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30.21 SLATE, SANDSTONE & OTHER DIMENSION STONES

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30-21 Slate, Sandstone & Other Dimension Stones

Slate, sandstone, limestone and quartzite are the principal rock types used as dimesnsion stones other than granite and marble. India is endowed with abundant resources of these types of dimension stones which are increasingly being used domestically. These stones are also important export commodities. India is one of the largest producers of dimensional stones in the world.

1. Slate

Slate is a fine-grained, very low-to-low metamorphic rock possessing a well developed fissility (splitting attitude) parallel to the planes of slaty cleavage. It is formed by the metamorphism of pre-existing clay rocks such as claystone, shale or siltstone. The most remarkable feature of this rock is that it has cleavage planes that are well marked which enable it to be split manually or mechanically into relatively thin slabs.Slate is a low-cost decorative stone used for exterior and interior decoration of buildings. It is significantly used in roofing. It is also used as school slate and also as building dimension stone. Slate has an aesthetic value like other dimension stones, granite and marble. Slate has emerged as a low cost alternative to granite and marble which are comparatively expensive. The exports of slate have increased over the period resulting in a boost to slate mining industry in the country. Micaceous and chlorite slates are generally preferred.

OCCURRENCES

The Aravalli Mountain ranges in Rajasthan and Haryana; rock assemblages under Kadapa System in Andhra Pradesh and Tamil Nadu; and Himalayan region in Northern India have undergone metamorphism and given rise to the slate deposits along with other metamorphosed products. The availability of slates has also been reported from Madhya Pradesh, Haryana, Himachal Pradesh, Jharkhand, Andhra Pradesh, Rajasthan, Uttarakhand, Bihar and Gujarat.

RESERVES/RESOURCES

An attempt has been made to prepare inventory of slate. This may not be complete. The total reserves/ resources of slate as on 1.4.2015 as per UNFC system are placed at 22.9 million tonnes under unclassified grade. Reserves/ Resources are located in Andhra Pradesh & Haryana (Table- 1).

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are given in the review on "Exploration & Development" in "General Reviews".

PRODUCTION

As per Govt. of India Notification S-O.423(E), dated 10.2.2015, 'slate' has been declared as 'Minor Mineral'. Hence the production data is not available with IBM.

Table – 1 : Reserves/Resources of Slate as on 1.4.2015
(By Grade/States)

(In '000 tonnes)

Grade/State	Reserves				Remaining resources								Total resources (A+B)
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
		STD121	STD122			STD221	STD222						
All India : Total	**19619**	**667**	**-**	**20286**	**-**	**-**	**1075**	**-**	**-**	**1511**	**-**	**2586**	**22872**
By Grade													
Unclassified	19619	667	-	20286	-	-	1075	-	-	1511	-	2586	22872
By States													
Andhra Pradesh	109	667	-	776	-	-	1075	-	-	1511	-	2586	3362
Haryana	19510	-	-	19510	-	-	-	-	-	-	-	-	19510

Figures rounded off

MINING AND PROCESSING

Mining of slate is done by opencast method. The slate bands are exposed by removing the overburden by means of drilling and controlled blasting. The mining in many places is carried out by manual means but in some mines, semi-mechanised method of mining is also adopted. After removing a thick slab of slate preferably of larger size, the slab is split using hammers, specially-made chisels and cutting knives. The saleable tile or slab of slate is obtained in 6 to 10 mm thickness for cladding and 20 to 35 mm thickness for flooring or for panels. The edges are cut manually by using machines to have a smooth and regular edge. The slate as building stone is marketed under the commercial names, such as Golden Copper, Green, Black, Panther, Mica, Speckled, Deoli, Mahi, Silver Grey and Peacock. Peacock is the only premier variety produced in Kund area, Haryana.

The overall recovery of slate is very low, being a fragile material among all the building/ dimension stones. Normally, huge accumulation of broken pieces in and around the slate quarry is observed incidental to mining & processing. Proper mining and processing techniques by using modern equipment may improve the situation in future.

USES AND SPECIFICATIONS

There are two main uses of slate as a natural stone in building work: 1) for roofing in the form of roofing tiles and 2) for flooring in the form of tiles and for cladding purposes.

For roofing tiles, the slate should be exfoliated easily and should be free from minerals like iron sulphides or carbonates which in time could cause corrosion and staining on roofing tiles. For cladding or flooring purposes, the slate should be able to bear the cutting processes for required sizes, polishing or smoothening process by machines and should not peel off during the process of fixing or laying. Bureau of Indian Standard has laid down Standard IS: 6250-1981 (First revision; reaffirmed 2008) namely, specification for roofing slate tiles with respect to requirement of dimensions, physical properties and workmanship of slate tiles used for sloped roof covering.

2. Sandstone

Sandstone is a sedimentary rock largely made up of sand grains in size ranging from 2 mm to 120 mm of varying compositions. The sand may consist of grains of quartz, felspar and other detrital minerals with interstitial cementing material. The composition of sand particles and the cementing material by and large defines the colour of sandstone while the mode of formation decides the thickness of bed which gives rise to various types of sandstones.

The colour of sandstone may range from dark red to brown, earthy to buff, white, yellow and a number of other shades. The pattern of the sandstone depends upon the thickness of bed. Sandstone produced in the country is being marketed as Vindhyan Red, Rainbow, Teak, Modak, Bundi, Bansi Pink, Mandana, Dholpur Cream, etc. The sandstone may occur as massive, thick, non-splittable bands or thin beds or layers that can be split by applying slight pressure.

RESERVES/RESOURCES

Occurrences of sandstone in India are spread across Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Madhya Pradesh, Meghalaya, Mizoram, Karnataka, Odisha, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu and West Bengal.

The reserve/resource estimation has not been considered important because of its abundance and easy availability. Hence, there is no comprehensive inventory of sandstone. However, the Centre for Development of Stones (CDOS), a

'Government of Rajasthan Undertaking' has reported estimated reserves of sandstone at over 1,000 million tonnes in the country. Huge deposits of sandstone in Rajasthan are associated with Vindhyan and Trans-Aravalli Formations, exposed over an area of nearly 35,000 sq km covering districts of Dholpur, Bharatpur, Karauli, Sawai Madhopur, Tonk, Bundi, Jhalawar, Kota, Bhilwara and Chittorgarh. It is also found scattered in the districts of western desert plain in the districts of Jodhpur, Churu, Bikaner and Nagaur. Splittable sandstone deposits are confined to an area of 16,000 sq km, out of which 10,000 sq km lies in eastern and south-eastern Rajasthan and 6,000 sq km in western Rajasthan.

In Gujarat, fine to medium-grained sandstone of varying colours ranging from white, light-purplish, reddish-brown, cream to yellow are found in the district of Kachchh. A brownish-yellow sandstone occurs near Chabari and Mainapara in Bhachau tehsil. The sandstone at Rampur, Katada-Roha and Rajoda Dungar near Mangwana in Nakhtrana tehsil is cream coloured and is fairly hard. Extensive deposits are found around Songir, Naswadi, Ghautoli, Namaria and Lachharas in district Vadodara.

The Vindhyan and Satpura Mountains in Madhya Pradesh have vast resources of sandstone. The red, cream and white sandstone are being quarried extensively in Panna and Shivpuri districts and in many areas near Jabalpur.

In Uttar Pradesh, sandstones suitable for making slabs and tiles are located in Agra, Mirzapur, Lalitpur, Allahabad and Sonbhadra districts. The sandstone of Lalitpur district is yellow, light green and maroon and takes good polish. The sandstone in Lalitpur occurs in Madanpur and Rampura (near Deogarh) areas and is traded under the commercial name Royal Gold, Beach Sand and U.P. Green. The sandstone of Agra occurring in Tatpur area is red and mottled and is used for interior as well as exterior flooring and cladding. In Mirzapur and Sonbhadra areas, good quality buff to pale and creamish sandstone is available.

The felspathic sandstone occurring with the coal seams as overburden is also used as building stone. The Kamthi Sandstone occurring in and around tehsil Saoner, district Nagpur in Maharashtra is being quarried and is used as building stone.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are given in the review on "Exploration & Development" in "General Reviews".

PRODUCTION

Sandstone being a 'Minor Mineral', its production data is not available with IBM.

MINING & PROCESSING

Mining of sandstone is generally done manually by using hammers and chisels of various shapes. The overburden is removed which is in the form of soil, rubble or non-splittable sandstone. The hard non-splittable sandstone is then drilled and blasted to expose the underlying splittable sandstone. But, with the advent of sandstone cutting and polishing machines, this operation is also executed carefully to obtain Khandas or blocks for further processing in the form of slabs.

In conventional mining, the natural vertical joints present in the range from 0.6 m to 60 m is an advantage. The initial quarrying starts from these joints. After making the initial cut, blocks having 1.2 m width, 3 to 4 m length and thickness up to the nearest cleavage plane are removed. The quarrying operation in Rajasthan has gone to the depth of 50 m.

In the absence of joints, a jhiri is opened in a line by drilling closely spaced (about 15 cm apart) oblong or eye-shaped holes (duggis) of

about 8 to 10 cm depth and the eye-shaped steel wedges (Gullas) are hammered in these holes by expert miners. The continuous hammering develops a crack along the holes. The mining starts from these blocks. The required length and width of the slab to be obtained are marked and cut accordingly using the same technique of wedging. The splitting of individual slab is carried out using natural bedding plane by inserting sharp wedges or by hammering alone.

A majority of quarry owners produce hand-dressed slabs and tiles in different thicknesses. But in the export market normally machine-cut tiles are in demand and the simple edge cutting machines with single or double cutters are used for getting machine-cut tiles. The further requirement of tiles in 10 to 12 mm thickness with one side natural and other calibrated has resulted in establishing cutting and polishing units of sandstone. In Rajasthan, there are four units engaged in the production of polished sandstone tiles measuring 30 x 30 x 1 cm and 40 x 40 x 1.2 cm. The sandstone is also exported with natural, honed and polish-finishes. BIS has prescribed IS:3622-1977 (First Revision, reaffirmed 2003) as the specifications for sandstone slabs and tiles.

3. Dimensional Limestone

The limestone which is used as a dimension stone differs from the limestone used for cement making or for any other industrial purpose in two ways: firstly, chemical composition and secondly, the mode of occurrence. In both the types, the major constituent is calcium carbonate. but, very high silica content gives limestone sufficient hardness to be utilised as a dimension or building stone. The industrial limestone occurs as massive formation with less intercalations while in case of dimensional limestone, thin-bedded deposits are preferred. Limestone which is compact and amorphous in texture is known as flaggy or splittable limestone and is quarried in the form of thin slabs ranging in thickness from 12 mm to 50 mm in ready-to-use form .

Limestone has been used since ancient times for construction of houses, flooring and for various other building purposes. In recent times, the use of limestone has increased manifold mainly in interior flooring, cobble stones and for decorative purposes in combination with other stones because of its various colours and shades. Depending upon the place of origin of limestone and its colour, various types of nomenclatures have been used in the trade for limestone, such as, Kadapa Stone, Shahabad Stone, Kota Stone with different shades and colours (Kota Blue, Kota Brown, etc.), Kachchh Stone, Miliolitic Limestone, etc.

OCCURRENCES

Occurrences of dimensional limestone have been reported from various states such as Shahabad Stone of Vijapura, Kalaburagi and Belagavi districts in Karnataka; and 'Kadapa Stone' of Kurnool, Anantapur and Guntur districts and 'Tandur Stone' of Kadapa district, Andhra Pradesh, etc. Other coloured well-known limestones are from Betamacherla, Tadipatri, Macherla, Nereducherla and Muddimanikyam. 'Milliolitic Limestone' from Saurashtra region, 'Yellow Limestone' of Kachchh district of Gujarat, 'Kota Limestone' of Kota district and 'Yellow Limestone' of Jaisalmer district, Rajasthan are the other prime localities of dimensional limestone occurrences in India.

Rajasthan is richly endowed with the occurrence of greenish-grey 'Kota' limestone. The Kota stone has gained tremendous popularity and is widely used for flooring and cladding purposes. The important deposits of limestone are in Kota, Jhalawar, Chittorgarh.

and Jaisalmer districts, Rajasthan. Kota, Jhalawar, and Chittorgarh are the major producing districts of the dimensional limestone in the state. Extensive limestone deposits are found in the Upper Stage of the Lower Vindhyans, represented by limestone which has a good potential as cement-grade limestone as well as flooring stone. Certain portions of the limestone having splittable form are used extensively as flooring stones. The limestone occurs in a north-south belt from Dalla-ka-Khera to Nimbahera and extends into Madhya Pradesh covering a distance of about 70 km. It is fine-grained, thinly bedded and has a total thickness of about 150 m. At few places, the major portion of the limestone deposit is suitable for cement making but there are pockets, containing splittable forms that can be used for building and flooring purposes directly.

Yellow limestone deposits of Jaisalmer: The yellow limestone of Jaisalmer is of Jurassic age and is found in Bada Bag, Mool Sagar and Kanod villages of Jaisalmer. It contains 42 to 51% calcium oxide and has a thickness of about 3m. It is quarried in the form of blocks and can be sawed into slabs and tiles. It is also termed as yellow marble as it takes reasonably good polish.

Flaggy limestone deposits of Jhalawar and Ramganjmandi, Kota area: It belongs to Lower Vindhyan Group and is available in plenty at Sarola Kotri Chitawa and Khokhriya-Khurd. Extensive deposits are available near Ramganjmandi, Aroliya and Parolia areas. Ramganjmandi and Jhalawar Road are the main railway stations from where the splittable limestone produced is dispatched to various parts of the country. In the last few years, export market of this limestone which is popularly known as 'Kota Stone' has also been developed.

MINING AND PROCESSING

Although the mining methods as well as the processing of limestone have changed over the years, still there is a scope for improvement in mining techniques. Simultaneously, the handling of waste and utilisation of waste rock is equally essential.

The mining of Kota Stone is carried out by opencast manual methods or by semi-mechanised methods. The Kota Stone is found in the form of natural thickness ranging from 12 to 150 mm or even more. The mined out slabs are cut to size by using hammer and chisel. Diamond saws are used to cut the tiles in required thicknesses and measurements. Tiles of Kota Stone are available in various size and thickness to suit the requirement of different building projects. This stone has a good market potential.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are given in the review on "Exploration & Development" in "General Reviews".

USES & SPECIFICATIONS

Application of Kota Stone ranges from interior flooring, wall cladding to exterior use in paving and facades for building of all kinds and types.

The Kota Stone has a natural split non-slip surface. Massive, dense and fine-grained varieties are generally durable as these are not porous. These are tough and have a crushing strength of 17.8 kg/mm^2 and a high compressive strength of over 2189 kg/cm^2. Abrasion value of Kota Stone is 18.12 to 18.32 and it has a high resistance to delamination and failure under freezing and thawing conditions.

Bureau of Indian Standards has prescibed Specification for Limestone (Slab & Tiles) as IS : 1128 - 1974 (First Revision, reaffirmed 2008).

4. Other Dimensional Stones

In addition to the dimension stones already described, other dimension stones are being quarried and used for the construction of houses and other building purposes.

In Odisha, Karnataka, Goa and in parts of coastal states, laterite is quarried in huge quantities. It is utilised as bricks in the construction of houses and pavements.

Huge deposits of basalt in Maharashtra, Karnataka and Gujarat are used as building stones since ancient times. Quartzite bands occurring along with phyllite schists are also utilised for building purpose.

In addition, stone aggregates, such as broken and sized pieces of limestone, dolomite, quartzite and sandstone are mixed either with cement for building and road-making purposes or with asphalt for mending road. To utilise the huge waste generated during mining and processing, a new variety of man-made stone 'Terrazo'' has been developed, which is composed of stone chips set in cement, epoxy or polyacrylate and then polished. The Terrazo is an economical alternative to solid marble slabs or tiles.

5. Felsite

Felsite is a fine, evenly grained acid or intermediate igneous rock, usually occurring as dykes and veins in country rocks and in the parent plutonic mass. BIS has prescribed the specification IS:10874-1983 (reaffirmed 2010) for felsite grinding media and liner stones. Felsite has architectural, industrial and antiquity uses. As per GOI Notification S.O.423(E), dated 10.2.2015, felsite has been declared as 'Minor Mineral', hence the production beyond January, 2015 is not available with IBM. However, the production value of felsite was provisionally estimated at ` 13.01 crore during 2015-16.

TRADE POLICY

As per the Export-Import Policy announced for the period 2015-20; and the Foreign Trade Policy thereunder, the imports of slate blocks or slabs whether or not roughly trimmed or merely cut are restricted under heading no. 2514.

Import of crude or roughly trimmed/cut blocks or slabs of sandstone and other monumental or building stones; viz, pakur stone, stone boulders, and others, are restricted under heading no. 2516. However, sets of curbstones and flagstones of natural stone (except slate) under heading no. 6801 and worked monumental building stone (excluding slate), tiles, cubes and similar articles of natural stone including slate, under heading no. 6802 can be imported freely. Worked slate and articles of slate or of agglomerated slate under sub-heading 6803 can also be imported freely. Exports of stone aggregates which are restricted under Chapter 25 of ITC (HS), 2015-20, Schedule 2-Export policy, are permitted to be exported to Maldives subject to ceiling limits. The limits are 5.5 lakh tonnes and 6 lakh tonnes for the years 2015-16 and 2016-17, respectively. The annual ceilings are monitored by CAPEXIL subject to exporters obtaining appropriate clearances.

FUTURE OUTLOOK

Slate is mostly used as a roofing material, but other uses like cladding and flooring tiles are also gaining momentum. Slate occurs widely in the country and detailed study has to be conducted to quantify the resources. The demand for dimension stones including sandstone & others and stone products is anticipated to grow at around 15%. A similar growth is also expected in exports.

The demand for artifacts, especially carved work is on the rise all over the world. India with its rich tradition of craftmanship and trained artisans can embark upon the world market.

Improved quarrying, finishing and hauling technology, availability of greater variety of stones and the rising cost of alternative construction materials are among the factors that suggest a consistent increase in demand for dimension stones in future.