CHAPTER VI

LIMESTONE AS DIMENSION STONE

Gujarat has vast resources of limestone. It is an important raw material used in metallurgical industries, chemical industries, manufacture of cement, manufacture of building lime and as building stone. The demand for the limestone as a raw material for industries is steadily increasing and its utilization as building stone is gradually decreasing.

Limestone, is a dimension stone includes pure and impure limestones much as magnesium limestone or dolomite. Compact, dense and relatively pure microcrystalline

Plate 6.2:

Kirti Mandir, Porbander (Junagadh district) made up of Miliolite limestone.

Plate 6.3: Close view of Kirti Mandir (Junagadh district).

varieties of recrystallised limestone and marble capable of taking polish are not included in this.

Miliolite limestone of Saurashtra coast is popularly known as 'Porbandar Stone'. 'Porbandar stone' is used as a building stone in many historical buildings such as Somnath temple at Veraval (Plate 6.1) and Kirti Mandir at Porbandar (Plate 6.2 and 6.3).

In Gujarat, limestones occur at different places in various stratigraphical horizons. Quarrying of limestone for dimension stone is carried out in districts of Junagadh, Jamnagar, Amreli, Kachchh, Rajkot, Panchmahals, Kheda, Sabarkantha and Bhavnagar (Fig. 6.1).

GEOLOGICAL SETTING

The stratigraphical sequence of limestones in Gujarat State is as follows:

Kankar	Recent
Miliolite Limestone	Pleistocene
Dwarka (Limestone)	Pliocene
Gaj beds (Limestone)	Oligocene
Kirthar-Laki (Limestone)	Eocene

Deccan Trap	Cretaceo-Eocene
Lameta beds (Limestone), Bagh beds (Limestone), Wadhwan sandstone	Cretaceous
Umia and Bhuj series	
Dhangadhra sandstone, Himatnagar sandstone, Katrol, Chari, Patcham (Limestone) series	Jurassic
Erinpura Granite	Post Delhi Intrusive
Calc gneisses, quartzite, marbles	Delhi system
Dolomitic limestone, Quartzite and phyllites	Aravalli system
Banded Gneissic Complex	Archean

DISTRIBUTION

Out of all the limestones available in Gujarat State only miliolite limestone of pleistocene age and Lameta limestone of Cretaceous age are used as dimension stone.

Miliolite Limestone occurs along the coast of Saurashtra, in island region of Saurashtra and Kachchh district. In Saurashtra it occurs in the districts of Rajkot, Surendranagar, Junagadh, Jamnagar, Amreli and Bhavnagar. It occurs in long, but discontinuous belts from Gopnath, South of Talaja to Miani near the mouth of Sani river, northwest of Porbandar. In the inland region of Saurashtra it occurs upto Chotila hills in Surendranagar district. These rocks either overlie Tertiary rocks or rest directly over trap of Cretaceous-Eocene age. They are well stratified and horizontal to subhorizontal. At places the amount of dip is upto 30°. Dip direction varies from south to southwest and at places it is north-east. Miliolite limestones are white to buff coloured and arenaceous in character. They are composed of the remains of Foraminifera of Miliolidae family (Plate 6.5). There is a controversy regarding their origin. However, it is found that some miliolite limestones are deposited under marine environments specially on coastal tract while others are deposited under aeolian environments specially as inland deposits. At present, quarries for dimension stone are mainly operated in districts of Junagadh, Rajkot and Jamnagar. However, smallquarries are operated throughout these deposits.

Plate 6.4 : Photograph showing cross stratification in Miliolite Limestone, Dungarpur quarry, Junagadh district.

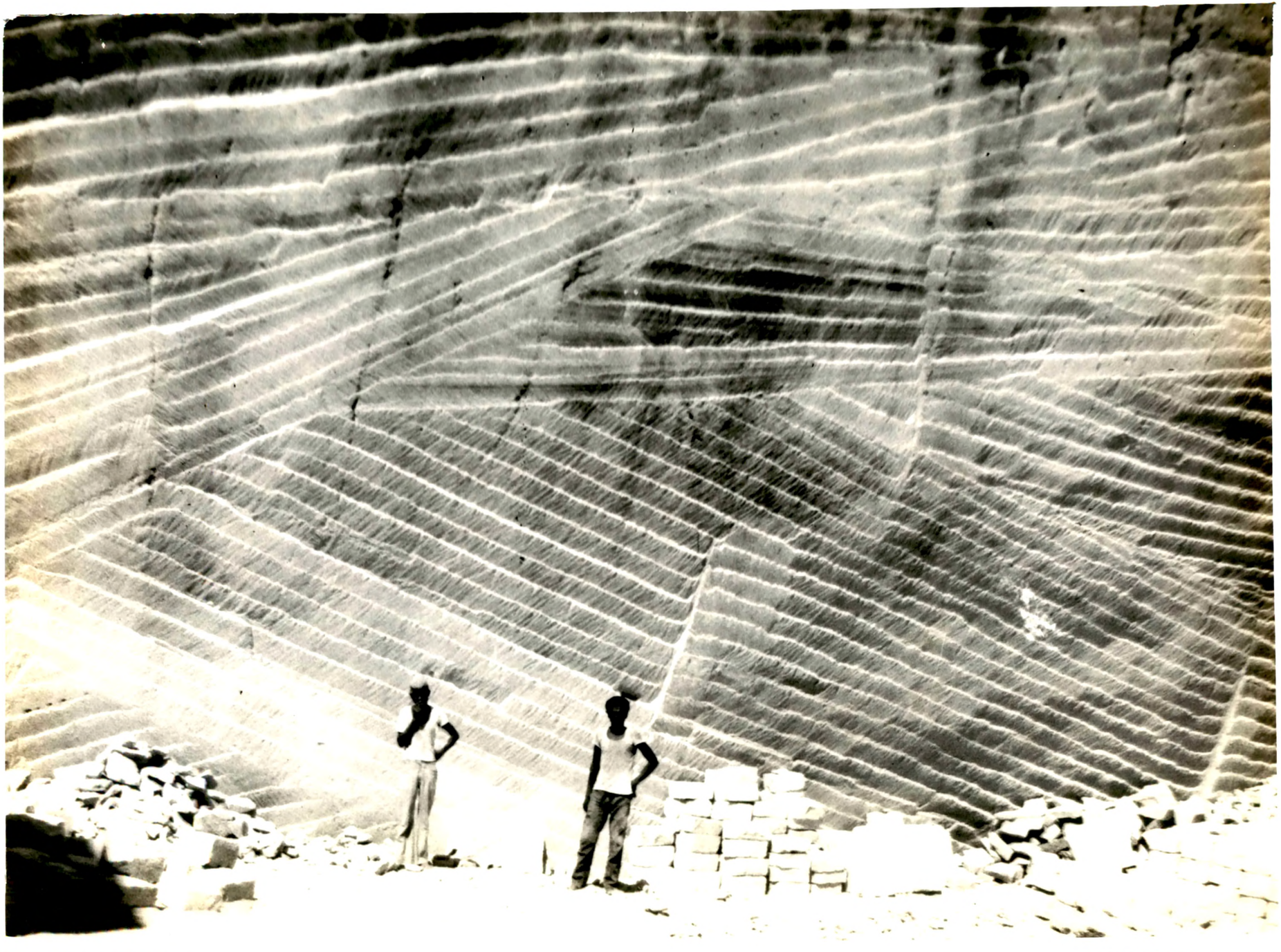

Plate 6.5: Photomicrograph of Miliolite Limestone (Crossed Nicols, X50).

Plate 6.6: Miliolite limestone quarry, Madhavpur, Junagadh district.

Lameta limestone occurs in Kheda, Panchmahals and Sabarkantha districts. This fresh water deposit occurs below trap at about same horizon or slightly above that of the Bagh beds of the Narmada Valley. Cherty and chalcedonic stringers, derived by solutions from overlying Deccan Trap commonly occur in these limestones. The limestone is mottled with limonitic spots and blotches. In thickness, these vary from few metres to 15 metres. At present these limestones are quarried at Parbia and Balasinor (Kheda district); around Dahod (Panchmahals district), and at Gabat (Sabarkantha district).

PROPERTIES

Miliolite limestones are white to buff in colour and arenaceous in character (Plate 6.5). This limestone is amenable to cutting and dressing and is easily carvable. The thickness of bedding planes varies from 15 to 20 cm. Miliolite limestone shows cross stratification in quarry section (Plate 6.4). These cross stratifications are direction of quarrying. Quarrying generally carried out against dip direction. It is noteworthy that this rock maintains a fairly good uniformity in its composition and texture. CaO content varies from 50 to 60%. This limestone

is of super-grade (Kulkarni, 1968). Its use as dimension stone should be restricted as it is very important raw material for chemical, metallurgical and cement industries. However, Miliolite limestone having CaO content less than 50% should be used as dimension stone. At present there is no such selection criteria.

Engineering properties of limestone are given in Table 6.1. This rock is weak to very weak according to Hawkes and Mellor (1970) (Appendix A). However, this stone is normally used as building stone where weight of structure is not more. This rock can be safely used as building stone. Water absorption of limestone is very high which results into pitting due to weathering. Lameta Limestone is medium strong to strong according to Hawkes and Mellor (1970) (Appendix A). It is notably impervious to moisture as water absorption is very less.

This stone because of its composition and texture is easily attacked by carbonation and sulphation resulting into chemical weathering.

All surface waters including rainwater, on dissolving CO_2 from the atmosphere become carbonic acid. This acid when reacts with limestone gives rise to calcium-bi-carbonate

which is easily soluble in water and thus accelerates weathering.

$$H_2O + CO_2 \longrightarrow H_2CO_3$$

$$H_2CO_3 + CaCO_3 \longrightarrow Ca(HCO_3)_2$$

The sulphur dioxide present in the atmosphere of the industrial areas when dissolves in water becomes sulphuric acid. This acid when reacts with limestone gives rise to gypsum which overcomes the resistance of the rock and breaks up the surface layer.

$$SO_2 + (O) \longrightarrow SO_3$$

$$H_2O + SO_3 \longrightarrow H_2SO_4$$

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

Oxidation of ferrous carbonate due to weathering causes colour change from white to buff.

Lameta limestones are earthy to massive, fine grained and whitish with spots of brownish colour or tinge. Under the microscope, rounded or subangular grains of quartz are seen in calcareous groundmass. It contains 32 to 40% CaO

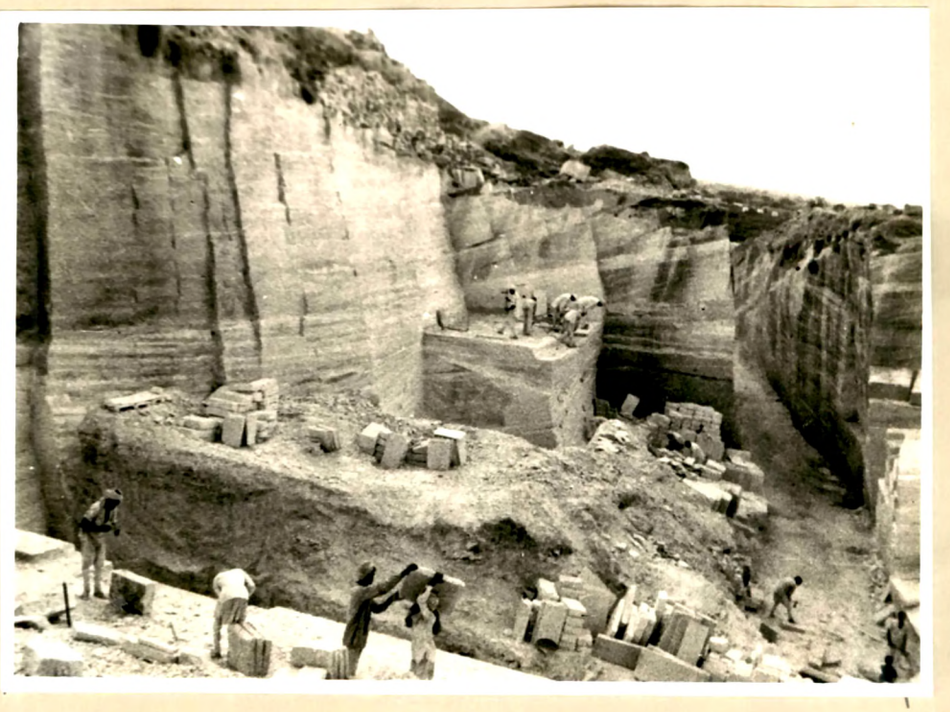

Plate 6.7: Miliolite limestone quarry, Ranavav, Junagadh district.

and 10 to 30% SiO_2. This limestone is of grade V and VI (Kulkarni, 1968). This limestone which is mainly used as guardstone, boundary stone and kilometer stone, is not much useful as building stone because it contains grains and pebbles of quartz as well as irregular concretions of pinkish chalcedony.

QUARRY METHOD

All the existing quarries of Limestone are shown in Fig. 6.1 and list of existing quarries is given in Table 6.2. All the quarries of limestone are approachable by motorable or cart truck road in all seasons (Fig.1.2).

The present author visited number of quarries in Junagadh district, which is having largest workable deposits of miliolite limestone. It has been found that quarry method is more or less the same. Aditiyana quarries near Ranavar (Plate 6.5), Madhavpur quarries (Plate 6.6) near Porbandar and Dungarpur quarries near Junagadh (Plate 6.4) are most productive.

Quarrying operations for taking out dimension stones from miliolite quarries are manual. The advantage is taken

of the bedding planes which are parallel to the rift direction. Height or workable depth of quarry is 25 metre. Bedding planes 15 to 20 cm in thickness, are taken advantage of in making steps for going upto the quarry site as well as in size of building stone. Miliolite when fresh, can be easily cut by axe and saw in any size and shape. The quarry-sap is advantageous in quarrying operations. This water containing mineral substances like silica and lime carbonate, evaporates when exposed to air. This results in 'case hardening' of miliolite limestone by deposition of silica in pores.

Overburden, if less than 15 cm, is removed by shovel. It is cavernous in nature from 0.5 to 2 m in quarry sections. After removing overburden and making the upper surface plane labourers make grooves with axe. Distance and depth of the grooves varies. Grooves are also made in the perpendicular direction so as to free the block in all direction except at the bottom.

Bed lifting or the separation of the blocks from the bottom is done by drilling holes with chisels and crow bars locally known as parai/kosh and subsequent use of wedges. Series of holes are drilled in which wedges are driven and hammered in succession until a floor break is

made. In this way a big block is separated and it is cut into blocks of desired size with the help of chisel, axe and hammer. Dressing of the individual block is made only at the quarry site with the help of chisel and hammer.

In case of Lameta limestone, quarry method is not developed for quarrying dimension stone. Chisel, hammer and iron bars are used for quarrying.

USES

Miliolite limestone is used as building stone in many historical buildings in Saurashtra. Miliolite limestone is at present used as building stone. This stone is popular in Saurashtra region and locally known as 'Bela' stone. 'Bela' is a building stone of 50 cm x 30 cm x 15 cm size. Thickness of this generally depends upon the thickness of bedding planes, which is normally 15 to 25 cm. Another popular product of Miliolite Limestone is 'Toda', which is of 70 cm x 30 cm x 15 cm size. Quarry waste can be used for lime burning.

Lameta limestones are mainly used as boundary, guard stone and kilometer stone. Its waste can be used as soft road aggregate. This waste can not be used in lime burning as it is siliceous in nature.

Table 6.1 : Engineering Properties of Limestone

Sr. No.	Location		Compressive Strength Kg/cm^2 IS 1121 : (Part I)-1974	Water Absorption % IS 1124-1974	Specific Gravity IS 1124-1974	Durability IS 1126-1974
1.	Alidar (Miliolite limestone)	(166)	39	8.97	1.96	-
2.	Gopnath(Miliolite limestone)	(174)	66	2.82	2.24	0.78/30 cycles
3.	Bhatiya(Miliolite limestone)	(178)	147	3.9	2.57	0.60/30 cycles
4.	Kalavad(Miliolite limestone)	(180)	20	14.51	1.87	0.42/30 cycles
5.	Aditiyana(Miliolite limestone)	(181)	46	10.90	2.65	0.78/30 cycles
6.	Dungarpur(Miliolite limestone)	(186)	71	10.91	1.6	-
7.	Kuchhdi(Miliolite limestone)	(191)	226	2.51	2.4	0.70/30 cycles
8.	Madhapur(Miliolite limestone)	(195)	105	4.99	2.23	0.03/30 cycles
9.	Porbander(Miliolite limestone)	(200)	217	5.67	2.65	0.79/30 cycles
10.	Roha Kotda(Miliolite limestone)	(207)	56	11.8	2.02	0.27/30 cycles
11.	Balasinor (Lameta limestone)	(208)	810	0.532	2.65	-
12.	Miralchedi (Lameta limestone)	(210)	180-1970	0.45-2.60	2.70	-
13.	Bamanbore (Miliolite limestone)	(211)	61	8.04	2.03	-
14.	Vasai (Lameta limestone)	(215)	694	0.29	2.70	-

Table 6.2 : List of Limestone Quarries (Fig. 1.2)

District		Location
Amreli	(166)	Alidar
	(167)	Chhara
	(168)	Devali
	(169)	Dolasa
	(170)	Ghantvad
	(171)	Govindpur
	(172)	Harmadin
Bhavnagar	(173)	Chogat
	(174)	Gopnath
	(175)	Mahuva
	(176)	Naip
Jamnagar	(177)	Bhanvad
	(178)	Bhatiya
	(179)	Chattar
	(180)	Kalavad
Junagadh	(181)	Aditiyana
	(182)	Chhaya
	(183)	Chorvad
	(184)	Delvada
	(185)	Devada
	(186)	Dungarpur
	(187)	Gosa
	(188)	Ishwariya
	(189)	Junagadh
	(190)	Kadarva
	(191)	Kuchhdi

contd...

Table 6.2 (contd.)

District		Location
	(192)	Khadiya
	(193)	Kutiyana
	(194)	Lati
	(195)	Madhapur
	(196)	Mangrol
	(197)	Miyani
	(198)	Oddadar
	(199)	Pata
	(200)	Porbander
	(201)	Ranavav
	(202)	Shapur
	(203)	Shil
	(204)	Una
	(205)	Veraval
Kachchh	(206)	Kotada
	(207)	Roha Kotda
Kheda	(208)	Balasinor
	(209)	Parbia
Panchmahals	(210)	Mirakhedi
Rajkot	(211)	Bamanbore
	(212)	Dhank
	(213)	Patanvav
	(214)	Wankaner
Sabarkantha	(215)	Vasai

Plate 7.1 : Kadana Dam (Panchmahals district) showing use of Quartzite as Rubble.