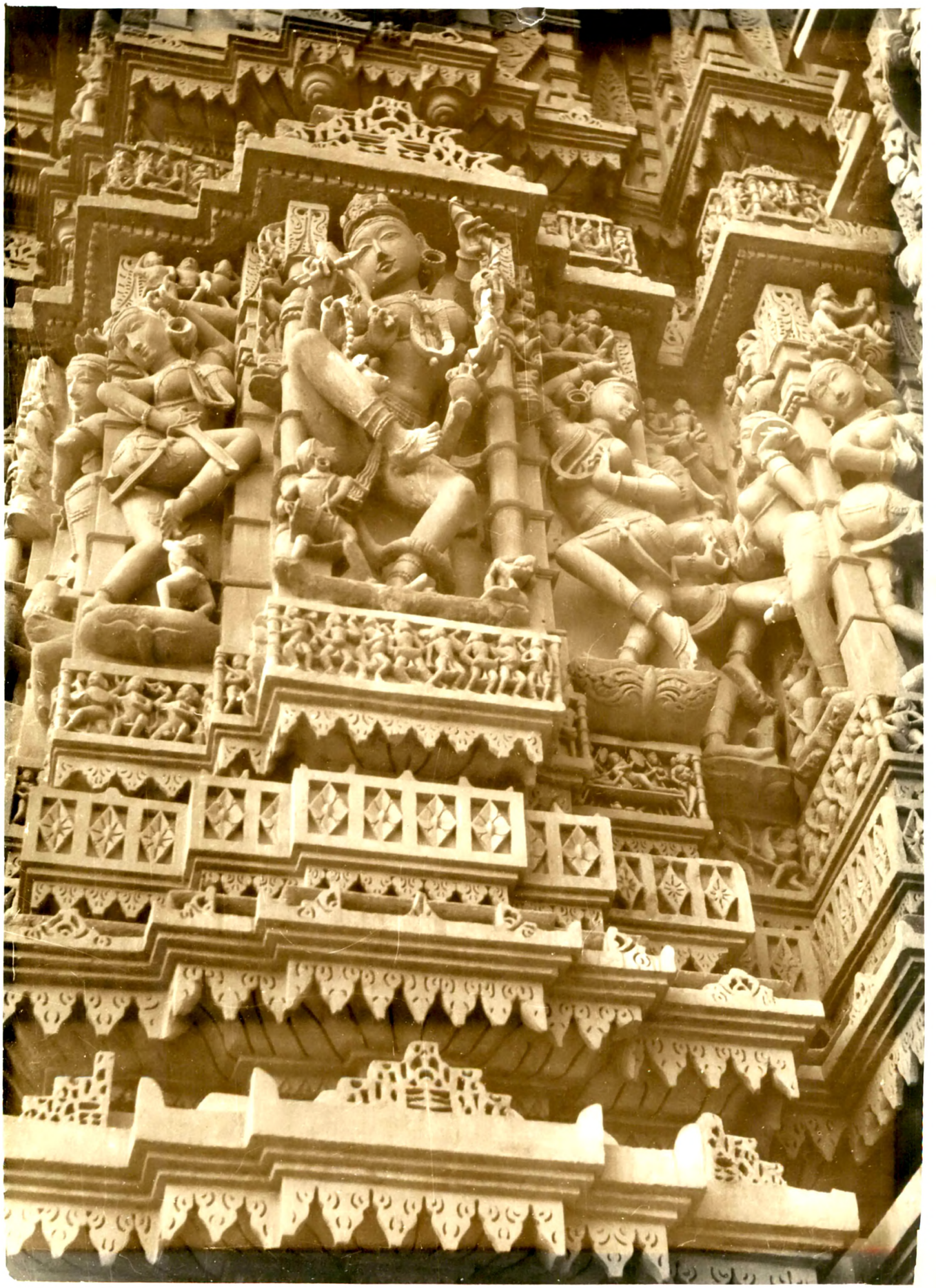

CHAPTER V

SANDSTONE AS DIMENSION STONE

Sandstone has been used since antiquity as constructional, ornamental and memorial stones. Sandstone is admirably suited for building work. From rude stone-knives and scrapers of pre-historic man to the beautifully carved monoliths of recent days sandstone has served the mankind through a great variety of uses.

Many historical structures were constructed using sandstone. In Madhya Pradesh well known Khajuraho temple was constructed with the help of buff coloured sandstone

in 10th Century A.D. In Tamilnadu ancient temple of Rameshwapuram was built from sandstone of Ramnathapuram district. In Orissa, famous Jagnaath temple as well as ancient temple of Bhubhneshwar were constructed with sandstone only. Upper Vindhyan sandstone of Rajasthan was used in ancient fort of Jodhpur city. Vindhyan sandstone from Chunar, Mirzapur, Fatepur Sikri in U.P. provided excellent building material since historical times. Even today we can see the famous Ashoka pillar in Sarnath which is 2200 year old. Juma Masjid, Qutub Minar and the Red fort in Delhi, Red fort and part of Taj Mahal in Agra and Akbar's Palace in Fatepur Sikri were built of red, Vindhyan sandstone.

In Gujarat, large quantity of sandstone is available. Sandstone occurs in the districts of Sabarkantha, Kachchh, Panchmahals, Vadodara, Surendranagar and Rajkot (Fig. 5.1). Himatnagar sandstone (Sabarkantha district) was used in the construction of Taranga Temple, Mehsana district (Plate 5.1) in North Gujarat and in Sachivalaya of Gandhinagar. Dhrangadhra sandstone (Surendranagar and Rajkot districts) was used in the construction of Man Mahelat palace of Dhrangadhra. Songhir sandstone (Vadodara district) was used in the construction of Kirti Mandir and Laxmi Vilas palace

at Vadodara. Bhuj sandstone (Kachchh district) is also very popular as building stone.

GEOLOGICAL SETTING

Sandstone is available in the following geological formations in Gujarat State.

Deccan Trap	Cretaceo-Eocene	
Bagh beds, Lameta Beds	Upper Cretaceous	Mesozoic
Wadhwan Sandstone	Mid. Cretaceous	Mesozoic
Himatnagar sandstone, Nimar sandstone, Dhrangadhra sandstone, Umia and Bhuj (Bhuj sandstone) series	Cretaceous	Mesozoic
Katrol, Chari, Patcham Series	Jurassic	Mesozoic
Erinpura Granite	Post Delhi Intrusive	Pre-Cambrian

DISTRIBUTION

In Kachchh district sandstone occurs in Jurassic and Cretaceous rocks, around Bhuj, Madhapur, Nakhtrana, Anjar

and Meghpur. In general these sandstones are fine grained, soft to fairly hard and varies in colour from white, light purplish, reddish brown, cream to yellow.

Jurassic sandstone mainly occurs in Patcham, Chari and Katrol series while cretaceous sandstone mainly occurs in Umia series and Bhuj series. This sandstone is a very popular as building stone.

Sandstone of Sabarkantha district is well known as Himatnagar sandstone. Large quantity of this sandstone is quarried near Panpur, Parbado and Himatnagar. This sandstone varies in colour from white to light pink. There are several bands of shale in this sandstone which are pink in colour. But some bands are white or show different shades of yellow, purple, pink, red and brown colour. These sandstones form lowlying, rather flat topped hillocks. In soil covered areas it is exposed in the sections of river nala and wells. These sandstones are horizontally bedded and are lower Cretaceous in age.

In Vadodara district sandstones mainly occur near Naswadi, Ghantoli, Namaria and Songhir. This dirty white to reddish white sandstone, equivalent to Nimar sandstone of Upper Cretaceous in age, is well known as Songhir sandstone.

In Surendranagar district, sandstones occurring near Dhrangadhra, known as Dhrangadhra sandstone is equivalent to the Umia bed of lower Cretaceous age. This sandstone is soft and yellow with white specks of kaolinised felspar, ferruginous concretions and intercalations of carbonaceous shales. The upper beds consist of gritty sandstone of purple or dark colour with layers of conglomerate. Dhrangadhra sandstone is overlain by Wadhwan sandstone exposed near Wadhwan city. Wadhwan sandstone is brick red in colour and less compact as compared to Dhrangadhra sandstone and often locally disturbed.

In Panchmahals district, horizontally bedded sandstones occurring SE of Pavagadh hill, are equivalent to Nimar sandstone. They are composed of conglomerate, gritty sandstone with porcelainic jasperoid bands uncomformably overlying Aravalli schist and phyllite. This sandstone is almost horizontal and is pinkish in colour.

In Rajkot district, Dhrangadhra sandstone occurs near Morvi. This sandstone is horizontally bedded and fine to coarse grained. Conglomerate, sandstones and

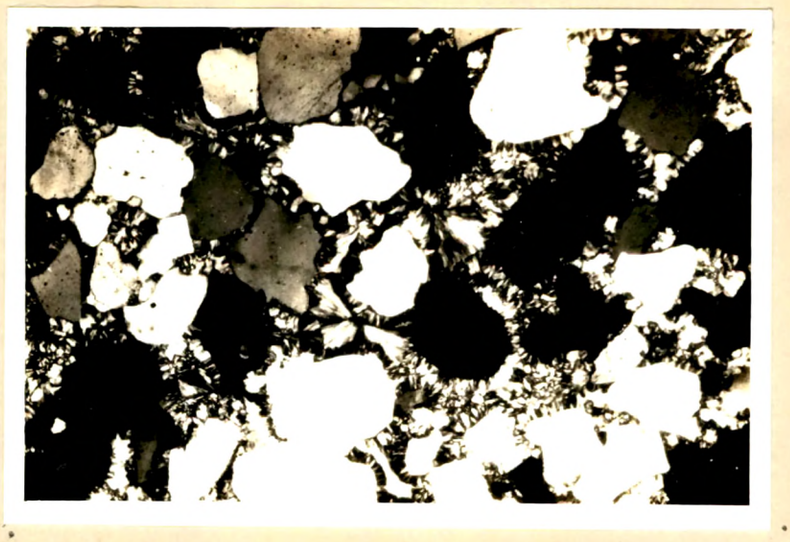

Plate 5.2: Photomicrograph of medium grained Sandstone showing siliceous matrix (Crossed Nicols, X50).

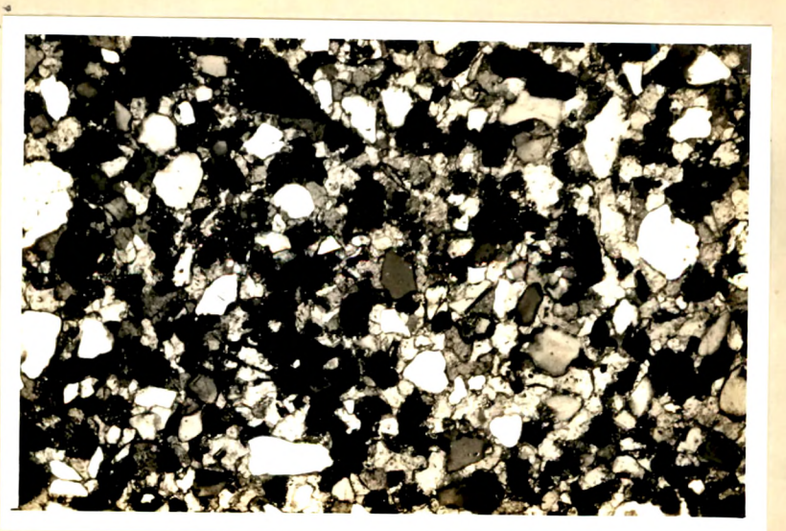

Plate 5.4: Photomicrograph of fine grained Sandstone showing calcareous matrix (Crossed Nicols, X50).

shales are intercalated with thin bands of coal, clay and ironstones. This sandstone grades from shales with layers of earthy hematite to brick red highly ferrugenous sandstone and often exhibit current bedding and ripple marks.

PROPERTIES

Sandstones from Himatnagar (Sabarkantha district), Bhuj (Kachchh district), Songhir (Vadodara district) and Dhrangadhra (Surendranager district) are most popular and commonly used as dimension stones.

Himatnagar sandstone: It is almost horizontally bedded. Cross bedding and graded bedding are very common. It shows different colour shades of pink, chalky white, red and brown, however, the dominant colour of the stone is chalk white. No separate quarrying of individual colour variety is made. The rock is medium to coarse grained. It is composed of quartz with silica as cementing material (Plate 5.2). In general rock is hard, compact and medium grained.

Songhir sandstone: The rock is white, cream and reddish brown. Cross bedding is common and rock is almost horizontally bedded. The rock is medium to coarse grained.

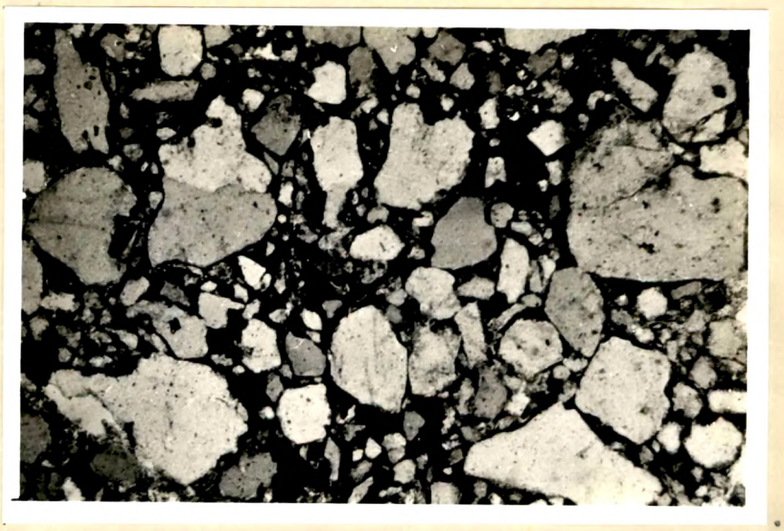

Plate 5.3: Photomicrograph of medium grained Sandstone showing ferruginous matrix (Crossed Nicols, X50).

Plate 5.5: Sandstone quarry, Dhrangadhra, Surendranagar district.

However, in general it is hard, compact and medium grained. It is composed of quartz with silica as cementing material.

Bhuj Sandstone: The rock is fine to medium grained and almost horizontally bedded. It is light purple to reddish brown. This rock can be very easily dressed as it is very soft, because it contains quarry-sap when this rock is in quarry. After its exposure to open air, it becomes hard. It is more or less friable in nature. It consists of quartz grains and are cemented by ferruginous matrix (Plate 5.3).

Sandstone occurs near Nakhtrana and Rapar are composed of quartz grains and are fine to medium grained in nature. Some fine grained sandstones are cemented by calcareous matrix (Plate 5.4).

Dhrangadhra Sandstone: This fine grained to coarse grained sandstone is white, light grey and with shades of yellow. This sandstone is hard, compact and massive. It consists of quartz grains and are cemented by sliceous matrix.

Engineering properties of various sandstones are tested and shown in Table 5.1.

Sandstone consists of sands grains, commonly quartz, more or less cemented by a matrix of other minerals. Sandstones often have widely spaced joints and beddings. Weathering of sandstone consist largely of attack on the cement and removal of the support for the sand grains. The cementing minerals may be removed or altered but if they consist of silica minerals the sandstones are little affected. Calcareous sandstones are largely affected by solution and because of initial porosity, solution goes to great depth. Clay matrix sandstones weather by breakdown and eluviation of clay. Iron oxide cements are altered to hydroxides. There is often migration of iron within the sandstone to form concretions or other accumulation.

Sandstones generally has high water absorption so plenty of water is absorbed. The variations in porosity make lines of weakness for physical weathering.

Crumbling sandstone, weakened by weathering, should be impregnated with a hardner in order to prevent further disintegration. Weathering of sandstone mostly consists of removal of cement. Silicification by treatment with organic silicates appears to be most appropriate because they form a natural and most efficient bond with the quartz grains of the sandstone. Potassium silicate and ethyl

silicate chemicals are being used to form silica bond with quartz grains. Epoxy resins and polysters are also being used as hardner for better mechanical bond in sandstone (Schmidt, 1969; Frankline, 1969).

However, weathering of sandstone is very less and normally sandstone is a very good building stone. In cold countries only weathering due to frost action may take place.

QUARRY METHOD

All the existing quarries of Sandstone are shown in Fig. 5.1 and list of quarries is given in Table 5.2. Normally all quarries of sandstone are approachable in all seasons by motorable road or cart truck but during monsoon in some of the quarries water form a pool which make quarry operation difficult.

In Gujarat State quarry method which is very simple and also manual, is carried out with only chisel, hammer, steel bar and wedges.

First step in quarrying is the removal of overburden which is generally very less. At places sandstone is exposed on the surface only. Stripping of overburden is

Plate 5.6: Sandstone quarry, Himatnagar, Sabarkantha district.

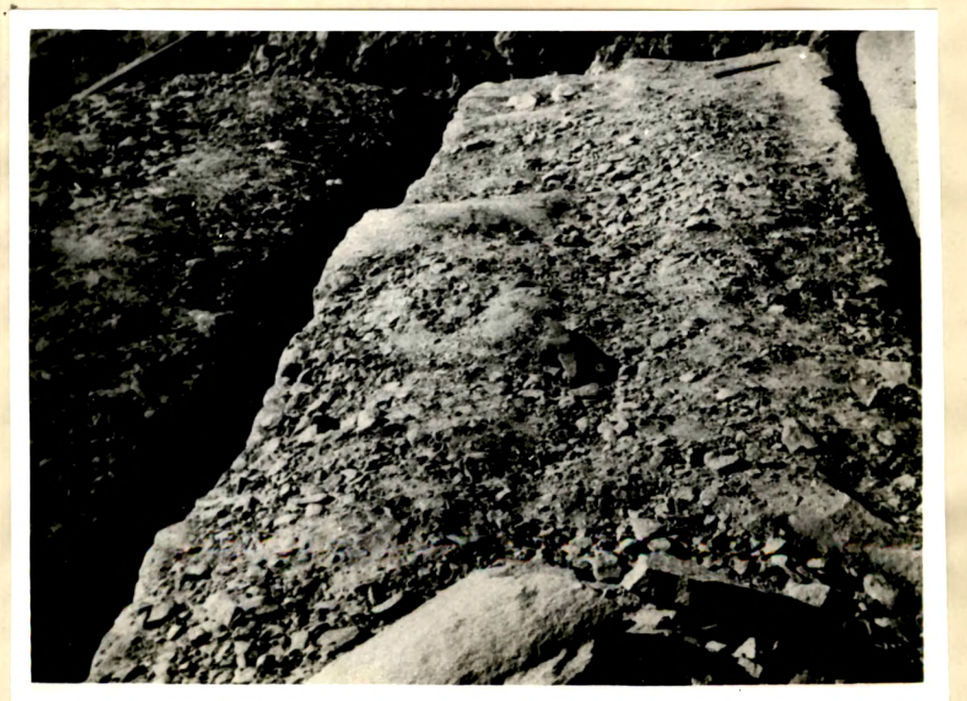

Plate 5.7: Sandstone quarry, Bhuj, Kachchh district.

carried out with shovels as there is no need of bulldozer or such other heavy equipment. After removal of overburden holes are drilled with chisel and hammer and at places with steel bars for primary cut. Holes are drilled upto a depth of 1 to 1.5 m. At many places they are using gun powder for blasting holes. At places separation of block from parent mass is done with drilling and broaching method in which wedges are driven with hammer. After that, bed lifting is done to separate blocks from the bottom (Plate 5.5). After separation of blocks from parent rock mass preparation of required size blocks and dressing is done at the quary site (Plate 5.6).

However, at Bhuj, quarry method is different from other sandstone quarries. This method is somewhat systematic and easy one. Bhuj sandstone contains quarry sap because of which sandstone remain wet and soft when it is in the natural position. When they have been cut and placed outside they become dry and hard. Quarry water or quarry sap containing mineral substances like silica,when evaporates deposited as a cement between the grains, increasing the hardness of the rock, especially at the surface.

After removal of overburden, channel is cut with an axe in the rock which is soft when wet due to quarry sap.

The size of block for making channel is 10 m long and 2 to 3 m broad (Plate 5.7). Then with the help of chisel type of tool, which is locally known as 'Hiss' cuts are made and the blocks are separated from the parent mass. Even iron bars are also used for separating the block from parent mass. For bed lifting, wedges are driven with the hammer and lifting 4 to 5 wedges at one time. After separation of the block, small blocks are prepared according to the size of consumers' demand with the help of chisel and hammer at the quarry site only.

In most of the sandstone quarries water table reached after a depth of 5-7 m which make quarry operation difficult. However, at present there is no arrangement to take out this water from quarry. This water can be removed from the quarry with the help of pumps which will increase the production.

Thickness of bedding planes play an important role in size of blocks. The occurrence of two sets of joints are of great assistance in quarrying. In most of the quarry sites, joints are not closely spaced and are advantageous for quarrying dimension stones. Joint spacing varies from 0.2 to 3 m which gives good quarry yield wastage is very less.

Quarry operation can be mechanised with the help of wire saw equipment which will be helpful for increasing the production.

Plate 5.8 : Photograph of Morvi Palace (Rajkot district) made up of Dhrangadhra Sandstone.

USES

In Gujarat, sandstone is mainly used as building stone however, it is also used as monumental stone in temples, which are easily carvable. Statues are made from sandstones. Himatnagar sandstone is mainly used as building stone, kilometer stone, boundary stone, guard stone veneer etc. Sandstone from Vadodara district is mainly used as grinding stone however it is being used as paving and curbing stone and the quarry waste is used as road aggregate and railway ballast. It can be used as building stone even today. Drangadhra sandstone is used as guard stone, building stone, carved and dressed stone for decorative purpose. This sandstone was used in the construction of Morvi Palace, Morvi (Plate 5.8). Wadhwan sandstone is soft and is locally used as building stone. This is not much useful for large structures as it is very driable in nature. Bhuj sandstone is popular as a building stone.

Table 5.1 : Engineering Properties of Sandstone.

Sr. No.	Location	Compressive Strength Kg/cm^2	Water Absorption %	Specific Gravity
		IS 1121: Part I - 1974	IS 1124-1974	IS 1124-1974
1.	Bhuj (140)	120	10.4	2.06
2.	Nakhtrana (143)	253	3.57	2.41
3.	Rapar (145)	580	9.0	1.85
4.	Vankaria (149)	1065	0.5	2.68
5.	Sultanpur (150)	224	0.7	2.48
6.	Panpur (152)	108-352	5.98-7.37	2.0-2.25
7.	Dhrangadhra (156)	179-245	0.47-1.30	2.42-2.48
8.	Ghantoli (165)	1032	1.5	2.45

Table 5.2 : List of Sandstone Quarries (Fig. 1.2)

District		Location
Kachchh	(135)	Adoi
	(136)	Akri
	(137)	Anjar
	(138)	Bharapar
	(139)	Bhachau
	(140)	Bhuj
	(141)	Chobari
	(142)	Madhapur
	(143)	Nakhtrana
	(144)	Netra
	(145)	Rapar
	(146)	Sumarasar
	(147)	Vadjhar
	(148)	Zuran
Panchmahals	(149)	Vankaria
Rajkot	(150)	Sultanpur
	(151)	Wankaner
Sabarkantha	(152)	Panpur
Surendranagar	(153)	Chamraj
	(154)	Chotila
	(155)	Dasada
	(156)	Dhrangadhra
	(157)	Halvad
	(158)	Khodu
	(159)	Muli

contd...

Table 5.2 (contd.)

District		Location
	(160)	Sadala
	(161)	Sayala
	(162)	Thangadh
	(163)	Umrada
	(164)	Wadhwan
Vadodara	(165)	Ghantoli

Plate 6.1: Somnath Temple (Junagadh district) made up of Miliolite Limestone.