CHAPTER II

CLASSIFICATION OF DIMENSION STONES

The classifications of dimension stones as suggested by ASTM (1952) and Barton (1968) are based on the petrological properties and those by Currier (1960) and Barton (1968) based on the use of dimension stones. Though they are too detailed and divorced to be of any practical value to the Gujarat stone industry they are mentioned here for the sake of comparison. Bearing this in mind, this author has modified the above mentioned classifications in accordance with the Gujarat stone industry. He has suggested seven principal trade groups and nine principal classes according to the utility of dimension stones.

COMMERCIAL LITHOLOGICAL CLASSIFICATION

The American Society of Testing materials (C 119-59, 1952) through its Committee on natural building stone, adopted the following classification for building stone. They have recognized seven principal classes.

(1) Granite: This term includes granite, gneiss, gneissic granite, granite gneiss as well as syenite, monzonite and granodiorite, and intermediate species with or without the gneissic and porphyritic texture. The term 'Commercial granite' includes other felspathic crystalline rocks such as anorthosite and laurvikite of similar textures and with minor amounts of accessory minerals, used for decorative purposes.

(2) Limestone: It is a sedimentary rock composed of calcium carbonate or double carbonate of calcium and magnesium.

(3) Marble: It is a crystalline rock composed predominantly of one or more of the following minerals: Calcite, dolomite or serpentine. Recrystallised limestones and compact, dense, relatively pure microcrystalline varieties, that are capable of taking good polish are included in 'commercial marbles'.

(4) Greenstone: It includes metamorphosed or otherwise altered rocks that have assumed a distinctive greenish color owing to the presence of one or more of the minerals - chlorite, epidote or actinolite.

(5) Sandstone: It consists of consolidated sand grains chiefly composed of quartz or quartz and felspar, with fragmental (clastic) texture and with various interstitial cementing materials, including silica, ironoxides, calcite or clay. It includes sandstone, conglomerate and quartzite.

(6) Slate: It is a microgranular metamorphic rock derived from argillaceous sediments and characterized by excellent cleavages along which the rock can be split easily into relatively thin slabs.

(7) Basalt and Traprock: It is a commercial term for all basic igneous rocks.

Barton (1968) suggested a classification of dimension stones into eight principal classes based on broader categories satisfying the commercial needs of the industry in readily cataloguing the building stones.

(1) Granite: It includes all Felspathic crystalline rocks of predominantly interlocking texture and with individual mineral grains visible to the naked eye. It includes gneiss, syenite, monzonite, granodiorite, anorthosite and intermediate petrographic species. Similarly textured 'Felspathic' crystalline rocks dark grey to black in colour are called black granite which includes diorite, gabbro etc.

(2) Limestone: It is a sedimentary rock composed essentially of calcium carbonate (calcite) or combinations of calcium and magnesium carbonates (dolomite).

(3) Marble: In the strict sense, it is a recrystallised (metamorphosed) limestone with interlocking or mosaic texture composed of crystalline grains of calcite, dolomite or both. In commercial usage, it is any calcareous crystalline rock or serpentine capable of taking good polish. Serpentine marble or verde antique is comprised of green to almost black serpentine, crisscrossed by veinlets of lighter minerals chiefly calcite or dolomite. They are not comparable with true marble in either origin or composition but because of their ability to take high polish and marble like veining

they are so classified. Travertine mentioned earlier under limestone, is related in origin to marble classed and sold as marble.

(4) Sandstone: In commercial usage it is a sedimentary rock consisting mostly of grains of quartz, quartz and felspars or rock fragments of clastic texture bonded by various interstitial cements including silica, clay, calcite or iron oxide.

(5) Quartzite: It is a metamorphic equivalent of sandstone that has become thoroughly indurated through firm cementation by secondary silica or recrystallization so that it is essentially homogeneous and fractures through the original sand grains. It shows low porosity and vitreous fracture as compared to high porosity and dull, rough fractures of sandstone.

(6) Slate: It is a microgranular rock derived from metamorphism of argillaceous sedimentary rocks. It is characterized by prominent cleavages oriented independently of the original sedimentary bedding.

(7) Greenstone: It is a crystalline metamorphic rock of greenish colour due to the presence of dominant

greenish mineral such as chlorite, epidote or actinolite. They are often the results of metamorphism of basic igneous rocks such as basalt lava flows and they exhibit an interlocking texture.

(8) Traprock or basalt: It is a general commercial term for all basic igneous rocks too fine grained to be called 'black granite'. Different producers may market the same rock as traprock, green decorative or black granite.

This author has modified the classification of dimension stones suggested by American Society of Testing Materials (1952) and Barton (1962) in accordance with the need of Gujarat stone industry and has suggested seven principal trade groups of dimension stones of Gujarat.

(1) Granite: It includes all felspathic crystalline rocks of predominently interlocking texture and with individual mineral grains visible to the naked eye. It includes granite, granite gneiss, gneissic granite, gneiss, granophyre and syenite. Gabbro which is classified as black granite by previous workers has been removed from this trade group because in Gujarat it has been termed as trap by stone industry.

(2) Deccan Trap: It is a general commercial term for all basic igneous rocks. However, Gujarat stone industry includes plutonic variety of igneous rocks such as gabbro as it is black in colour. Deccan Trap includes basalt, dolerite, gabbro, rhyolite, trahyte, norite etc. Though their petrographical characters are different they are included in this trade group because of more or less similar colour.

(3) Sandstone: In commercial usage, it is a sedimentary rock consisting mostly of grains of quartz, quartz and felspars or rock fragments of clastic texture bonded by various interstitial cements including silica, clay, calcite or iron oxide. In commercial nomenclature the term has been broadened to include coarser-grained rock including conglomerate and other fine grained rocks such as siltstones.

(4) Limestone: It is a sedimentary rock composed essentially of calcium carbonate (calcite) or combinations of calcium and magnesium carbonates (dolomite). It excludes recrystallised limestone, and compact, dense, relatively pure microcrystalline varieties, that are capable of taking good polish. They are included in 'Commercial marble'.

(5) Quartzite: It is a metamorphic equivalent of sanstone that has become throughly indurated by recrystallization through firm cementation by secondary silica so that it is essentially homogeneous.

(6) Marble: In a strict sense, it is recrystallised (metamorphosed) limestone with interlocking or mosaic texture composed of crystalline grains of calcite, dolomite or both. It includes all calcareous crystalline and serpentine rocks capable of taking good polish.

(7) Phyllite and slate: They are microgranular rocks derived from metamorphism of argillaceous sedimentary rocks characterized by prominent cleavages.

CLASSIFICATION BY UTILITY

The classification of dimension stones suggested by Currier (1960) and Barton (1968) is based on the use of dimension stones.

Currier (1960) has suggested the following classification according to the use of the dimension stones.

1. Building stone:
   (a) Rough construction
   (b) Cut stones, slabs and mill block
   (c) Rubble.

2. Monumental stone;

3. Ornamental stone;

4. Paving Blocks;

5. Curbing;

6. Flagging (except slate);

7. Slate:
   (a) Roofing slate
   (b) Millstock slate: Electrical slate
   Structural slate
   (mantles, tiles, steps,
   risers, sills)
   Blackboard and school slates.
   (c) Flagstones.

1. Building stone: embraces a wide variety of uses viz. construction of walls, foundations, sills, chimneys, trim for other material, steps etc. and in engineering structures such as retaining walls, bridge and sea walls. The blocks and slabs for these purposes are finished to various degrees, ranging from roughness,

"rock faced" (having broken surfaces) blocks to finely finished and carefully shaped slabs for interior panel and wainscotting. According to Currier, no sharp distinction is made between building stone and monumental or ornamental stone used for structural blocks and slabs. Though primarily chosen for their durability and soundness they are often chosen for their ornamental value. Moreover monuments range from simple markers to ornamental structure that are essentially buildings. Thus the same quarry may produce stone that, by selection, will be used for building, ornamental or monumental purposes. According to Bowles (1917) four principal forms of stones are used for the construction of wall, viz. cut or finished stone, ashlar, rough building stone and rubble. Cut or finished stone consists of blocks shaped and sized accurately and uniformly, except for corners, door and window spaces, caps and cornices for which blocks are carefully carved or shaped to requirements. Moreover they are surface tooled. Ashlar blocks are rectangular, generally small and have rock faced, sawed or planed surfaces. Rough building stone consists of rock faced blocks of various shapes and

sizes. Rubble is generally applied to irregular blocks having one good face and is the cheapest form of building stone.

2. Monumental stone: Stone marketed as monumental stone must satisfy more exacting requirements, than even the highest grades of cut and fashioned building stone. In general, uniformity in texture and colour, freedom from flows and suitability for polishing and carving are the principal requirements.

3. Ornamental stone: Some stones used for ornamental purposes would not satisfy the requirements for carving, because of certain distinctive qualities such as marking and colour.

4. Paving block: It is a small rectangular block used for road, dock, freight yard and any other area subjected to heavy and abrassive commercial traffic.

5. Curbing stone: Production of long slab for edging roadway and sidewalk comprises an important part of the stone industry. Relatively thin and short slab is used for face bordering slope of highway. For the production of both types stone should possess

an easy rift (cleavage) to obtain straight and fairly smooth faces with a minimum of working.

6. Flagging (except slate): It consists of thin slab used for walk, driveway and paved area such as courtyard, carport, patio and the like. In general stone that permits easy splitting into thin slabs of uniform thickness is most suitable as flagstone.

7. (a) Roofing slate: It possesses smooth, straight and easy cleavage, without nodules, "knots" or bands of foreign minerals. The size of roofing slate generally ranges from 7 by 9 cm to 16 by 14 cm and one to 2.5 cm thickness.

   (b) Mill stock slate: It includes block and slab suitable for fashioning into structural unit, slab and plate for electrical purpose, blackboard and the like. Electrical slate requires in addition strength and very low electrical conductivity, furthermore it must be easily workable by cutting and drilling without chipping.

   (c) Flagstone: Slate used for flagging has less restriction as to physical properties than

that for other dimensional purposes. Quarry blocks and slabs discarded from mill stock and roofing stock are commonly acceptable.

Barton (1968) has suggested following classification of dimension stone by use.

1. Building, structural or architectural stone:
   (a) Rough construction or architectural
   (b) Ashlar
   (c) Dressed construction or architectural
   (d) Rubble
   (e) Veneer
2. Ornamental stone
3. Monumental stone
4. Paving block
5. (a) Flagging (including flagging slate)
   (b) Roofing slate
   (c) Mill stock slate; structural; electrical i.e. blackboard.

(1) Building stone: embraces a wide variety of stones having a wide variety of finishes used in structures (building, bridges, walls etc.)

(a) Rough construction stone: It consists of faced blocks of various shape with the rough or say quarry finished.

(b) Dressed construction stone: It consists of blocks and slabs shaped and sized accurately for specified use.

(c) Ashlar: It consists of blocks, generally small, with sawed, planed or rock faced surfaces.

(d) Rubble: It consists of rough irregularly shaped pieces of stone. It generally has one fairly good face. It may be left entirely as broken out from the quarry or may be partly trimmed.

(e) Veneer: It is a thin slab which is used in nonload bearing situation or as facing over other material (such as concrete) to give the external appearance of thicker block or regular ashlar.

(2) Ornamental Stone: It consists of stone which has distinctive marking or colour which make it prized for its decorative effect.

(3) Monumental stone: It must meet exacting requirement such as uniform texture and colour, freedom of flows and general suitability for polishing and carving.

(4) Paving block: It is small rectangular block originally used for heavy vehicular traffic but

now-a-days it has been used as border for walk, driveway, patio and flower garden etc. It includes curbing stone which are used along street or highway, to maintain the integrity of sidewalk and border.

(5) (a) Flagging stone: It consists of thin slab, easy to split or be cleavable into slab. For sidewalk, driveway etc.

(b) Roofing slate: It must be smooth, easily cleavable, straight splitting slate used for roofing.

(c) Millstock slate: It consists of block and slab suitable for structural unit, facing panel, electrical purpose, blackboard etc. Electrical slate requires low conductivity and must be drillable without chipping. For blackboards, slate must have a suitable, even colour, low reflectivity and should be able to take a very smooth finish.

The author has modified the classification suggested by Currier (1960) and Barton (1968) and has classified the dimension stones of Gujarat into nine principal classes according to their utility.

(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 boundary stone
(9) Miscellaneous stone.

(1) Building stone: It is used in structures such as building, retaining wall etc. It includes a broad spectrum of stones with a wide variety of finishes. It is further subdivided into five subclasses.

(a) Rough construction stone: It consists of rock faced blocks of various sizes and shapes. A seawall may commonly be faced with such rough block.

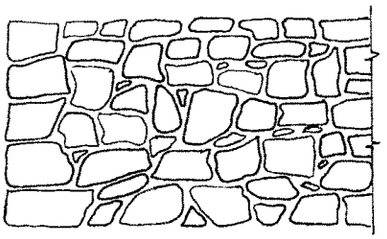


FIG 2·1 RANDOM RUBBLE (UNCOURSED)

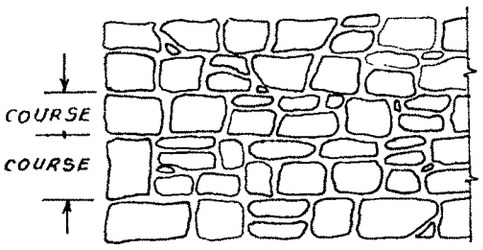


FIG 2·2 RANDOM RUBBLE (COURSED)

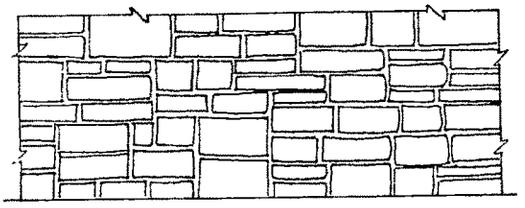


FIG 2·3 SQUARED RUBBLE (UNCOURSED)

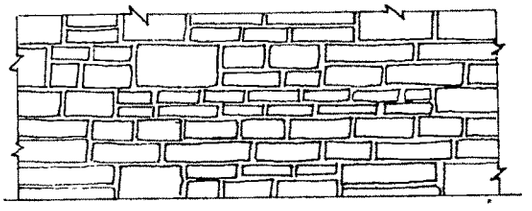


FIG. 2·4 SQUARED RUBBLE (COURSED)

(b) Dressed construction stone: It consists of blocks and slabs shaped and sized uniformely and accurately for specified use, except for corner, door and window spaces, cap and cornice for which the blocks fully carved or shaped to requirements.

(c) Rubble: It includes rough irregularly shaped pieces of stone. Generally it has only one fairly good face with other faces left undressed or partly trimmed. For rubble masonry the size of stone is in accordance with IS 1597: Part I - 1967. The length of the stone shall not exceed three times the height and the breadth and base shall not be greater than three-fourths of the thickness of wall or less than 15 cm. There are three types of rubble walling (IS 1597: Part I-1967).

(i) Random rubble: In this type, masonry is constructed of stones as they are obtained from the quarry. In uncoursed masonry (Fig. 2.1), the mason selects blocks of all shapes and sizes more or less at random and places them in position to obtain a good bond, while restricting cutting of the

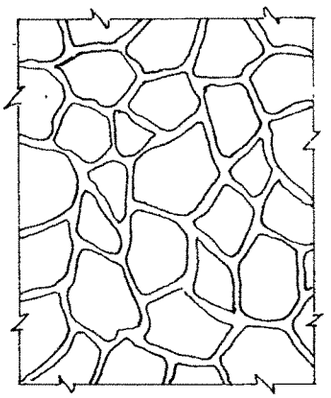


FIG. 2·5 POLYGONAL RUBBLE

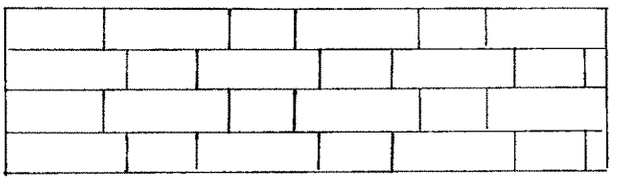


FIG. 2·6 ASHLAR (PLAIN)

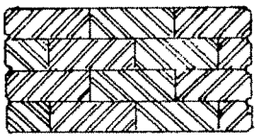


FIG. 2·7 ASHLAR (SUNK OR MOULDED)

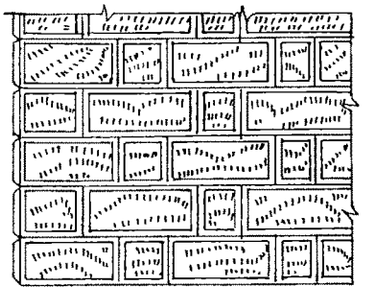


FIG. 2·8 ASHLAR (QUARRY FACED)

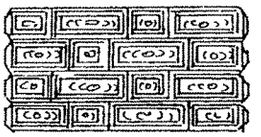


FIG. 2·9 ASHLAR (CHAMFERED)

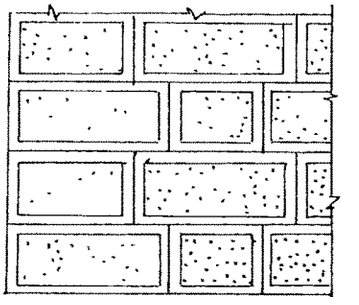


FIG. 2·10 ASHLAR (ROUGH TOOLED)

stones to the removal of inconvenient corners with a scabbing or spalling hammer. In coursed masonry (Fig. 2.2) the work is roughly levelled upto courses at intervals varying from 30 to 90 cm in height.

(ii) Squared Rubble: In this type of masonry stones are roughly squared as risers and strechers with varying height are used. They are laid uncoursed or brought to coursed (Fig. 2.3) by levelling them upto courses of varying depth from 30 to 90 cm. In coursed masonry (Fig. 2.4) the height of courses vary from 10 to 30 cm but the stones in one course is roughly squared to the same height. The faces of stone may be pitched to give a rock face appearance or may be dressed smooth. A variant of this type of walling may be formed by the introduction of pinning, that is, smaller stones in the same courses at intervals, producing a chequered effect.

(iii) Polygonal Rubble (Fig. 2.5): Walling stone with no pronounced stratification is roughly hammer-pitched into irregular polygonal shapes and bedded to show the face-joints running irregularly in all directions.

(d) Ashlar: It includes block, generally small with sawed, planed or rock faced surfaces. This type of masonry used for important building where strength and the life of the structure is the criterion. There are five types of Ashlar masonry (IS 1597: Part II-1967).

(i) Plain Ashlar(Fig. 2.6): Stone blocks of same height in each courses are used and every stone is fine tooled on all beds, joints and faces, full and true.

(ii) Sunk or Moulded (Fig. 2.7): The exposed faces of each stone block shall be gauged, cut, grooved, rebated, sunk or plain moulded as the case may be. Stone blocks of same height in each courses are used.

(iii) Rock or Quarry faced (Fig. 2.8): The faces of each stone block exposed to view, shall have only chisel draft 25 mm wide allround the edges and between the drafts be left rough as the stone comes from the quarry. In chamfered type (Fig.2.9)

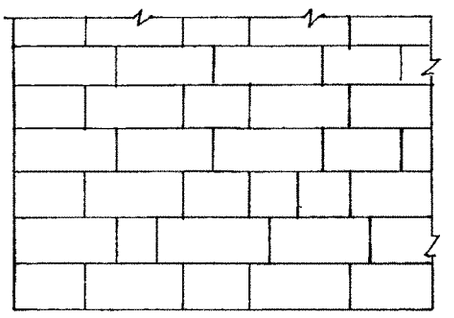


FIG. 2 II ASHLAR (COURSED)

the edges are bevelled to 45° for a depth of about 2.5 cm. Stone blocks of same height in each course are used.

(iv) Rough tooled or punched (Fig.2.10): The faces of each stone block exposed to view, shall have fine dressed chisel draft 2.5 cm wide allround the edges and be rough tooled between the drafts and on all beds and joints.

(v) Block in course (Fig. 2.11): This is hammer-faced or pitch-faced regular coursed masonry in large blocks. It is superior type of coursed rubble masonry.

(e) Veneer: It includes thin slabs used in non-load bearing situations or as facing over other materials to give external appearance of ashlar. The thickness of veneer slab is usually less than 6 cm.

(2) Monumental stone: It includes stone having uniform texture, freedome from flow and general suitability for carving and polishing. It is used for monuments.

(3) Ornamental stone: It includes stones having distinctive markings and colour which make them prized for their

FIG. 2·12 KILOMETER STONE

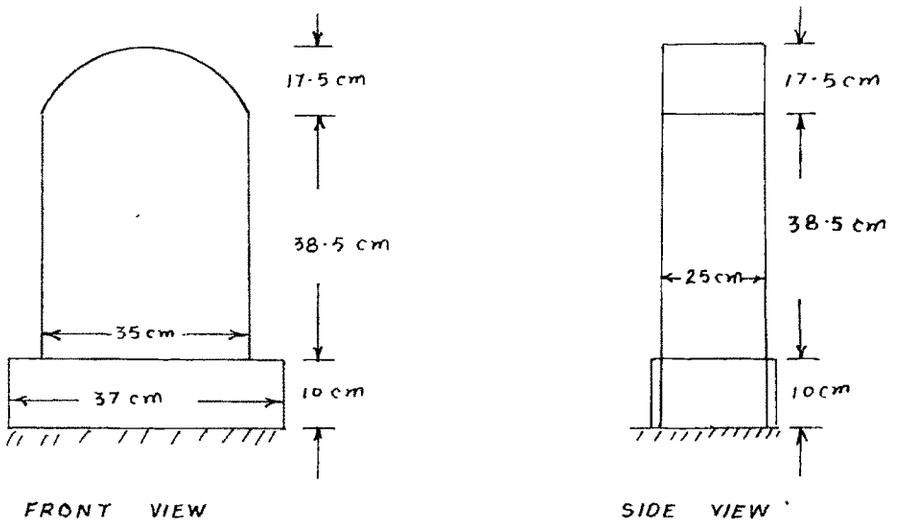
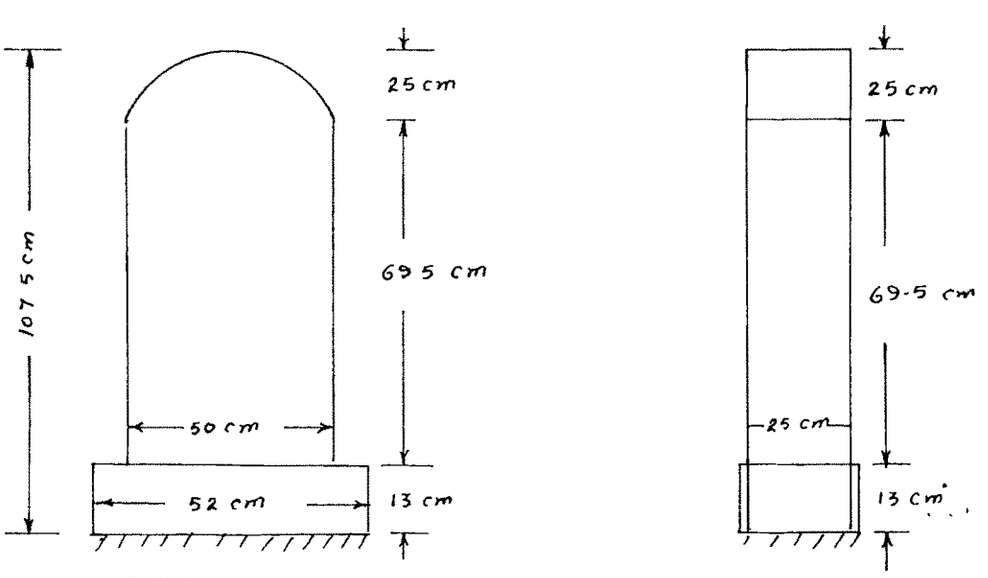


FIG. 2·13 5th KILOMETER STONE



decorative effect. It is very difficult to mark a sharp limit between monumental and ornamental stone. Some stones can be used for building, monumental as well as ornamental purposes.

(4) Roofing and flooring stone: They are the stone slabs used for roofing and flooring purposes.

(5) Paving Block: It includes small rectangular block used for road, dock, freight yard and any other area subjected to heavy and abrassive commercial traffic. Now-a-days paving block is limited to sidewalk, footpath, flower garden etc.

(6) Curbing stone: It includes slab used for edging roadway and sidewalk. This stone will maintain integrity of sidewalk and border.

(7) Kilometer Stone: It is used on the road for indicating distance between two stations. Its shape and size are according to specifications suggested in P.W.D. hand book of Roads (1972). There are three types of kilometer stones:-

(i) Kilometer Stone (Fig.2.12): This stone should be 66 cm above the ground, 37 cm in width and 25 cm in thickness. It should be about 20 cm below

FIG 2·15 GUARD STONE

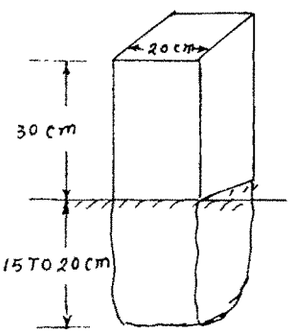
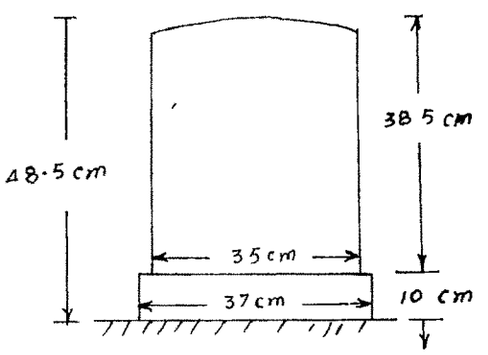
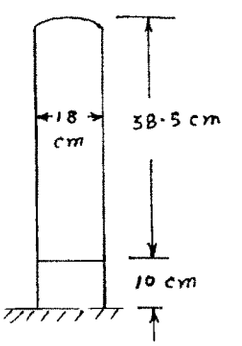


FIG 2·14 HALF KILOMETER STONE

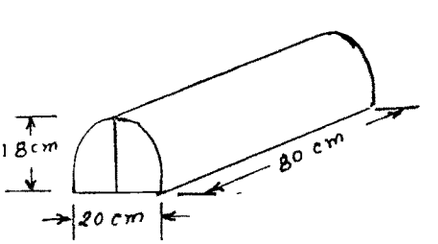


FRONT VIEW



SIDE ELEVATION

FIG. 2·16 MUNDANI



ground so that it remains stable. Thickness can vary by ± 2 cm according to material available. Top portion is semi-circular.

(ii) Fifth kilometer stone (Fig. 2.13): After every 5 km this stone is laid. It is bigger in size than normal kilometer stone. This stone should be 107.5 cm above the ground, 52 cm in width and 25 cm in thickness. It should be about 30 cm below ground so that it remains stable. Thickness can vary by ± 2 cm according to material available. Top portion is semi-circular.

(iii) Half kilometer stone (Fig. 2.14): This stone is fixed between two kilometer stones. This stone should be 48.5 cm above the ground, 37 cm in width and 18 cm in thickness. It should be about 20 cm below the ground so that it remains stable. Thickness can vary by ± 2 cm according to material available. Top portion is semi-circular.

(8) Guard and Boundary stone (Fig. 2.15): They are stone blocks used on highway, to mark danger zone and boundary of road. Guard stone is normally placed outside sharp curve, on hill slope etc. Boundary stone is also known as limit stone fixed at Taluka and District boundaries, at the point where highway, state highway, district road

and corporation road section starts. Guard and boundary stone are square or quadrant topped. Projection above ground is 30 to 37.5 cm as per P.W.D. Hand book of Roads (1972).

(9) Miscellaneous Stones: They are the stones which do not fit in any of the above groups. These stones are mainly used locally for various purposes. They include Fencing stone, Mundhani (Fig. 2.16) i.e. stone line marking the limit of cattle food in a Cattle-shed.