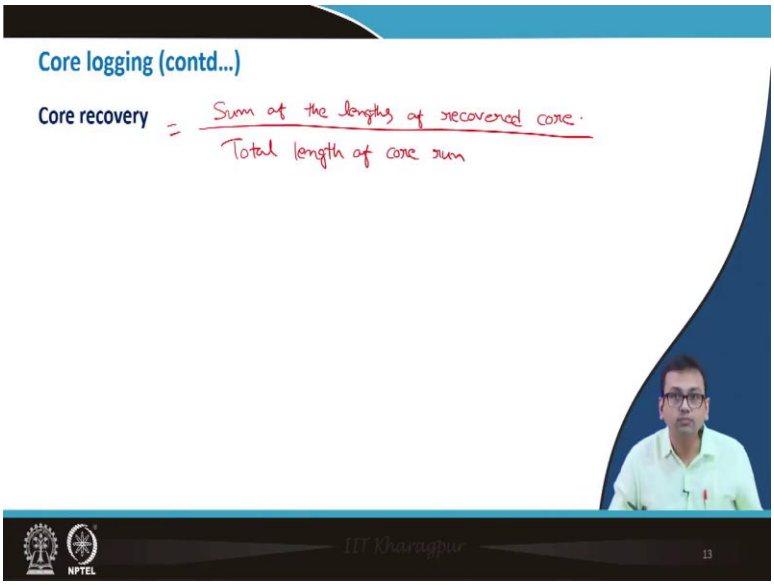

Now we will discuss about core recovery. It indicates the loss of rock core due to drilling. So, at the time of this drilling operation, we may not recover some of the portion. So that portion is actually lost. So it indicates the loss of rock core due to drilling.

In slide 14, the evidence of no recovery of rock core is clearly presented in the figure. What can be the cause? The one of the causes of rock core loss is like washing out of the weak zone. So, we can write the causes of rock core loss is

1. The washing out of the weak zones by drilling fluid.
2. The grinding of core during drilling.

Other thing may be the discontinuity or the cavity. That is obvious that we will not find any material there.

So, what is core recovery?

Core recovery is the ratio of the sum of the length of recovered core to the total length of core run.

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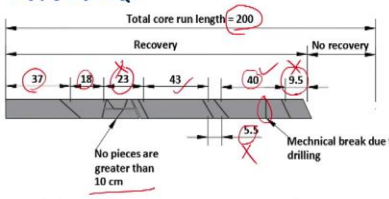
Core logging (contd...)

Problem on RQD



All the dimensions are in 'cm'

Q. Find out the RQD and Core recovery ratio.

$$RQD = \frac{\text{Sum of the length of the core pieces} > 10\,cm}{\text{Total core run length}}$$

$$= \frac{(37 + 18 + 43 + 40) \times 100}{200} = \frac{138 \times 100}{200}\,\%$$

$$= 0.69 \times 100\,\%$$

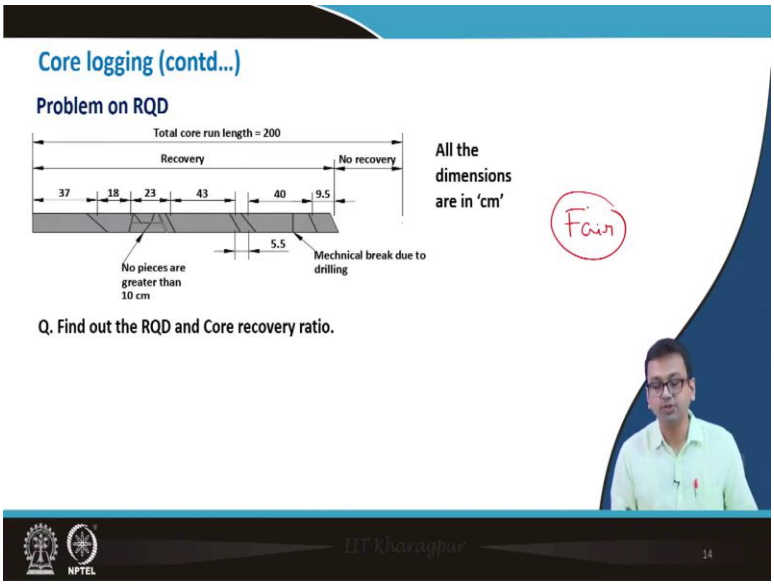
$$= 69\,\%$$

Core logging (contd...)

Rock Quality Designation (contd...)

- Rock quality classification based on RQD:

RQD (%)	Rock Quality
< 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Very good



A problem on RQD let us try to solve. This will clear all the doubts regarding RQD. The recovered rock core is presented in slide 14. The dimensions of different pieces are also measured. The total core length is 200 centimeter. All dimensions are in centimeter. Find out the RQD.

Solution:

$$\text{RQD} = \frac{\text{the sum of length of core pieces greater than 10 centimeter}}{\text{total core run length}} \times 100\%$$

$$= \frac{37+18+43+40}{200} \times 100\%$$

$$= 69\%$$

You can see that RQD is presented in terms of percentage. From the RQD table, the rock quality is falling as fair.

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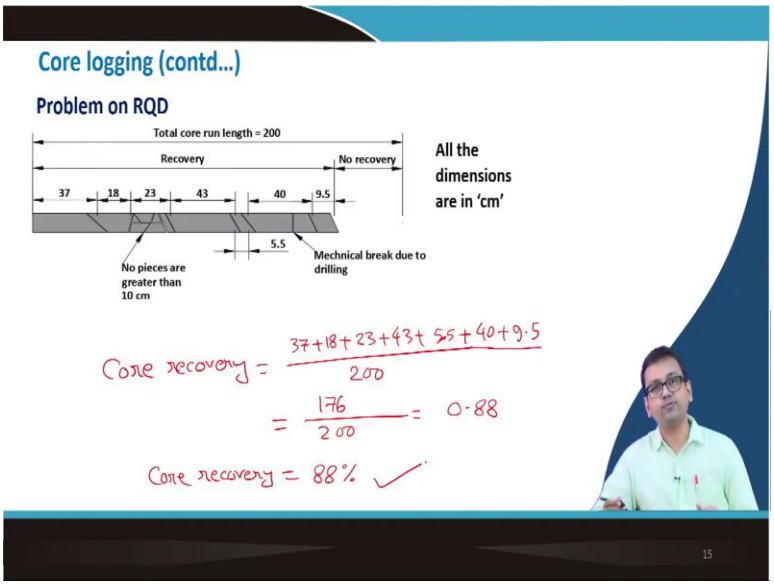

$$\text{Core recovery} = \frac{\text{the sum of the length of recovered core}}{\text{the total length of core run}} \times 100\%$$

$$= \frac{37+18+23+43+5.5+40+9.5}{200} \times 100\%$$

$$= 88\%$$

So, core recovery is equal to 88%.

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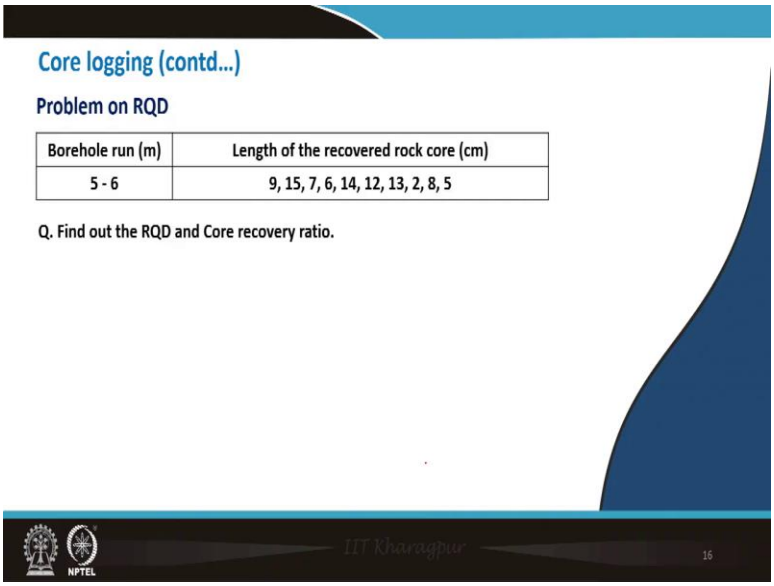

Now, I think another problem is there which maybe we will do in our next class. After that we will briefly discuss about the core orientation. Then, we will start another topic that is different geophysical investigation. So, thank you. So let us stop here today's class.

In this today's class, we have learnt about core logging as well as RQD fracture index and core recovery. Also, we have learnt the different advantages and disadvantages of different methods. So, thank you.