CHAPTER I

I N T R O D U C T I O N

John Ruskin has said "The style of a national architecture may evidently depend in a great measure upon the nature of the rocks of the country". 'Stone' has been used throughout historic time as a major construction material because it affords strength, durability, architectural adaptibility and aesthetic satisfaction. No other type of material combines all these qualities.

As one of the most widely accessible building materials available to man, natural stone has been in

extensive use for many centuries. From the most remote period of civilization, stone has been used to penetrate the memory of individuals or to immortalize their noble achievements. Ancient memorials ranged from single piles of stones (Caires) or single markers, to great obelishs and pyramids or magnificient mousoleums. These constructions made from naturally occurring materials like rocks and aggregates exist on the face of the earth. Not all rocks can be used for such purposes. A set of specific properties makes particular types of rocks suitable for such construction. With time and increasing knowledge we have come to a stage of exact delimitation of the minima of such qualifications but the ancestors of the earliest days had quite a fair knowledge about properties of natural construction materials.

It is often forgotten that during nine-tenth period of Man's existence, his only tools were chipped stones and his only shelter were the rock cut caves. But remarkably enough, even early man appears to have observed some obvious elaborate ceremony and lavished loving care in interring their dead, which is evident from the valuable finds in the earliest great limestone caverns in Europe dating back to Upper Palaeolithic times and to the presence of 'dolmens' which are circular moulds of large blocks of rocks errected

around the burial spot to protect the dead from the scavenging and ravaging animals. These can be noticed in many parts of Tamilnadu even today. Even the religious places of early man are only in the nature of open air sancturies endorsed by pillars and slabs of rock such as the 'Stoneheye in England'.

As is only natural, the early man utilised only the locally available stones for making his tools, for sheltering himself and protecting his dead ancestors. Later on, he developed the art of transporting huge blocks of stone over a long distance to places where they were not available, which is evident from the mighty pyramids of Egypt. Still later, with the advance of civilization beauty became the keynote in the choise of building material and a monumental example of this is the Tajmahal in Agra, but at the present day, utility is the keynote and our skyscrappers are constructed of masonry and stones are polished for use as ornamental, memorial and decorative stones.

Many historical buildings were built with the help of stones. The Tajmahal of Agra built of white marbles is one of the most beautiful and costly

memorials ever built. Cleopatra's Needle a shaft of stone now standing in central park Newyork City, was fashioned from Egyptian granite 3500 years ago. Temple of Athena Nike built of white Pentellic marble in Athens, Greece in 450 BC. In South India ancient temples of Tamilnadu some more than 1200 to 1300 years old work constructed out of granites. Qutab Minar and Red Fort, Delhi and many historical structures around Agra and Delhi were built of red sandstone. The famous caves at Ajanta and rock cut temples at Ellora were hewn in the Deccan trap. Even during the present day, stones are used for the construction of major civil engineering works of more or less permanent nature, as in the construction of the Bombay Harbour, Bhakra-Nangal dam and Hirakund dam.

THE STONE INDUSTRY

The term 'Stone' is applied commercially to all natural rock material that is quarried or mined for constructional or industrial uses. 'Construction stone' applies only to rock material that is used directly for construction purposes, i.e. without calcining or chemical

processing, for building monument, highway, crushed aggregate, paving, retaining wall, sea wall, shaped and finished block, slab, rough quarry block etc.

Construction stone has a wide variety of uses, but it is convenient and practicable to classify it into two main categories, viz. crushed and broken stone and dimension stone.

Crushed and broken stone includes rip-rap, crushed stone and stone fragmented of various sizes for special purposes. The size range of crushed and broken stone is from large blocks to finely comminuted material. Crushed stone comes from quarries operated solely for that material, because many more rock formations are suitable for crushed stone than they are for dimension stone.

Dimension stone is a natural rock material quarried to obtain block, slab or pieces which are required to meet size and/or shape specifications. Dimension stones are subjected to restrictive and exacting specifications. The most prominent qualities are strength, durability, hardness and ornamental value. These in turn depend upon the mineralogic composition, texture, structure and colour. Dimension stone, a basic building and ornamental

material, competes with an ever-increasing variety of alternate materials.

Dimension stones, with their almost infinite variety, have a broad range of properties and uses. Natural stone was beyond doubt, the first mineral commodity used by man. Today the use of dimension stone is widened to encompass building exterior and interior, decorative and ornamental modes, statuary, monument, paving curbing, flagging, roofing and miscellaneous categories such as black board, surface plate etc.

The degree of utilization of dimension stones and crushed and broken stones for construction purposes has been a significant index of the progress of civilization. From the structures unravelled in Mohenjo-Daro, Harappau and the pyramids to the Hoover, Balera-Naryl and Hirakund dam, one can trace a continuous increase in utilization of natural material in ever increasing proportion.

SCOPE OF WORK

Gujarat has vast resources of construction stones such as granite, Deccan Trap, sandstone, marble, quartzite,

FIG. 1·1

LOCATION MAP

LOCATION
20.1° - 24.7° NORTH LATITUDE
68.4° - 74.4° EAST LONGITUDE

AREA
1,94,984 SQ KILOMETRES

POPULATION
2,66,97,475 (1971 CENSUS)

LANGUAGES SPOKEN
GUJARATI, HINDI, ENGLISH

CLIMATE
SUMMER . 40°C AVERAGE MAXIMUM
· 26°C AVERAGE MINIMUM

WINTER 29° C AVERAGE MAXIMUM
· 12° C AVERAGE MINIMUM

RAINFALL VARIES BETWEEN 33 TO 152 CMS.
JUNE TO SEPTEMBER

limestone, phyllite and slate. An attempt has been made by the present author to prepare a detailed and systematic account of the dimension stone resources of the Gujarat State (Fig.1.1).

Dimension stone is one of the important natural resources that finds extensive use in the present day construction industry. 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.

It is for the first time that this type of work has been initiated. At present all the data and other informations are very scattered. A detailed and systematic account of the dimension stone resources of the State of Gujarat prepared by the present author includes classification of dimension stones into trade groups and according to the need of the stone industry. Physical, chemical and engineering properties of various stones are studied to suggest proper utilization of dimension stones by the stone industry. An attempt has been made to correlate different properties of each rock group.

Profiles of existing quarries were examined to study major structural features. Thickness of overburden, weathered zone and bed rock were measured. Quarry method was studied and recommendations are made for making better quarry yield. Experimental polishing of some stones was carried out to find out whether they can be used as monumental and/or ornamental stone.

At present, there are about 2000 dimension stone quarries in Gujarat State. The author has shown all these quarries and their approach roads in Fig. 1.2. In this map only the important town located nearby is shown instead of a cluster of quarries. As for example, Madhavpur limestone quarry (Quarry No.195), indicates about 80 quarries situated in that area.

In Gujarat, Dimension stones of different rock types occur at different places in various stratigraphical horizons. Dimension stones from several areas are extensively used as building stone, monumental stone, ornamental stone, guard stone, kilometer stone etc. Gujarat State has provided beautiful marble widely used in ancient as well as modern Jain temples of Palitana, Girnar and Delwada, Mt. Abu. Miliolite limestone

popularly known as 'Porbander stone' is used in many public buildings as well as in the well known Somnath temple at Veraval. At present quartzite is used in Kadana Reservoir Project. Deccan trap is used in the masonry work of many of the irrigation projects in Gujarat as well as in Saurashtra region.

As a result of this study the present author is able to throw some light on the suitability of various rocks of Gujarat as dimension stones in present environment and also on the future development of the dimension stone industry.

PREVIOUS WORK

Except for some scattered references in the records and memoirs of G.S.I. very little information is available on this subject in published literature.

B. Ramarao (1931) suggested the use of granite as a building stone in his report on the geology of former Bariya State of Panchamahals district. Gupta and Mukherjee (1939) in GSI record on Geology of Gujarat and Southern Rajputana described utilization of slate and phyllite from Zalod and sandstone from Vankaria in Panchmahals district

for roofing and flooring stone and building stone respectively. Roy (1951, 1953) described building materials of Bombay and Saurashtra region. Merh (1953) described marble rocks of Jariba near Ambamata. Kulkarni (1968) studied limestones of Gujarat for his doctoral work. Kulkarni (1969) published a review article on the use of various stones from Gujarat as building stones. Kachhara (1971) reported the use of Ambaji marble for building, monumental and ornamental purposes. Krishnaswamy (1968) in his Mineral resources of India described various building stones of Gujarat. Desai (1974) published a review article on dimension stones. Kulkarni and Shah (1975) described quarrying of quartzite at Kadana dam site.

In recent years, agencies of Government of Gujarat such as Gujarat Engineering Research Institute, Vadodara made a survey of construction materials from all districts of Gujarat. So far they have published reports on Panchmahals, Sabarkantha and Kheda districts. The Directorate of Geology and Mining, Government of Gujarat also have investigated some of the deposits of dimension stones.

However, all the existing data are scattered and not easily available. The present author has attempted to collect information about dimension stones of Gujarat from all possible sources. This has been further supplemented by his own investigations.