

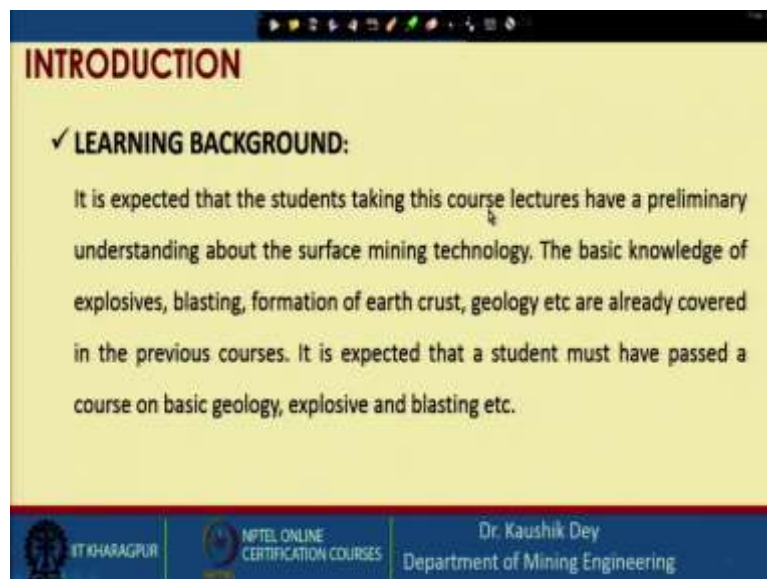
Surface Mining Technology
Professor Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology Kharagpur
Lecture 51
Dimensional Stone Mining - I

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Let me welcome you to the NPTEL online certification course of surface mining technology. In this course so far, we have covered 50 lectures, this is lecture number 51. In this lecture we will start the dimensional stone mining method. There will be 3 lectures on this and this is the first lecture of this dimensional stone mining method.

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INTRODUCTION

✓ **Learning Objectives of This Course:**

- To know the different unit operations associated with surface mining.
- Methods of surface mining.
- Deployment of machineries in surface mining.
- Productivity analysis of surface mining.
- Safety and environmental control of surface mining operations.
- Special methods of surface mining.

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So, just like every lecture, let us once look into the learning background required for surface mining technology course and the objective of surface mining technology courses, these are the objectives.

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INTRODUCTION

✓ **LEARNING OUTCOMES:**

It is expected that the students taking this course lectures will be able to envisage the surface mining operation and its technological nitty-gritty. It is expected that a student will be able to design the drilling and blasting rounds for surface blasting, will be able to choose, deploy and design the mine machineries for a set production target. The desired safety and environmental requirements will also be addressed.

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✓ **LEARNING OUTCOMES:**

The student will also have an overall idea about the special methods of surface mining including sea bed mining, dimensional stone mining, highwall mining etc. The students will also able to deliver the technological and managerial requirements to the special safety requirements like slope stability and sump management etc.

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And the expected learning outcomes from the participants of surface mining technology course are these.

(Refer Slide Time: 1:14)

INTRODUCTION

✓ **SOME TEXT BOOKS AND REFERENCES**

1. Mishra G. B., 1978, Surface Mining, Dhahbad Publishers
2. Das S. K., 1998, Surface Mining Technology, Lovely Prakashan
3. Deshmukh R. T., 1996, Opencast Mining, M. Publications, Nagpur.
4. De Amithosh, 1995, Latest Development of Heavy Earth Moving Machinery, Annapurna Publishers
5. Hartman H. L., 2002, Introductory Mining Engineering, Publishers John Willey and sons

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INTRODUCTION

✓ **SOME TEXT BOOKS AND REFERENCES**

6. Peter Darling, 2011, SME Hand book, SME Publication
7. Rzhovsky, V. V., (1983), Opencast Mining Unit. Operation, Mir publications
8. Rzhovsky, V. V., (1985), Opencast Mining Technology and Integrated Mechanisations, Mir publications

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And these are some of the text books and references, which in general, we expect that a participant of surface mining technology course will follow. Apart from that the references for each lecture and each slides are given during the syllabus, most of the photos are taken from the web sources, their citations, their references are given and along with that videos or most of the videos are taken from YouTube, their references are also given along with those videos.

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INTRODUCTION

✓ **Retrospect Previous Lectures:**

In previous lectures, the phases of mining for extracting a deposit are discussed. The commencement of mining excavation through opening of box cut is discussed. The unit operations Drilling technology, Blasting technology, excavation and loading technology, are discussed. Operations of shovel, surface miner, dragline, bucket wheel excavator etc are also discussed along with their pit layouts.

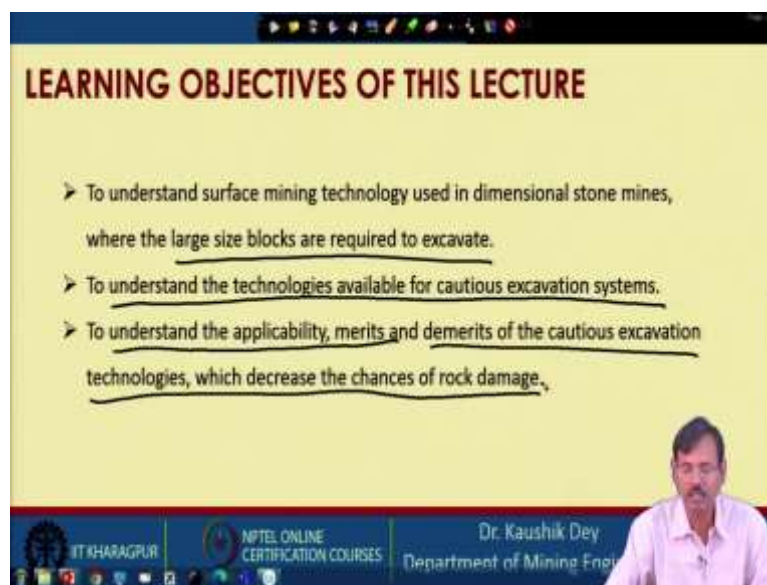
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So far let us look into what are the topics we have covered, we have started with the status of surface mining worldwide, we have seen their status, the phases of mining and deposit are also discussed with special reference to surface mining excavation systems of those deposits.

And we have also covered the commencement of surface mining operation through the opening of box cut. And different excavation techniques either using the drilling and blasting technology or the blast free technologies, mostly blast free technologies we have covered, dripper, surface miner, bucket wheel excavator, all these are the blast free technologies.

Those are already discussed. Fragmented rock mass, their excavation and loading is also discussed during this course. And also, the large distance stripping of the overburdened rocks is also discussed in using drag line and stripping shovels, those are already discussed in this course.

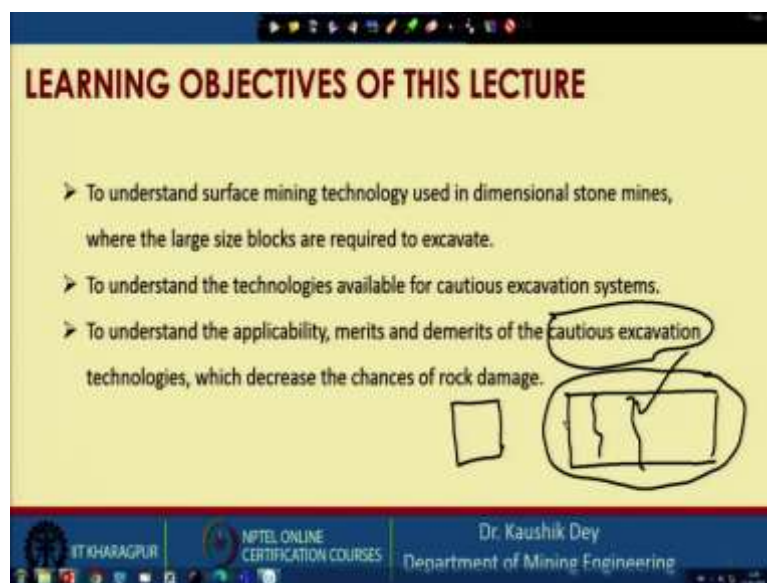
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LEARNING OBJECTIVES OF THIS LECTURE

- To understand surface mining technology used in dimensional stone mines, where the large size blocks are required to excavate.
- To understand the technologies available for cautious excavation systems.
- To understand the applicability, merits and demerits of the cautious excavation technologies, which decrease the chances of rock damage.

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LEARNING OBJECTIVES OF THIS LECTURE

- To understand surface mining technology used in dimensional stone mines, where the large size blocks are required to excavate.
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- To understand the applicability, merits and demerits of the cautious excavation technologies, which decrease the chances of rock damage.

Diagram: A hand-drawn sketch showing a small square on the left and a larger rectangle on the right. The larger rectangle contains a jagged, irregular shape representing a rock mass. A speech bubble points to the jagged shape with the text 'cautious excavation'.

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Now we will look into the methods of dimensional stone mining, so we have mentioned the learning objectives for this dimensional stone mining method lectures, these are to understand

surface mining technology used in dimensional stone mines where the large blocks are required to excavate, to understand the technologies available for cautious excavation system, to understand the applicability merits and demerits of this cautious excavation technologies and which decrease the chances of rock damage.

This is required because, these dimensional stones, we want that must be in a large size so as it is of large size because the large size dimensional stones are having high value. If the size is reduced their value is significantly decreased. So, that is why we want the large size dimensional stones and that is why the excavation technology is different from that, or so far that excavation technology we have covered this process is different.

Also, we have to take the cautious excavation system so that there should not be any crack generation in this, if any crack is generated in this, then again, the value of this block reduces significantly. So, we do not want to initiate any crack. So, these are some constraints while the dimensional stone mining is carried out. But before this let us understand what is a dimensional stone?

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DIMENSIONAL STONE MINING

What is dimensional stone?

- Dimension stone is natural stone/rock that has been selected and finished (e.g., trimmed, cut, drilled, ground, or other) to specific sizes or shapes. Colour, texture and pattern, and surface finish of the stone are also normal requirements.
- Dimensional stones can be igneous, sedimentary or metamorphic formations.

<https://www.gilegocorp.com/wp-content/uploads/dimensional.jpg>

https://bloggranite.com/wp-content/uploads/2016/08/granite_coun-tertop-1000x500-1.jpg

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So, dimensional stone is basically a natural stone or rock that has been selected and finished and to specific sizes and shapes and in generally used for the home furnishing or similar uses. The colour texture, pattern and surface finish of the stones are very important considering its price.

So, you can see some of the different colour textures of the different dimensional stones are shown here, you can see these are the excavated dimensional stones of regular sizes,

finishings are different. So, these are the granite stones, it is having some different types of finishing, marbles are of different types of finishing.

So, there are different colour, texture, pattern and surface finish required time to time as per the dimensional stones requirement. And dimensional stones may be igneous, sedimentary, metamorphic but as these are possible to excavate in a fixed dimension of x and y and z, so that is why these stones are called dimensional stone.

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So, these are some of the special marbles, marble is considered one of the major dimensional stone apart from the granite and etcetera. So, these are some special marbles, this is yellow marbles which is available in Jaisalmer in India and there are many other places also available. So, these are some of the, this is milky white marble. So, these are different types of marbles which are available and these are considered as a very, very special marble.

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DIMENSIONAL STONE MINING

What is dimensional stone?

Most common stones are –

- Granite ✓
- Limestone ✓
- Marble ✓
- Sandstone ✓
- Quartzite ✓
- Slate ✓

Mainly used in home furnishing

The slide features a hand-drawn diagram of a rectangular block with a smaller rectangular piece on top, representing a stone used in home furnishing. The slide also includes a video player interface at the bottom with the text 'IT KHARAGPUR', 'NPTEL ONLINE CERTIFICATION COURSES', and 'Dr. Kaushik Dey, Department of Mining Engineering'.

So, what are the dimensional stones? Dimensional stones are commonly granite, limestone, marble, sandstone, quartzite and slate. So, these rocks are, one can able to excavate these rocks in shapes, so you can excavate a piece of marble of this shape. So, that is why these are called dimensional stone. And this is showing that its main use is in home furnishing or some of the graffiti.

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DIMENSIONAL STONE MINING

What is dimensional stone?

<https://www.youtube.com/watch?v=5a022mUenYs&t=57s>
(YouTube)

The slide features a video player interface showing a hand holding a smartphone to take a photo of the pyramids. The slide also includes a video player interface at the bottom with the text 'IT KHARAGPUR', 'NPTEL ONLINE CERTIFICATION COURSES', and 'Dr. Kaushik Dey, Department of Mining Engineering'.

DIMENSIONAL STONE MINING

<https://www.youtube.com/watch?v=5e022m42mfo&t=57s>

What is dimensional stone?

(YouTube)



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DIMENSIONAL STONE MINING

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DIMENSIONAL STONE MINING

<https://www.youtube.com/watch?v=5e022m42mfo&t=57s>

What is dimensional stone?

(YouTube)



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So, let us once look into the different use of the dimensional stones. So, wherever you will see you will find out a huge use of dimensional stones whether it is from the pyramid or from the current day's big buildings. So, these are even if slabs or all these graffiti's everywhere, the dimensional stones are used. Nowadays it is now an integral part of the civil construction specially for the housings and infrastructures.

So, these are especially available and the occurrence of dimensional stones are found right from Africa to Europe to Asia almost in everywhere. A huge source of dimensional stones is found and the challenges in dimensional stone excavation is their cutting in large blocks. So, this excavation technique is basically cutting, so that the minimum damage is used, and there are different technology available for cutting of these rocks and their cautious excavation has to be carried out so that there should not be any there should not be any cracks initiated into this block.

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DIMENSIONAL STONE MINING <https://www.youtube.com/watch?v=6d22m4UmY6k>
(YouTube)

What is dimensional stone?

3. Splitting



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DIMENSIONAL STONE MINING <https://www.youtube.com/watch?v=6d22m4UmY6k>
(YouTube)

What is dimensional stone?



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What is dimensional stone?



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DIMENSIONAL STONE MINING <https://www.youtube.com/watch?v=5622m4UvYs>
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What is dimensional stone?



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What is dimensional stone?



It's a satisfying feeling to produce products-

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What is dimensional stone?



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So, that is why these are the slot drilling technology which are used and generally the two large pieces are broken. So, like that way, these are different technologies we will continue the study of this different technologies but this is basically showing the different use how the finishing is made, this is the final pieces and based on that the scaling, based on the size of the block, based on the colour of the block, the price of the block is determined.

And that is why dimensional stone is very useful and the benefit of the dimensional stone is that once it is used as the dimensional stone for home furnishing etcetera, but when it is broken into a smaller pieces, that time also this dimensional stones can be used as the part of the stone, as aggregates as a part of the sand making all these way these dimensional stones can be reused. Even if, once it is, say there is a crack occurred in a side of the dimensional stone, then also the stone can be cut again in a smaller piece and that can be reused.

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The slide is titled "DIMENSIONAL STONE MINING" and contains three bullet points. Red circles and lines highlight specific information in the text. The first bullet point states that the business has a yearly turnover of US\$ 60 billion in 2008 and India mined marble worth Rs 2000 Crore in 2012-13. The second bullet point lists states where marble is found: Rajasthan, Gujarat, Haryana, Andhra Pradesh, Madhya Pradesh, Jammu & Kashmir, Maharashtra, Sikkim, Uttar Pradesh, and West Bengal. The third bullet point notes that Rajasthan accounts for 95% of the total production, with other states being Gujarat, Haryana, Andhra Pradesh, and Madhya Pradesh. At the bottom, there are logos for IIT Kharagpur and NPTEL, and the name of Dr. Kaushik Dey from the Department of Mining Engineering.

DIMENSIONAL STONE MINING

- Dimension stone mining business has yearly turn over of US\$ 60 billion in the year 2008. India is reported to mine marble of Rs 2000 Cr in the year 2012-13.
- The occurrences of marble have been reported from many states, viz, Rajasthan, Gujarat, Haryana, Andhra Pradesh, Madhya Pradesh, Jammu & Kashmir, Maharashtra, Sikkim, Uttar Pradesh and West Bengal.
- Among the above states, marble deposits of economic importance are localised in, Rajasthan (95% of total production), Gujarat, Haryana, Andhra Pradesh and Madhya Pradesh.

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So, dimensional stone is having the facility of re-use and that is making it a very, very special. Now let us look into the dimension of stone mining, if you are considering Indian context in this, dimensional stone mining business has yearly turnover of 60 billion dollar in 2008 and India is reported to mine marble of rupees 2000 crore in the year 2012-13.

The occurrence of marble are found in these states Rajasthan, Gujarat, Haryana, Andhra Pradesh, Madhya Pradesh, Jammu and Kashmir, Maharashtra, Sikkim, Uttar Pradesh and West Bengal. However, Rajasthan holds the 95 percent of the total production in the country and rest are found mostly in these five states.

So, these are the national scenario of marble mining and Rajasthan is famous for countries dimensional stone mining and mainly that is marble, all the great marbles are coming out from there and Taj Mahal which is built with Markhana marbles are, Rajasthan marble deposit is a part of that.

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DIMENSIONAL STONE MINING

Some special marbles

- Yellow marble from Jaisalmer
- Pista marble (amphibolite variety) from Andhi-Jhiri belt, Jaipur, Alwar and Dausa districts, Rajasthan.
- Brown green and golden ultramafics from Dunkar, Churu district, Rajasthan.
- Chocolate-brown and English teak wood marble from Jodhpur district, Rajasthan.
- Parrot green marble from Jhilo in Sikar district, Rajasthan.
- Chocolate-brown or wood-finish marble from Mandaldeh, Chittorgarh district, Rajasthan.
- Purple marble from Tripura Sundari in Banswara district, Rajasthan.
- Blue marble from Desuri in Pali district, Rajasthan.

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Now let us look into some of the special marbles, yellow marbles which is available in Jaisalmer is a famous product. Even if the powders of these stone marbles, these yellow marbles which are coming out that is used with adhesive to prepare different stone utensils. Then Pista marble is the amphibolite varieties, this is available in Jaipur, Alwar and the Dausa district of Rajasthan. Brown green marble and golden ultramafic are also available in Dunkar, Churu district of Rajasthan. Chocolate brown and English Teak wood marble are also available in Jodhpur district of Rajasthan. And Parrot green marble from Jhilo in Sikar district of Rajasthan.

So, these are the different colour marbles, you can see Rajasthan itself is producing that many types of marble and this is from Mandaldeh, Chittorgarh district where the chocolate brown and wood finish marbles are available. Purple marbles are available in Tripura Sundari in Banswara district of Rajasthan and blue marbles are available in the Desuri of Pali district of Rajasthan.

So, Rajasthan itself is generating yellow marble, Pista marble, then brown green marble, golden marble, chocolate brown marble, english teak marble, parrot green marble, then purple marble, blue marble. So, all these marbles, these colours of marbles are available and depending on their colours these marbles are having different values. So, that is why this, but

fortunately we are having this much deposits and we are having significant deposit related to the marble.

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DIMENSIONAL STONE MINING
Exploration for dimension stone

- The homogeneity of a dimension stone deposit in terms of colour, texture and discontinuities that is particularly relevant during geological surveys as it is the base for establishing the limits of a dimension stone deposit.
- Carvalho et al (2008) have proposed the following decision criteria on exploration for dimension stone:

Dimensioning	Homogeneity	Fracturing
<ul style="list-style-type: none"> Thickness of productive units (sedimentary beds, metamorphic facies etc) Volume of the deposit Spatial Disposition 	<ul style="list-style-type: none"> Colour Texture Discontinuity <p><i>Scaling</i></p>	<ul style="list-style-type: none"> Preferential directions Frequency Density Intensity Type and morphology <p><i>Beds</i></p>

Exploration of the dimensional stone is in general carried out and we look into the colour, texture and discontinuities that is particularly relevant during the geological service and it is the base of establishing the limit of a dimensional stone deposit.

So, generally we look into the beds, thickness of the beds which are formed there and that is the natural separation plane from which these marbles are, then, this dimensional stone separates and we are looking on this and there may be some particular joint sets may occurs, we are also looking at this because that is acting as the side of a dimensional stone. We cannot allow a joint surface in between a stone so basically joints are considered as the boundary of the dimensional stone.

So, thickness of the productive unit, sedimentary beds are considered as the dimension, the volume of the deposit and special deposition is considered. Homogeneity is very, very important, that colour, texture, discontinuity and along with the scaling. Scaling is also another important thing, if there is a small dark spot in a milky white marble then that dark spot is reducing the price of that marble significantly. But a systematic dark spots or systematic scaling may be considered or may raise the value little bit but that is consider scaling is not at all wanted in a dimensional stone.

So, fracturing is preferential directions of fracturing is used. Frequency of fracture basically if it is closely spaced then it is reducing the price. Density is also important, intensity and type

and morphology is also very, very important while we are exploring a dimensional stone deposit.

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DIMENSIONAL STONE MINING
Exploration for dimension stone

- According to Carvahlo et al (2008), these criteria can be evaluated by the basic geological tools of geological mapping and fracturing survey.
- Thematic geological mapping, with strong support from the techniques of structural geology and diamond core drilling, is fundamental for the research and evaluation of data that are intrinsic to the dimensioning and homogeneity qualification of the deposits.

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And these criteria can reveal the basic geological tools of geological mapping and the fracturing survey for the dimensional stones.

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DIMENSIONAL STONE MINING
Marble reserve in India

State/Type	Reserves				Remaining reserves				Total reserves (A+B)
	Proved	Probable	Total	Possible	Under development	Under development	Under development	Total	
All India - Total	10776	17264	28040	19942	72289	107329	135469	163500	247000
By Grades									
White Colour	7170	11104	18274	81	51942	70212	122154	192366	262630
Other Colours	3606	6160	9766	21861	40347	107117	117963	122144	174370
Unclassified	-	-	-	21879	-	49212	51091	51091	51091
Not Known	-	98	98	1007	3999	-	4006	4006	4006
By States									
Andhra Pradesh	-	-	-	-	-	-	9	9	9
Chhattisgarh	-	-	-	-	-	-	83000	83000	83000
Gujarat	-	-	-	30171	41000	71329	148771	219900	220171
Karnataka	-	-	-	1234	1402	-	2636	2636	2636
Jammu & Kashmir	-	-	-	-	-	-	44700	44700	44700
Madhya Pradesh	-	128	128	92	92	17942	17722	17844	17970
Rajasthan	10076	17264	27340	1007	25000	10083	37300	47383	74723
Uttarakhand	-	-	-	-	-	-	2182	2182	2182
Unclassified	-	-	-	-	-	6007	6007	6007	6007

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Now let us look into the Indian deposit, we are having a proved reserves of you can say 103 million tons, this is expressed in thousand tons. So, we are having proved reserves of 103 million ton in the country and it is mostly you can see, mostly from Rajasthan we are showing.

And we are having most deposits related to white coloured marble and if you are considering a resources also then it is becoming almost three times of the proved reserved. So, this is the current scenario of the marble reserve of the country. These are probable and this is our indicated and inferred deposit, it is expected that we are having significant quantity of marble but most of these are in Rajasthan only.

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DIMENSIONAL STONE MINING Marble Production in India

Table - 3: Value of Production of Marble, 2009-10 to 2011-12
(By States)
(value in ₹'000)

State	2009-10	2010-11	2011-12 (P)
India	12794100	13954172	14012403
Andhra Pradesh	170	138	81534
Gujarat	422610	136248	399729
Jammu & Kashmir	96	539	295
Madhya Pradesh	290965	344304	358015
Rajasthan	12080259	13472943	15172830

Source: State Governments.

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And if you look into the status, the production value is again expressed in thousand rupees, so you can see this is 12700 million rupees or you can say 1200 crores of rupees are produced, marbles of that much market values are produced in 2009-10 which is increased significantly in 11-12, probably in 2021, the amount is significantly high, the recent values can be obtained from the site of IBM, the annual mineral report, these are taken from the mineral report of the IBM. So, this is the marble production and you can see again most of the production has come, 95 percent production has come from Rajasthan state.

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Table - 4: Exports of Marble: T (By Countries)

Country	2011-12		2012-13	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	325241	5861834	372348	5438796
China	88546	760616	103339	1012017
USA	10626	436904	14488	682486
Egypt	51370	583257	48912	641870
Nepal	48341	309796	40745	443766
Italy	12908	180267	17118	232213
Saudi Arabia	7320	101579	10585	198088
UAE	10284	191155	10983	189752
Chinese Taipei:				
Taiwan	3108	28170	13581	175546
Hong Kong	20983	122506	22921	159794
Germany	2765	52058	5412	118872
Other countries	71181	1096126	83384	1577182

DIMENSIONAL STONE MINING
Marble Production in India

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Table - 4: Exports of Marble: T (By Countries)

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All Countries	325241	5861834	372348	5438796
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Other countries	71181	1096126	83384	1577182

DIMENSIONAL STONE MINING
Marble Production in India

Handwritten notes:
Granite → Strong
Roof
Floor
Bridge
India → Sit

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And India is also earning a huge value from exporting marble, you can see 543 crore rupees; 543 crore rupees was earned in the year 2012-13 by exporting marble to these countries. And you can see China is the main consumer, apart from that it is exported to a number of other countries and there may be some famous countries like say Italy, the Italian marble in term we are calling, so Italy has having a very good marble deposits but despite that they are also importing marbles from India because every types of marbles are not available in everywhere.

Similarly, India is also importing marble from the other countries because those types of marbles are not available in the country so that is why those marbles are imported. So, it is not that India is only exporting, India is also importing. Similarly, other countries are also

exporting and importing depending on the types of marble. So, this is basically practiced. So, marble is a very, very important industry and very profitable industry.

And not only marble, along with this other dimensional of stones like granite. This is mostly used as a strong dimensional stone, the strength of strong dimensional stone because the strength of marble is not as much as granite but this is used as a strong dimensional stone. Often it is used as the roof, as the floor, as the bridge also and the main use of this is as anti-skid or anti skidding floor furnishing, granite is very, very important.

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Country	2011-12		2012-13	
	Qty (l)	Value (₹'000)	Qty (l)	Value (₹'000)
All Countries	325741	5861854	372388	5408796
China	81546	760616	103338	1012017
USA	10626	416904	14468	602486
Egypt	51370	513257	49912	641070
Nepal	48741	309796	40745	443766
Italy	12908	190267	17118	232213
Saudi Arabia	7320	101579	10585	198098
UAE	18284	191155	10983	189752
Chinese Taipei				
Taiwan	3108	28170	13581	175546
Hong Kong	20983	122506	22921	158794
Germany	2765	52958	5412	118872
Other countries	71381	1096126	83384	1577182

So, this basically the different types of dimensional stones are available, along with that slate is also there which is very commonly used as a home furnishing and for other different uses are also there for the slate. Slate is basically the metamorphosed cell that is called slate. So, this is basically metamorphic rock which is used for the home furnishing.

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DIMENSIONAL STONE MINING **Marble polishing**
<https://www.youtube.com/watch?v=10gkqg-p0JY>



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Now let us look into the furnishing technology of the dimensional stone. So, after excavation of the dimensional stone, how we furnish that one. Let us once look into this technology. So, this is the piece of dimensional stone, you can see it is a marble.

So, this marble is now placed in this machine, so they are handling this marble very cautiously so that no cracking occurs here. So, now they have placed the marble in a proper position so that it can be polished.

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Now this machine is basically the polishing machine and this polishing is controlled. Now you can see there are n number of blocks are placed for polishing. Now blocks are placed properly below this polishing stone.

(Refer Slide Time: 24:02)

DIMENSIONAL STONE MINING **Marble polishing**
<https://www.youtube.com/watch?v=rlkg-pudJWY>



1 2

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This slide shows a close-up view of a marble polishing machine. Two large, dark grinding wheels are visible, labeled with the numbers 1 and 2. The machine is mounted on a metal frame. A small inset video in the bottom right corner shows Dr. Kaushik Dey speaking.

DIMENSIONAL STONE MINING **Marble polishing**
<https://www.youtube.com/watch?v=rlkg-pudJWY>



2 3

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This slide shows a different view of the marble polishing machine. Three grinding wheels are visible, with the middle one labeled 3 and the one to its left labeled 2. The machine is mounted on a metal frame. A small inset video in the bottom right corner shows Dr. Kaushik Dey speaking.

DIMENSIONAL STONE MINING **Marble polishing**
<https://www.youtube.com/watch?v=rlkg-pudJWY>



1 2 3 4

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This slide shows a wider view of the marble polishing machine. Four grinding wheels are visible, labeled 1, 2, 3, and 4 from left to right. The machine is mounted on a metal frame. A small inset video in the bottom right corner shows Dr. Kaushik Dey speaking.



So, you can see these are the polishing stone, below this motor and this will be allowed to polish and you can see the water is given during this polishing from the center of the polishing stone. Now the polishing has started. So, this is a huge machine simultaneously you can see 1, 2, 3, 4 numbers are given polishing units are provided and this is C polishing longitudinally from one side to another side. So, this is longitudinal polishing carried out, up to the furthest length.

Then it is polishing in the transverse direction and again it is returning the polishing towards the back side. So, in this case you can see the polishing is carried out from both directions so that maximum smoothness can be achieved. So, in a transverse direction also it is carried in longitudinally also it is carried.

And this quality polishing stones are also very special type, there are different polishing stones also available for having the level of polishing, 1, 2, 3, 4, 6 like that way, gradation of polishings are fixed. So, this is the polishing technique, so let us stop our lecture at this position. The mining methods will be started from the next lecture. Thank you!