CHAPTER X

SUMMARY AND CONCLUSIONS

'Stone' has been used throughout the historic times as a major construction material for buildings, monuments etc. largely because it affords strength, durability, architectural magnificence and aesthetic grandeur. No other type of construction material combined all these qualities. Not all rocks can be used for such purposes and only certain rocks having specific properties are suitable as dimension stones.

The term 'Stone' is applied commercially to all natural rock material quarried or mined for constructional

or industrial uses. 'Construction stone' applies to rock material used without calcining or chemical processing for construction purposes such as buildings, monuments, roads, shaped and finished blocks, slabs, rough quarry blocks and crushed aggregates. Construction stones having wide variety of uses can be classified for all practical purposes into two main categories namely crushed and broken stone and dimension stone.

'Dimension stone' is a natural rock material that is quarried to obtain blocks, slabs or places as per size and/or shape specifications.

SCOPE OF WORK

State of Gujarat has vast resources of construction stones such as granite, deccan trap, sandstone, limestone, marble, quartzite, phyllite and slate. At the instance of Shri S.D. Desai the study of the dimension stones of Gujarat was taken up by the present author with a view to assess the dimension stone resources. A detailed and systematic account of the dimension stone resources of the state prepared by the present author includes classification of dimension stones into trade groups and also according

to the need of the stone industry. Physical, chemical and engineering properties of various stones are studied and recommendations are made for their proper utilization by the stone industry.

CLASSIFICATION OF DIMENSION STONES

The present author has modified the classification suggested by American Society of Testing Materials (1952) and Barton (1968) and has classified the Dimension stones of Gujarat into seven Trade Groups as follows:

1. Granite
2. Deccan Trap
3. Sandstone
4. Limestone
5. Quartzite
6. Marble
7. Phyllite and slate.

The present author has also modified the classification given by Currier (1960) and Barton (1968) and has classified the Dimension Stones of Gujarat according to their use by the stone industry into nine classes as

follows:

1. Building stone:
   (a) Rough construction
   (b) Dressed construction
   (c) Rubble
   (d) Ashlar
   (e) Veneer
2. Monumental stone
3. Ornamental stone
4. Roofing and flooring stone
5. Paving block
6. Curbing stone
7. Kilometer stone
8. Guard and boundry stone
9. Miscellaneous stone

GRANITE AS DIMENSION STONE

Godhara and Idar granites equivalent to the Erinpura granite of Rajasthan, exposed in parts of Vadodara, Panchmahals, Kheda, Mehsana, Banaskantha and Sabarkantha districts, are quarried for use as dimension stones. Gneissose granites exposed in Vadodara and Panchmahals districts and Granophyre from Bhavnagar district are also quarried.

In general granite is pink to grey, homogeneous, fine to coarse grained and equigranular or porphyritic rock. It consists of quartz and felspar (orthoclase, microcline) in nearly equal proportion and mica and chlorite in small amounts. Granite is difficult to cut and dress because not only all its constituents except mica and chlorite are hard, but are also interlocked. The fine to medium grained variety can be dressed and is quarried as dimension stone. Granite is one of the most durable of all building material as the quartz and felspar are highly resistant to normal weathering. However, felspar will disintegrate slowly if exposed to an acid bearing atmosphere. Under ordinary atmospheric condition granite will endure for centuries without significant change in colour or durability. Granites of Gujarat are very strong, durable and notably impervious to moisture.

Quarrying is done by manual method only. Stone industry has not given adequate attention to this stone having large reserve in the state. Quarrying is done by skilled workers who are in this profession for generations. At present the blasting holes are made by drilling and broaching methods. Quarry operations can be mechanized by

introducing jet piercing method and by the use of wire saw equipment for making primary cuts.

At places, granite boulders are worked for quarry face split by drilling a hole with point and hammer and blasting with a light charge of gun powder. Ammonium nitrate can be used instead of gun powder and inclination of the blasting holes may be kept 15° to 20° from horizontal to increase the blasting efficiency. Ammonium nitrate and fuel oil mix, which barely costing 1/3 of the cost of high explosive and having heaving effect rather than shattering effect is advantageous for the production of dimension stones. At present only government agencies are using this stone for the dam and road construction. Polishing of granite is not done for its use as monumental and ornamental stones having good market in India and abroad. Stone industry can very well establish the cutting and polishing of granites for their use as building, monumental and ornamental stones. Quarry operation can be mechanized by introducing jet piercing method and using wire saw equipment for quarrying. Crushed aggregate of granite produced as quarry waste can be used as road aggregate to balance the economy of quarry operation for dimension stone.

DECCAN TRAP AS DIMENSION STONE

Deccan trap is the most extensive geological formation covering about 1/3 of the total area of the state of Gujarat. Commercially this includes all types of volcanic and hypabyssal rocks. There are about 890 quarries in the state producing mainly crushed aggregates along with rubble as per consumers demand.

Trap rock is generally grey to black. It ranges in texture from completely aphinitic to porphyritic and compact to amygdaloidal. It consists of plagioclase feldspar and pyroxene. The amygdules, if present are generally filled with secondary minerals like zeolite, calcite and free silica. On weathering the rock is stained or skinned with iron oxide. It is exposed in south Gujarat i.e. Dang, Bulsar, Surat and Bharuch districts. Isolated exposures of this rock are found in Baroda, Panchmahals, Kheda, Sabarkantha and Banaskantha districts. In Saurashtra region, it occurs mainly in Rajkot, Bhavnagar, Jamnagar, Junagadh and Amreli districts covering more than 2/3 of the total area. In kutch district Traprock is exposed between the sedimentary rocks of the Mesozoic and Tertiary age.

Open pit quarrying is done on large scale because this rock, having great thickness is also exposed over large areas. Quarrying is mainly done by manual method but drilling, transportation and crushing operations are mechanised. Quarrying method is not systematic. Holes drilled for blasting are random. No system has been adopted by quarry owner. Systematic quarrying will increase the production.

At present, this stone is mainly used as crushed/ broken stone but quarry operators are also supplying rubble according to the needs of consumers. It is used as a guard stone, boundry stone, kilometer stone and also as rubble and ashlar blocks for the construction of the dams and buildings. Fine grained, dense and dark coloured variety can be used as memorial stone because it takes good polish and shows colour contrast between inscription and polished surface.

LIMESTONE AS DIMENSION STONE

Miliolite limestone known as 'Porbander stone' from Saurashtra and Kachchh is widely used as building stone because it can be easily cut and dressed. Largest workable

deposits of this stone are situated in Junagadh district. Other limestones from Kheda and Panchamahals districts are siliceous in nature and are used as guardstone and boundary stone.

Quarrying operation for building stone is manual in which advantage is taken of the bedding planes. Miliolite limestone is amenable to cutting and dressing by axe and saw, and is easily carvable. The cut blocks of this stone locally called 'Bela' are used in building construction. This limestone, because of its composition and texture, is easily attacked by chemical weathering mostly by the process of carbonation and sulphation. Lameta limestones are grey and hard.

Miliolite limestone will not be suitable for its use in industrial areas having acidic fumes in the atmosphere because it will quickly disintegrate. Quarry waste can be used in the manufacture of building lime.

SANDSTONE AS DIMENSION STONE

It is available in large quantities. Sandstone is quarried in the districts of Sabarkantha, Kachchh, Panchmahals, Baroda, Surendranagar and Rajkot.

Sandstone is fine to coarse grained and bedded. It shows variety of colours. It is mainly composed of quartz cemented together with either calcareous, siliceous or argillaceous matrix. It can be easily dressed and carved in any desired shape.

Quarry method is manual. It is very easy to cut and dress when it is fresh due to quarry sap. It becomes hard when exposed to air. At present this stone is used as building stone and grinding stone.

MARBLE AS DIMENSION STONE

There are two commercial deposits of marble in the state. Marble of Ambaji area (Banaskantha district) belongs to Ajabgardh series of Delhi system while that of Chuchhapura (Vadodara district) belong to Champaner series of Aravalli system. Limestone from Andhav (Kachchh district) is golden yellow in colour and takes beautiful polish. It can be used as dimensions stone.

Marble of Ambaji is white with shades of black, pink, grey and green at places. Marble of Chuchhapura is of variegated green and white appearance.

Although the quarry operation is manual, polishing of marble is done in a mechanised way. Marble of Ambaji is used in the construction of the famous Jain temples at Dilwara (Mt. Abu), Kumbharia, Palitana and Girnar.

There is a lot of waste product in quarry operation for marble near Ambaji. This can be reduced by improving quarry methods. At Chuchhapura, quarries have reached great depths and are without benching. This is highly disastrous for quarry workers.

QUARTZITE AS DIMENSION STONE

Quartzite, mainly composed of a recrystallized quartz is medium to fine grained and grey to pinkish grey. Quartzite being very hard, jointed and brittle, cannot be quarried for very large size rubble. Quartzite is not amenable to dressing hence it is only used in uncoursed masonry work. Quartzite is available in great abundance in Vadodara, Panchmahal and Sabarkantha districts. It is mainly used as rubble in the construction of Kadana dam and sometimes as blocks in bridge piers.

PHYLLITE AND SLATE AS DIMENSION STONES

Extensive deposits of phyllites and slates belonging to Aravalli system, are present in Panchmahals and

Sabarkantha districts. They are grey and brown with less pronounced cleavage. Slaty character is due to the presence of master joints. Quartz and mica are the chief minerals present in these rocks. This stone is quarried by wedge method and is mainly used as flooring stone and at places as roofing stone.

Table 10.1 : Engineering Properties of the Dimension Stones of Gujarat

Trade	Compressive Strength Kg/cm^2	Water Absorption %	Specific Gravity	Durability
	IS 1121: Part I - 1974	IS 1124-1974	IS 1124-1974	IS 1126-1974
Granite	673-1400	0.07-0.62	2.60-2.70	0.09/30 - 0.31/30 cycles
Deccan Trap	644-1600	0.18-3.03	1.82-3.02	0.072/30 - 0.8/30 cycles
Sandstone	108-1065	0.47-10.4	1.85-2.68	-
Limestones				
(i) Miliolite limestone	20-226	2.51-14.51	1.6 -2.65	0.03/30 - 0.79/30 cycles
(ii) Limestone	61-1970	0.45-8.04	2.03-2.75	-
Quartzite	820-2020	0.14-0.84	2.55-2.73	0.15/30 - 0.16/30 cycles
Marble	657-958	0.12-0.39	2.66-3.72	-
Phyllite and Slate	87-463	0.01-2.65	2.61-2.95	-