CHAPTER V: RELIGIOUS SPACE

V.1 ROCK-CUT MONUMENTS
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'Religious Space' here means the place where auguries are made and worship performed to God or supernatural powers. In this sense, 'Religious Space' in ancient India includes all the structures built exclusively for religious purposes such as the Buddhist stūpas, chaitvas, vihāras, jainamonasteries and Brahmanical temples. These religious structures were made in different building materials viz., brick and stone in case of free standing monuments whereas some were made in the form of caves cut into the rock. Chronologically speaking the last category of monuments were caused to be excavated first and then the technology improved and they began to be built in brick and stone. Archaeological evidence for religious buildings in early Andhradesa comes forth only from Period II onwards, though we have some perceptions of an early form of Brahmanical structure mentioned in the Vedic literature. In the following sections of this chapter the evolution of building technology of these religious monuments is studied, dividing them into three categories viz., Rock-cut monuments, brick monuments and stone monuments.

We begin our discussion on the monumental buildings of rock-cut technology with a brief introduction on the origin of rock-cut technology in India in general and Andhradesa in particular, taking into account its prevalence in the contiguous regions around Andhradesa. Archaeological investigations in Andhradesa have revealed that human habitation during the Palaeolithic period was concentrated mainly along the banks of rivers and
in the forests as this was convenient for collecting food materials and taking shelter in natural caves or caverns. The Mesolithic people also continued to live in natural caves and sub-terranean passages which have been noticed at Muchchatla Chintamanugavi and Belum in sub-region D. During the Neolithic period people continued to live in natural caves and under serpenthood shaped rock-shelters as noticed at Dupadugattu, Sanganonpalli and Uppair in sub-region A, and at Kethavaram in sub-region B. During the course of the evolution of Neolithic society people began to live in pits, cut into the ground as dwelling pits which have been uncovered at Utnoor in sub-region A, Veerapuram, Nagarjunakonda and Gandluru in sub-region B. Evidence of scooped or dressed activity during the Megalithic period has been noticed under the serpent hood shaped natural rock-shelters at Budgepalli in sub-region A. Scooping and cutting the rock for funerary buildings is also known from Jonnawada in sub-region C. The people who wanted to keep the skeletal remains of their dead in safe enclosures, selected the hill slopes and excavated the laterite rock. These early evidences attest to the knowledge of scooping and cutting of live rock, which had its origins in the later phase of Period I of our study. Earlier, as is well-known, the most natural instinct of man for many centuries during the pre-historic period was to find shelter in caves and rock-cut shelters. This was no exception in the case of Andhradesa. There were no monumental buildings consciously built by man, but naturally available in nature. As the dawn of history emerged in early India, natural caves or caverns began to be selected for the dwelling of the monks or ascetics during the rainy season known as vassavasa when perigrination was not possible.
One of the early Buddhist texts states: "as in olden times the bhikkus dwell now here and there, in the woods, at the foot of trees, on hill sides, in grottoes, in natural caves, in cemeteries, in forests, in open lands and in heaps of straw". The same text also informs us that "there were some vihāras and monasteries but these were thatched; in the cold season they were cold and in the hot season hot". On the request of the bhikkus, the Buddha was said to have allowed the monks to use guhas or caves among the other five kinds of dwellings. The Buddha himself is said to have stayed in the natural caves of Saptaparni at Rajagriha. The Buddhist monks must have thus lived in natural caves up to the 3rd century B.C. if not later, when they shifted to rock-cut caves soon after the excavation of caves was initiated during this period. During the Mauryan period excavating of rock-cut caves can be seen in the natural caves of the period at Ramgarh and Budhani. Similarly, in Āndhradeśa also, natural caves at Kapparaopet in sub-region A, seem to have been used by Jaina ascetics as dwelling places and hence the hill in which they lived is called as Munulagutta, meaning 'the hill of the ascetics'. Here, the natural rock inside the cave was fashioned into four rock-cut beds to be used for sallekhana, a ritual practiced by Jaina monks during their last days. Based on the recovery of the coins of Simuka Satavahana near the caves, these caves are dated by P.V.P. Sastry to the 2nd century B.C.

Apart from these early natural caves which were used for habitation, live rock was cut into caves for dwelling and religious purposes. The secluded location of the hills, far away from human habitation, with the tranquility necessary for the meditation and religious practices of the Buddhist and Jaina monks, was responsible for the selection of this kind of site. Soon there was the proliferation of rock-cut monastic and ritual
In India the practice of rock-cut technology for monumental buildings was, for the first time, initiated during the Mauryan times and the earliest caves excavated are the caves called after Lomas Rishi and Sudama caves at Barabar and Nagarjuni hills in Bihar. These were scooped during the reigns of Asoka and his grandson Dasaratha. These earliest examples of rock-cut buildings are the exact replicas of, probably the then existing wood and thatched structures. The caves in Barabar and Nagarjuni hills were excavated by quarrying into the hardest rock. Their carving and polishing was with a unique technique, which began and ended there within the same century. This method of rock-cut technology of the Magadhan region in all probability, served as models to the early examples of such rock-cut activity in the Western Deccan, coastal Andhra and Orissa. The beginning of rock-cut technology in the Western Deccan has been noticed at Ajanta, Bhaja, Kanheri, Kondavite and Pitalkhora and this goes back to the 3rd century B.C. The Orissan examples at Udayagiri and Khandagiri on the other hand, were excavated by the Chedi King Kharavela in the 1st century B.C. Rock-cut technology in early Andhradesa can be considered co-eval with the Mauryan experiments or be attributed to a slightly later date.

The monuments made with the help of rock-cut technology in Andhradesa can be studied in several varieties such as chaityagrihas, stupas, viharas, and cave temples. All the major religious faiths, viz., the Buddhism, Jainism and Hinduism have been affiliated to monumental buildings made with this technology. These monuments are studied below sub-regionwise in the different periods categorised by us above. These monuments have been found
distributed in almost all the sub-regions of our study. The earliest rock-cut monument has been reported in the form of a **chaitvagriha** at Guntupalli in sub-region C and the earliest **vihāra** in the same technique, has also been reported from the same site. Those at Rampa Errampalem and Sankaram have also been found in the same sub-region and belong to an early period. Monolithic **stupas** cut-out of rock-boulders have been reported from Karukonda in **sub-region B** [Map IX & Chart V B]. Rock-cut temples of the Brahmanical faith have been found near Vijayawada and its suburbs in sub-region C, at Bhairavakonda in sub-region B and at Gandharikota and Adavi Somanapalli in sub-region A In Period III [Chart V C]. A few Jaina rock-cut caves have been noted at Sangamayyakonda in sub-region C belonging to Period IV [Chart V D]. Thus it can be seen that rock-cut technology began to operate from as early as the 3rd century B.C. and continued upto the 12th century A.D. It is however significant to note that it is **coterminus** with the brick and stone built technologies in early Āndhradesa.

The earliest sites of rock-cut caves in Āndhradesa are located in a fertile tract which has its own economic **implications**. A general increase in the wealth affected the development of rock-cut technology in that, donations began to be made for it. The building of rock-cut monuments and their maintenance needed money and patronage. The members of the royalty and chieftains and important officers of the State contributed to the excavation of the caves. Besides the ideological concepts of the monks and the availability of suitable mass of rock, trained architects and sculptors, under the supervision of a **Navakammika** assisted by **Silavaddhakīs**, **Mithikās** and **Avesanins**. smiths and painters were factors responsible for the excavation of these caves which Geoffrey Scott calls: "**Useful satellites of architectural history**".
The earliest rock-cut chaitvagriha of Andhradesa found at Guntupalli is similar in plan to the circular chaitvas at Mahakali and Junnar. The entrance facade of the Guntupalli rock-cut chaitva arch resembles the facade of the Lomas Rishi cave [Plate XV]. The chaitva consists of a small circular chamber containing a rock-cut stupa in the centre with a domed roof, surmounted by curved stone ribs resembling an umbrella frame. The vaulted roof seems to have been a copy of an evolved form of wooden structure, with long radiating rafters running downwards from a single point and crossing at regular intervals through horizontally laid rafters. This treatment shows that an earlier practice in wood was transferred into stone which turned out to be more permanent. A large curved arch, above the main entrance, was cut out to form a chaitva window, through which light was admitted which fell directly on the stupa inside. Percy Brown has rightly observed, "it is here that a small circular chamber has been found which explains the kind of shelter that was first erected over the stupa the beginning of chaitya hall".

The measurements of the various parts like the height, width, the radius and centres of the doorway and the arch of this chaitva could be said to have been derived from a 'grid pattern'. The pattern was evolved with the help of a ball of string and certain nails. S.Ganesh Rao who has observed and studied the arch of the facade of Lomas Rishi cave has concluded that "it was carved on the grid pattern, where mathematical calculations and scientific precision was applied". In our recent survey in and around Gopalapatnam, a Buddhist site in sub-region C the rock-cut cells along with a few natural caves were provided with rock-cut beds,
windows and doorways, the caves are to be datable to the 2nd century B.C. [Plate XV]

Another site, where rock-cut stūpas in Āndhradeśa have been noticed is Karukonda in sub-region B [Plate XVI]. This is the only site which has stūpas of big size cut-out from living rocky boulders. Based on architectural style these cut-out stūpas have been dated to the 3rd-4th centuries A.D. At Salihundam, a 4th century A.D. Buddhist site in sub-region C, nearly 30 small votive stūpas were cut-out in similar method. Here, the stūpas did not require much scaffolding because the scooping of the natural rocky terrace was started from the sheet rock of one metre height. Cutting out the natural outcrop was entirely different from the cut-in technology. In the case of the former, the selected boulder was to be first provided with some scaffolding all around so as to draw the elevational plan in the first instance and its cutting would begin from the top itself, after removing the unnecessary mass through a slow chiselling process. Probably cane rings were used to the required diametre of the stūpa and also a hemispherical cane frame in elevation might have been used to achieve the perfect circle and hemispherical shape. It is also possible that a pre-drawn scale model of the stūpa on cloth was consulted while cutting out these stūpas.

Apart from the stūpas the rock-cut technology was also used to build viharas in Andhradesa. Here, we notice certain interesting features in plan and execution. The vihara sometimes became both a monastic dwelling and a sanctuary as has been observed at Guntupalli, where rock-cut chaitya and vihāra were excavated side-by-side.
Period II: Rock-cut Chaityagriha, Guntupalli, Sub-region C

Period II: Rock-cut Vihara, Gopalapatnam, Sub-region C
As mentioned above, caves were preferred for dwelling by the Buddhist monks and probably permanence may have been one of the reasons that led them to choose excavating of rock-cut viharas in preference to wooden structures and even, brick or stone built structures. Indeed, this has been stated by a donor at a cave in Kanheri. He states in an inscription that the excavation of a chaitya could be ensured until the end of the 38 cosmic era. From the technical point of view, to select a cave dwelling meant that it had to be cool during summer and warm during cold seasons.

Rock-cut viharas in Andhrades'a have only been found located at places like Guntupalli, Rampa Errampalem and Sankaram in sub-region C. It is in this sub-region that the geological pre-requisite of the existence of suitable rock for excavation of caves was readily available. At Guntupalli five rock-cut viharas with rectangular halls and cells have been reported. The front facade was carved with three doorways, and two cells had windows on either side. The portion above the doors and windows was decorated with horse-shoe arches with finials. The ceiling portion of the facade looked like a chaitva window, with radiating ribs again, resembling a wooden structure. The rectangular halls were pierced with openings into cells, sometimes containing raised beds and pillows which were also cut in rock. Niches were provided in the walls probably to keep the lamps. Scholars like I.K. Sarma opine that these cells were residential in nature. It has also been suggested that there was an evolutionary pattern from single cell to a row of cells in quadrangular form, found at Guntupalli. Small channels were seen on the floor, in all probability meant for drainage. A drain or sewer known as niddhamana or niddhamamāgga has been mentioned in literature. Based on the
palaeography of a Brahmi inscription found on the steps leading to the monasteries and the crude finish of the vihara with its plain walls bereft of any decoration, it has been suggested by scholars that a date of 2nd century B.C. be assigned to these constructions.

Three rock-cut residential cells intended for Buddhist monks, square, rectangular and circular on plan, have been reported from Rampa Errampalem. The square cell here has a screen wall at the entrance to shed light into the interior of the cell. This is a new technological innovation when compared to the Guntupalli caves where windows were provided with cavities in the wall to probably fix wooden frames with wooden door leaves.

A few Jaina caves with their entrances carved with simple jambed designs have been reported from Sangamayyakonda in sub-region C. These caves are plain and bear the carvings of the Jaina tirthāṅkaras. Based on stylistic grounds of sculpture and architecture, these caves are dated to 12th century A.D. The absence of decorative motifs denote that the rock-cut technology discontinued from this period onwards, for, we do not have any rock-cut monument excavated after this period.

Some caves being unfinished or semifinished, furnish good clues for the study of the different techniques adopted in scooping, chiselling and smoothening the walls, ceiling and floor surfaces of these monumental buildings. For this we have evidence coming from the caves of the Barabar hills, Nasik and Ajanta in the Western Deccan, from the Udayagiri and Khandagiri caves in Orissa and most importantly from our point of view from
Guntupalli in Andhradesa. Based on their individual observations different methods of scooping have been proposed by scholars like Dehejia, Nagaraju, Gupta and Mohapatra. According to Gupta the work was of two types: One type of scooping was used for removing the matrix of the rock so as to obtain a hollow **interior**. The other type of scooping was used to chisel out the rough surface as per the plan, in height and depth. In the first type the work involved 'blocking' and 'rough chiselling' techniques. In this connection Gupta cites the example of the Barhut Sculpture which depicts the method of rock-hewing in 'blocking technique'. The Sculptural panel from Barhut shows the method of excavation of a hill for making a cave. The sculptors were using long pointed tools and chisels for scooping the rock. For cutting the upper portion, the workers had made landing steps by fixing nails at regular intervals without using ladders for scaffolding [Figure 7].

After completing the process of blocking and rough dressing, fine chiselling was undertaken with pointed chisels, as seen from the walls of the Guntupalli example. The sculptors have left extant some marks on the walls and also some stone ridges to follow up on the work. However this is left **incomplete**. The chiselling of ridges were gradually removed with grooves to obtain a flat surface. Gupta calls this work of removing the ridges as 'pecking'. In this method, the final shape of the cave arch, ceiling, walls and flooring was obtained, after which a fine smooth surface was attained by using the flat chisels. The walls and ceilings might have been rubbed with stones, mixed with sand and water so as to remove all the chisel marks. Finishing was probably done simultaneously on the outside when the interior work was going on. Cutting of the mass between the architectural members, probably went on side by side, as Vidya
Period II: A Sculptural panel showing sculptors excavating a cave 
Bahrut
(Reproduced from S.P.Gupta, The Roots of Indian Art, Delhi, 1981, p.206, Pl.4 (b))
Dehejia has observed from the unfinished cave V at Ajanta. The cutting of the cave according to her, began from the ceiling, downwards, thus minimising the need for scaffolding in the preliminary stage. On the other hand, S.P. Gupta has opined that the work of cutting the cave progressed from the bottom to the top upwards. Kail however, agrees with Dehejia in this regard.

On observing some of the unfinished rock-cut cells at Guntupalli, the process and techniques of excavation can further be explained. In the first stage, the design was drawn on the rock which was then cut to get a perpendicular line so as to obtain a clear vertical face. This enabled the workers to proceed with the plan into a verandah or hall or the cells inside. After making the initial arrangements for minimum scaffolding, the cutting was probably started from the ceiling. In the next stage the horse-shoe projected gables over the doors and windows were taken up for workmanship and these were blocked out. Raised beds and niches were also carved accordingly.

There is no evidence to learn, on how much time it took for excavating these caves. This probably varied from place to place. At Guntupalli, for instance, it must have taken at least four to five years for completing both the chaitva and the viharas. This is on the basis of an estimate provided by S. Mizuno and T. Nagahiro in the case of the Buddhist caves at 'Yun-Kang' in northern China, excavated during the 5th century A.D.

During the period from the beginning of the 5th century A.D. the activity of cutting the rock for building Brahmanical temples has been
noticed at the Undavalli, the Mogalrajapuram and the Akkanna-Madanna caves near Vijayawada in sub-region C, the caves at Bhairavakonda in sub-region B belonging to 5th-7th centuries A.D., and the caves at Gandharikota and Adavi Somanapalli in sub-region A which belong to the 9th century A.D. [Chart V C & Map IX].

After a lapse of four centuries, the rock-cut tradition was revived for building religious shrines, this time those of the Hindu faith. The caves at Mogalrajapuram and Undavalli were cut in sandstone while at Bhairavakonda the rock cut into was a schistose intrusion, in the hill particularly chosen, owing to its soft nature for scooping. Here, it should be mentioned that the earlier Buddhist caves were cut in Khondalite stone. There are two rock-cut caves in the Akkanna-Madanna group, five each at Undavalli and Mogalrajapuram. The cave temple in each case, contains a rectangular pillared hall with a single shrine chamber and sometimes with three cells. At Bhairavakonda the rock-cut caves are eight in number, similar in plan, with a square chamber in the rear and a pillared hall in the front. In the early caves at Vijayawada the beams, brackets and pillars were short and massive, devoid of sculptural decoration and with minimum inter columnar space like the Pallava cave temples. The pillars of the early phase of rock-cut activity initiated by the Pallava architects were massive and short and there was a tendency for the pillars of the latter phase to become thinner and taller. Sometimes they were flatter with an oblong section and the space between them was wider. The mandapas of the Pallava cave temples were divided by an inner row of pillars and pilasters into artha and mahamandapas. The pillars of the facade clearly resemble more the conventional type of contemporary
DISTRIBUTION OF ROCK-CUT MONUMENTS
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## Period II: Rock-cut Monuments

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<th>Brahmical</th>
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## Period IV: Rock-cut Monuments

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structural temples. The mandapas of the cave temples at Vijayawada were divided into proximal and distal sections, the outer corresponding to the mahamandapa and the inner to the arhtamandapa. The front elevation of the facade was often cut to a varying depth into the sloping face of the rock according to the degree of the slope. The required height of the facade was cut with an adhistāna as at Mogalrajapuram, having a flight of rock-cut steps in front. The top of the pillars were cut with massive taranga capitals with beams. The overhanging ledge projecting above the beam was left as a kapota and was sometimes made with decorations.

The Durga cave at Vijayawada is the earliest, followed by the Akkanna-Madanna caves, with archaic features such as plain pillars. The development is seen in the next stage of rock-cut technology in these caves where the triple shrine cave was provided with taranga type of capitals for the pillars. Besides a spacious open front and decorated mouldings, on adhistāna and prastara were also noted as improvements over the earlier caves. The Undavelli caves being the largest of the group at Vijayawada, reveal further developments in the rock-cut technology when compared to the Buddhist caves of Guntupalli in terms of plan, elevation, execution and amenities provided, like having stepped entrances with balustrades, spacious pillared halls for congregation and festive occasions, a broad opening on the front side, allowing sufficient light into the interior mandapas and even into the cells. Access from one storey to another was possible through the rock-cut steps [Plate XVI]. Excavated in three storeys in receding order, excluding the unfinished ground floor, these caves are akin to the Do-tal and Teen-tal caves at Ellora. The pillars of the ground floor were massive and without bases or capitals whereas the
Period II: Rock-cut Stupa, Karukonda, Sub-region B

Period III: Storied Rock-cut Temple, Undavelli, Sub-region C
pillars of the upper storeys had the taranga capitals. The portion above the beams was carved like a cornice with Kudu decorations.

The softer nature of the mass and low tensile strength naturally allowed the sthapatis and workers to go deeper into the rock as at Undavalli whereas the hard granite rock at Mamallapuram restricted the size of excavation. The process of excavation was done by the blocking and pecking techniques, as denoted by the chisel marks in the unfinished caves. After excavating the ground floor, some portion on the top was removed by scooping to obtain the vertical face. The design of the first floor and other floors was done by this method in descending order. The door jambs were carved with dwarapglas. The elaborate plans, elevation of storeys and expanse, fluted middle sections of the pillars, with corbels on the top and sculptural decorations when compared to other caves at Vijayawada were a substantial technical advancement from the earlier period. Since the caves were excavated at different heights, the excavators saved both labour and expenditure by following the configuration of the rock and by connecting different caves wherever necessary by rock-cut steps.

At Bhairavakonda in sub-region B, a further development in rock-cut technology is observed, as, here the hill was scooped into caves at different levels presenting a panoramic view to the visitors. The front side slope was cut and totally removed to attain an open terraced front court, giving access to the temples and to accommodate more people on special occasions. The pillars of the facade were carved with aśwapada fluted shaft and there was a special arrangement of the kuḍam, disc and taranaa podikas. Some times the front pillars were carved with lion bases.
similar to the ones found in the caves at Mahabalipuram. An increase in decoration and creating additional members to the pillars is a marked development here in comparison to the Undavelli examples. The pillars support the well-defined uttaram and kapota decorated with haṁsa, vāli and nāsi motifs. The sthapatis who were adept in structural engineering recognised that the pillars at the wall side were non-functional like the central ones and hence, provided half or engaged pillars. The size of the pillars was also reduced allowing sufficient light inside, in contrast to the massive pillars of Vijayawada caves.

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At Gandharikota there are two rock-cut cells hewn into the natural rock on the southern face of the local hillock. On the hind wall were hewn some triangular niches for keeping lamps. The presence of mortice holes in the door sills indicates some sort of wooden doors for the cells. The roof portion was constructed with dressed stones above the rock-cut walls. The door-ways were carved with designs suggesting a date of about the 9th century A.D.

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At Adavi Somanapalli a new technological development can be seen as in the case of the first cave. The rock surface here has been cut perpendicularly and then scooped into the plan of a mandapa supported by two non-functional crude pillars. In the second cave a beam and cornice were introduced and the pillars were cut with square bases, octogonal sections in the middle, and a square block, topped by taranga type of podikas below the beams. In the third and fourth caves, shrine chambers with a door-way were added by scooping. Some art motifs such as purnaghata on the door jambs have been depicted. The next stage of development is seen in the fourth cave where its flat ceiling was plastered with lime to
obtain a smooth surface and then painted depicting some Puranic themes in different colours. On close observation it is noticed that the process of cutting the rock was the same as in the case of the above examples. The walls and ceilings were dressed flatly and were rubbed with stones to attain a smooth finish. Pillars were cut to a height of 2 metres whereas the height of the ceiling was 2.20 metres. Based on stylistic grounds these caves have been dated to the 9th century A.D.

To sum up, the origins of rock-cut technology in Andhradesa can be traced back to the 3rd century B.C. and it continued to be used for excavating religious structures up to the 12th century A.D. However, its continuity was broken in two spells, i.e., from the 1st to 5th centuries A.D. and from the 9th to 11th centuries A.D. In other words, this technology gradually became less important and then totally disappeared after 12th century A.D. This is because, activity of building the temples with stone as well as brick had gained momentum by the 7th century A.D. The latter were now distributed over the plains whereas rock-cut technology was restricted to religious structures that were spread over hilly areas especially Buddhist and Jaina monasteries.

The above descriptions were taken up sub-regionwise against a site wise detailing of the various aspects which facilitated us to enquire the diffusion of rock-cut technology from the contiguous regions and highlight variations from one sub-region to another within the Andhradesa. The activity of using rock-cut technology was found in building different monuments such as the Buddhist chaityas, vihāras complexes and cave temples of Brahmanical faith. Among these, as discussed above, the Buddhist
chaitva at Guntupalli in sub-region C belonged to the 3rd century B.C. and is the earliest monument cut into the natural rock, imitating the contemporary wooden structures, in shape and the Mauryan examples of Lomas Rishi cave in plan, elevation and execution. The rock-cut technology might have originated to create permanance. Further, monks needed to be away from posh habitations. The caves were cut with arched entrances and halls finished in vaulted roofs with radiated ribs.

Though the buildings of rock-cut technology are distributed in sub-regions A, B and C it is seen that in sub-region C there were a large majority of them concentrated. It was because of the rock deposits of Khondalite and Scists that facilitated the architects to scoop rock-cut monuments in this sub-region. The probable techniques employed in cutting these monuments included drawing of the plans and removing the stone in 'blocking' and 'pecking' techniques followed by chiselling.

The rock-cut technology initiated by the Buddhist architects during the 3rd-2nd centuries B.C. in sub-region C disappeared from the 1st century A.D. because of the lack of patronage that had been mainly fostered by royalty and merchants. This in turn was due to the decline in trade on the coastal port towns of Andhradesa. It was during the 5th-6th centuries A.D. that the rock-cut technology was resumed in the same sub-region in the excavation of some Brahmanical cave temples. The caves in and around Vijayawada, and after two centuries, at Bhairavakonda have been scooped into pillared halls, with ante chambers and sometimes, with three levels of excavated structures. The techniques employed at Bhairavakonda were more akin to those found at Mahabalipuram in Tamil Nadu, a region contiguous to sub-region B. There were few rock cut caves in sub-region A as noticed.
only at Gandharikota and Adavi Somanapalli. After a lapse of three centuries the activity was found at some Jaina caves at Sangamayyakonda in sub-region C. Artistic and architectural embellishments to provide sufficient light in the interior could not be fully achieved in rock-cut technology as a limited scope was possible for these. Further, from the early medieval times onwards building of free standing stone temples in almost all sub-regions gained momentum, supported by munificent grants offered by the local chiefs, nobles, and royalty. This hindered the progress of rock-cut technology and finally it disappeared by the 13th century A.D. in Andhradesa.
FOOTNOTES


5. Ibid. p.2.


18. G. Jawahar Lal, Jainism in Andhradesa. (as depicted in Epigraphs), Hyderabad, 1994, p.36.


38. ASWI-V. Ins.no.475.


43. Jgataka. vol.1, nos.475, 490.


46. ARAP. 1982-83, p.9.


53. Ibid. 1981, Pl.86b.


55. This can be deduced on observing the work of present day sculptors.


61. Ibid, pp.21-23.


65. Ibid. p.124.

66. Ibid. p.125.


68. Ibid. 1965, pp.17-18, Pl.IV, fig.4.


V.2 BRICK MONUMENTS
A change in the technology from rock-cut to brick has been noticed in free standing brick buildings which began in Andhradesa from the 2nd century B.C., i.e., Period II onwards and continued up to the 13th century A.D., i.e., Period IV. Rock-cut technology had to give way to brick because the former could only be located where natural rock was available whereas, bricks could be used anywhere, i.e., plains and hills. These brick buildings can be studied in their different forms ranging from chaityagrihas, stupas, and viharas of the Buddhist faith and temples of the Hindu faith.

We begin our discussion with the chaityagrihas built in brick as these are the earliest brick structures known in the region under study. The chaityagriha at Guntupalli in sub-region C is datable to the 2nd century B.C. This circular chaityagriha was raised on an adhistāna, having mouldings of upana, iagati and prati. Inside it, the wall portion was built to plumb, whereas the outer wall had projected mouldings from the wall. These mouldings have served as the footings of the basement and have also given beauty to the building. As the brick technology was in its initial stages, the masons provided heavy walls though this does not seem to have been necessary. Bricks were of the wedge shaped type and set in mud mortar with thin joints. Chamfered bricks were used for the mouldings denoting that the brick makers followed the designs intended for the proposed buildings and also prepared moulds accordingly in required sizes and shapes. These bricks might have been manufactured at the foot of the hillock, where, it is noticed that fine clay free from sand and gravel and
water were easily available. Burnt bricks must have been carried to the hill top by head loads since the way to hill top was only meant for walking as no cart track can be located here. Wet clay paste was used as binding material. The constructional features of the circular brick Chaitva at Guntupalli reveals that the circular plan was almost copied from the local rock-cut examples. Circular chaitvagrihas have also been reported from Bavikonda, Thotlakonda and Salihundam in the same sub-region [Chart V B 3, 25, 28] [Map X].

The surroundings of the Chaitvas at Bavikonda and Thotlakonda were paved with rubble and plastered with lime [Plate 8]. The floors of the Chaityas were also plastered. Usage of lime was a technological improvement than the earlier use of mud mortar as lime offered longevity to the structure and also arrested the leakage of water. Lime must have been adopted by the builders after thoroughly observing the weathering effect on the unplastered ones.

Besides the circular ones, apsidal Chaityas were also built for Buddhist worship. The earliest apsidal Chaitva built in brick has also been noticed at Guntupalli. This is followed by the ones at Ramatirtham, Sankaram, Bavikonda [Figure 8] and Thotlakonda, all located in sub-region C, and at Chandavaram and Nagarjunakonda in sub-region B [Chart V B 14A, 23, 26, 3, 28, 6, 18]. The apsidal Chaitva at Guntupalli, dated to 2nd century B.C., was located on a levelled terrace of the hillock which measured 16.75 x 4.40 metres in length and width respectively. The thickness of the side wall was 1.30 metres. A partition wall was constructed to separate the apse from the hall. Both circular and apsidal
(a) A circular brick Chaityagriha, Thotlakonda, Sub-region C
(Reproduced from V.V.Krishna Sastry et al, Thotlakonda, A Buddhist Site in Andhra Pradesh. Hyderabad, 1992, Fig.No.8)

(b) An apsidal brick Chaitya, Bavikonda, Sub-region C
(Reproduced from N.R.V.Prasad, Bavikonda: A Buddhist Site in North Coastal Andhra Pradesh, Hyderabad 1994, Fig.No.7)
Chaitvas were built simultaneously. Niches were provided in the wall probably to keep objects of worship or lamps. Door jambs were also constructed with brick in semi-octagonal plan. The basement was decorated with moulded bricks. The roof of the Chaitva was of brick and lime in barrel vaulted shape. A notable development in the brick technology noticed here was the reduction of the thickness of the wall to 1.30 metres when compared to 2.14 metres in the case of the circular Chaitva described above. Perhaps the masons might have constructed the latter with more width than the required for the sake of stability. Though it was difficult to make the apsidal chaitva, the shift from circular to apsidal plan may have been made as the latter accommodates more monks and worshippers inside it, than the former one.

Some interesting constructional features have been noted in an apsidal Chaitva griha at Chandavaram in sub-region B datable to 2nd century B.C. The walls were constructed with brick courses whose middle portion was filled with rubble and pebble set in mud mortar. This can be said to have been an improvement in the building technology as the use of brick was curtailed and excessive wastage of it was saved. Interestingly, the entrance was constructed terminating into a semi-circular plan with a narrow entrance, an innovation noticed only in this example. In the later examples of apsidal Chaitvas found at Thotlakonda, Ramatirtham, Sankaram and Salihundam, moulded bricks were used at the plinth level. Recovery of terracotta finials within the Chaitvas lead us to surmise that the barrel vaulted roof was decorated with finials made by specialists in the field.
During the second phase of Period II of our study, the apsidal Chaitvas at Nagarjunakonda in sub-region B of the 3rd century A.D. [Chart V B 18] were constructed on well elevated platforms. These raised floors were approached by flights of steps. This might have been due to the low lying profile of the area near the river, with possibility of water stagnation and to overcome this, the floors were raised. The interior floor and the surrounding area of the Chaityas were laid with lime concrete or, sometimes paved with dressed slabs. Laying of lime concrete on the floors was also an improvement in the building technology of the period as in the earlier period only lime mortar was used to plaster the floorings. Stone pebbles and brick bats were mixed in the lime mortar probably to attain longevity of the floor so that it did not demand periodical repairs.

A further development in the building technology of the brick structures was noticed here as the outer walls were encased with stone slabs. This was an engineering technique applied to arrest the rain water from entering the structure. For an earlier period at Thotlakonda stone slabs were planted only upto the plinth level whereas here the slabs were arranged upto the wall portion.

Construction of partition walls was continued with a view to probably provide a clear background on the rear portion for the votive stupa or idol in the chaityagriha. The architects, after careful consideration and observation, wanted to transmit the super imposed load of the roof by arranging the lime stone pillars duly inserted into the longitudinal wall. Every care was taken to relieve the walls from receiving the load. Wedge shaped bricks were used for the apse portion, of the Chaitva. the votive stupa and the moon stones. In constructing the walls, scaffolding probably of wood and ropes must have been used. Foundations below the groundlevel
were laid by excavating a pit into the ground to a depth of 1'-0 and this was filled with random rubble stones set in mud mortar as a level course upon which the brick courses were raised.

The above discussion reveals that the brick built Chaitva plans were circular and apsidal and had moulded basements which probably provided for additional strength to the structure. The floor levels were raised to considerable height and were approached by steps. Mud and lime were used for masonry, flooring and plastering. Later, the Chaitvas were provided with stone basements as seen at Nagarjunakonda, a new development not noticed in the brick basement at Guntupalli. The doors were provided with brick jambs. Wedge shaped, rectangular and square bricks were manufactured. The vaulted roofs were made of bricks and lime mortar. The vault shape was probably arrived at by arranging a wooden frame or using the centering technique. The walls were invariably plastered in the early examples and were then encased with stone slabs in the later periods. Overall an improvement is seen with regard to the brick technology which was evolved in the construction of chaitvagrihas.

A similar development is underlined in the next part of our discussion which dwells on the building technology of the brick stupas. The antiquity of building stupas in Andhradeśa goes back to the 4th century B.C. It can be stated that below a later dated stupa at Amaravati, a megalithic burial was found followed by the evidence of NBP ware and Mauryan polish which suggests the early beginning of stupa construction. A simple building technology was involved in making funerary structures in case of the pit burials and dolmenoid cists which were constructed above the ground level.
in hemispherical shape. For instance, the funerary structures noticed at Chagatur, Peddamarur and Gondimalla in the form of the construction of the circle with dressed stones and cairn filling were in hemispherical shape. At Chagatur there was a raised basement resembling a Pradakshināpatha. Ultimately, these developments contributed partially in laying the foundations for the development of stūpas from the technical point of view. These emerged in the early historical context of Andhradeśa. In this context, it is interesting to note that a small stupa at Amaravati was raised exactly on an urn burial.

We have some evidences on how stūpas were to be built in the literature of the Buddhists. It is significant to note that the techniques involved and the process of building a stupa has been fully explained in Buddhist texts like the Mahāvamsa datable to 3rd century A.D. According to it the stupa construction should be supervised by a superintendent of works called as Kammādhiṭṭāva or Navakarmika. In this connection the first step suggested according to the above work was to select a proper site for the proposed stupa. Next, this site was to be marked by putting a post on the ground. On an auspicious day, the people and the King were supposed to attend the site for laying the foundation stone. The foundations were to be filled with pulvarised stones mixed with slabs. This system contributed to the making of a solid base for the construction of a hemispherical dome. The text further adds that a Pradaksināpatha was to be provided all around the dome, which was to enable the pilgrims to circumambulate the dome. In the second stage the drum was supposed to be constructed with bricks and then encased with stone for stability. It can be said that for the early stūpas, the anda was constructed of mud which was covered with brick or stone later as observed at Chandavaram. This formed the third stage of the
construction. After that a hārmika with a post in the centre, crowned by umbrellas was to be kept as the last stage of construction. The text continues to describe that a second Pradakshināpatha around the base of the stupa was to be constructed subsequently. Railings of wood or stone were to be erected around the pradaksināpatha and hārmika. To reach the drum, a sodana or staircase was to be constructed. The Mahāvaṁśa also suggests that the stupa construction must be considered as a collective project, in which everybody joined hands and its completion, the text says, was to be a source of joy for ever.

In all probability keeping in view the textual traditions and taking into account the methods delineated therein, the architects of early Āndhradeśa normally selected a suitable site in close proximity to where building materials such as stone were available or, near the river bed for collection of alluvial soil for making fine bricks and mortars. The availability of water needed for construction and lime deposits also determined the choosing of a site. Alternatively, the hilly tract was also often selected as the terrain served as a good foundation for the buildings saving a lot of expenditure on making the foundations.

The Buddhist stupas built in brick, both solid and wheel-shaped types have been found mainly in sub-regions B and C. These two sub-regions have fertile tracts and were well connected by trade routes both land and sea and therefore, they became the locales where Buddhist pilgrims concentrated. Very few stupas have been noticed in sub-region A, this being an area with largely semi-arid soils. For probably the same reason only one Buddhist stupa has been noticed in sub-region D. stupas
constructed on hills, exploiting the natural sloped terraces have been noticed at Bavikonda, Thotlakonda, Pavurallakonda and Gopalapatnam in sub-region C, at Chandavaram, Phanigiri and Nagarjunakonda in sub-region B, and at Nandaluru in sub-region D.

In sub-region C, the earliest stūpa was constructed at Amaravati. Some of the earliest donative records mentioned it as mahāchaitva datable to the 3rd century B.C. Recent excavations at the site conducted by I.K. Sarma have revealed a two period sequences in which Period IA is characterised by early Mauryan building activity datable to the 4th century B.C., and Period I is, which, said to be Asokan, i.e., the 3rd century B.C. The latter has yielded a good number of Northern black polished shreds and some structural additions. The above evidence reveals that the stūpa at Amaravati had its foundations right from the pre-Mauryan period.

The stupa at Amaravati was a solid variety type, filled with brick [Chart V B 2]. The vertical portion of the dome was also embellished with slabs. The curved portion was plastered in lime and had stucco decorations. Over the top of the drum was a harmika railing from the centre of which rose the shaft of the Chātrāvalī. It's size was the largest of all the stūpas of Andhradesa and measured 168'-0 in diametre at the dome and 198'-0 including the lower Pradaksināpatha. The drum had a projection of 32'-0 by 6'-0 avaka platforms built of brick at the cardinal points. There was a Pradaksināpatha around the drum with a width of 11'-3" paved with slabs on a well laid brick flooring.

The stūpa at Vaddamanu (area VDM IV) has also yielded NBP ware during the course of excavations. There is a label inscription found on
the rock reading Rāiā Dā (So) maka which, along with the NBP ware, indicate that the beginning of the stupa construction can be datable to the Mauryan period. The method of construction here, however, varies from that of the Amaravati example of the similar period. The Vaddamanu stupa has three concentric circles with a width of 120 metres, each arranged with stone blocks and brick linings on either side. The solid variety of stupas have also been found at Dhulikatta, Bhattiprolu, Chandavaram, Bavikonda and Thotlakonda [Chart V B].

The stupa at Bhattiprolu was built of brick with the central portion in wheel-shaped plan. Scholars like I.K. Sarma opine that the beginning of the wheel-shaped plan must be traced to the Mauryan time. The tube-like brick body at the centre of the stupa was intended for marking the centre of the dome in order to facilitate the laying of brick courses according to plan. In this connection a passage in the Mahāvamsa describes that a King Devānampiya Tissa (c.250-210 B.C.) should be remembered, as, he selected an auspicious site for the future construction of a Mahāstūpa and in doing so, his first action in this connection, was to mark the spot by the erection of a vupa. The drum and dome parts came to shape after the wooden and axial parts were fixed. The Pradakṣiṇāpātha was paved with brick. Wedge shaped bricks were used on the central hub portion. An inscription in 3rd century B.C. characters has been found on the relic caskets recovered from the stupa at Bhattiprolu, which records that the stūpa was constructed by one Raja Kuberaka probably a local Chief or King.

The stūpas at Dhulikatta and Chandavaram datable to the 3rd-2nd
centuries B.C. belong to the solid variety type. An important aspect which can be said to be a technological improvement in constructing brick stūpas has been noticed at Dhulikatta. Here, the stupa was constructed on a raised platform of bricks built on rubble foundation, whereas the stūpa at Chandavaram was built on a levelled terrace of a hillock [Plate XVII]. In both the cases, the core was filled with brick and mud. At Chandavaram, the architects, with foresight, took advantage of a natural hill slope in arranging the terraces of the stupa in order to obviate erosion which would have caused seepage of water into the foundation of the stūpa during the rainy season. Bricks were paved in header and stretcher method. Wedge shaped bricks were used at Chandavaram, whereas, at Dhulikatta the masons filled the gaps between the rectangular bricks with earth and brick bats to be able to get a perfect circle. Plastering was done in both the cases. Another technological achievement which can be seen in case of the stupa at Garikapadu that belongs to the 3rd Century B.C., was that its central core was filled up with lime concrete, which afforded stability to the structure. This is a rare feature to be noticed at such an early date. Stupas constructed with similar constructional technology have also been noticed at Gudivada, Thotlakonda and Bavikonda in sub-region C built between the 2nd century B.C. and the 1st century A.D.

From the next phase of Period II, i.e., from the 2nd century A.D. onwards stupas were built in brick in wheel-shaped or in concentric circles with radiating spokes connected to the hub some times, in Swastika shape or, in square shape emanating from the hub at the centre. The stupa at Pedaganjam had its hub in Swastika pattern. The stupas at Ghantasala, and Alluru, in sub-region C and the stupas at Nagarjunakonda, Phanigiri, Jaggayyapeta, Gummadidurru and Nelakondapalli [Plate XVII]
Period II: Solid type of brick Stupa, Chandavaram, Sub-region B

Period II: Wheel-shaped brick Stupa, Nelakondapalli, Sub-region B
in sub-region B were built in wheel-shaped plan. A majority of the stupas at Nagarjunakonda were built in wheel-shaped plan with avaka platforms [Chart V B]. Here the stupa at site 43 had a brick rim on the outside and the interior was packed with rubble and earth. They were provided with 4, 6, 8 and 10 spokes. In highlighting some of the technological aspects noticed by us, it can be pointed out that the wheel-shaped plan had gradually evolved and came to be selected as it provided better structural stability. It also minimised the expenditure on materials. Based on the size of the stupa the number of spokes were, accordingly, increased as a constructional technique to ensure stability. In case of larger stupas the strength was ensured by the addition of rings connected by further radial walls, which were plastered. For example, the stupa on site 9 at Nagarjunakonda had two concentric circles, each 24 ft and 41 ft in diametres and with eight and sixteen spokes respectively. In the first instance the first circle was built with 8 spokes and in between this was filled with mud, whereas, the second concentric circle was connected by sixteen radiant walls also filled by debri and finally, the outer wall was built with bricks. This arrangement was obviously done for attaining the best possible structural stability.

It has been noticed that stupa building activity began on the plains. These were mainly of the solid variety type, filled with earth inside the brick walls of the drum and the dome. Making of wedge shaped bricks and their use for stupas was noticed for the first time in early Āndhradeśa at Amaravati. Great emphasis was laid on stability and durability, without using stone on the basis of a new technique of providing internal concentric circles. Pradaksināpathas were also paved with bricks and plastered. Steps leading to the upper Pradaksināpatha were
built of bricks and plastered as seen at Chandavaram. The stupas built in brick technology reveal that the builders were experts in layouts, making circles with a central axis or tube like vupa. After making the plan they started building the drum and the dome of the solid variety type. This was followed and perfected by innovating the wheel-shaped stupas while ensuring the structural stability. Mud was used as binding material. The inner core was filled with mud, morrum, brick bats stones and sometimes with mud and bricks in alternate courses. Some stupas had rubble foundations as in the case of Thotlakonda, Bavikonda and Gopalapatnam in sub-region C and Dhulikatta in sub-region A, whereas the stupas at Chandavaram and Phanlgiri were built on hilly terraces [Chart V B].

There was a gradual evolution in the building of stupas in early Andhradesa. Though brick work was considered inferior to stone masonry, it was realised that this could be overcome if the bricks were properly manufactured and laid in layers. In fact, this had the advantage of being composed in small units and gave a flexibility of greater constructional possibilities. This was specially needed for the construction of circular buildings and the knowledge of good brick making techniques was essential for the execution of such works. Regarding the stability of formation and strength of construction, Percy Brown writes in the case of the Amaravati stupa, that it "formed a grand structural foundation to the Mahastupa". Using gnomon for marking the orientation of the building and other such aspects all speak of the involvement and expertise of the building technologists and engineers of the age. Regarding the transportation of materials and execution of stupa buildings, we have some idea as to how this was done, as, it is found depicted in the Barhut Sculptures. In
This representation, the bricks, stone blocks and paving stones are seen loaded onto carts which were drawn by a pair of humped oxen. One of these is seen having arrived at the site and the animals are shown unyoked, while a porter is shown carrying basket loads on his head or shoulder between the cart and the building site. The brick pavers are seen squatted on the ground arranging the material on the prepared ground in a regular pattern. For this early period such descriptions on technology are rare pictorial evidence.

Viharas were part of Buddhist religious establishments and the dwelling places of the monks. They were also built in brick at a good number of Buddhist sites both on plains and on hilltops. vihāras situated on the plains have been reported from Dhulikatta in sub-region A, at Nelakondapalli in sub-region B, and Dharanikota, Bhattiprolu, Gudivada, Alluru and Ghantasala in sub-region C [Chart V B]. Viharas on the plains have not been reported from sub-region D. Brick built viharas situated on hilltops have been noticed at Thotlakonda, Bavikonda, Gopalapatnam, Pavurallakonda, Ramatirtham, Salihundam, and Sankaram in sub-region C; at Chandavaram, Phanigiri and Nagarjunakonda in sub-region B and at the solitary site of Nandaluru in sub-region D [Chart V B].

At Amaravati in sub-region C, the existence of huts built of wattle and daub and posts near the stupa have been brought to light in recent excavations. These formed part of the Vihāra and are dated to the earliest structural activity at the stupa site which is said to belong to the pre-Mauryan Period IA, i.e., 400-300 B.C. At Bhattiprolu, a two winged brick-built vihara was brought to light which consisted of four cells, rectangular in plan, provided with verandahs, datable to 2nd century B.C.
To accommodate more monks the size of the vihāras gradually grew and partitions were made to provide separate dwelling rooms for the monks. These partitioned rooms were known as Parivena. The bricks were laid in course lengthwise on either side of each layer, sometimes, widthwise as stretcher and header, using mud as binding material. The hearthing, i.e., portion between the two brick courses of a layer, was filled with brick bats and mud. Brick laying was a fine testimony to the engineering skills of the period. The bricks used for construction of walls were fine, well burnt using the clay soils available nearby.

The exterior and interior walls were well-plastered in fine lime. The presence of seashells in the lime plaster indicates that they were grounded and mixed with river sand for preparing lime mortar and also used in lime concrete. This was noticed in the case of all the vihāras in the north coastal area of Andhradesa. Even today, people who live in coastal areas use seashells for making lime mortar, simply because they are locally available and serve as a good binding material. Lime making troughs have been reported from Ramatirtham. Slime of trees was said to have been mixed while plastering the vihāra. Trowels of different sizes had been used to plaster the walls. The vihāras were decorated with stucco designs and terracotta finials. Pieces of stucco work and earthen finials recovered from Thotlakonda and Bavikonda excavations attest to this. The excavations also yielded iron nails and revets, suggesting that wooden doors and rafters were used for the doorways and roofings respectively.

The floors of the vihāras were laid with small nodules of stone

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covered by lime plaster, which were sometimes given a brick paving. The other structures noticed at a good number of sites, as at Thotlakonda, included a store room, refectory and a kitchen. The kitchen complex called Kappivabhumi was built outside the Viharas, near water sources as noticed at Thotlakonda. There was also a refectory near it. The separate entity for the kitchen complex, away from the main monastery was probably meant to provide tranquility and sanctity for the residential cells. The technique in laying floor with lime concrete inside the refectory is interesting. The ground was first levelled and was partitioned with rubbles and bricks and then rammed. After that, lime concrete was filled up inside the blocks in order to keep it intact. The floor was thus laid, because, usually in a kitchen, the usage of water was considerable and could cause damage to the clay floors, thereby demanding frequent repairs. Often wet floors attracted termites and insects, which would also be unhygienic in the cooking area. To overcome these disadvantages, the builders opted to lay such insect or damp proof course, for floors, with lime mortar or lime concrete as at the refectory at Thotlakonda [Plate XVIII].

The Viharas at Chandavaram were constructed on stone foundations and were provided with verandahs. The flooring was strengthened by a deposit of compact mud concrete, mixed with chips of shale stones. These Viharas, on the recovery of Satavahana coins, have been dated to the 2nd century B.C. Chamfered bricks were used for the outer course of the wall to drain off the rain water. They also added beauty to the structure. Moulded bricks were used for the Purnaghatas, the bases of the pilasters on either side of the doorways. The cells at Thotlakonda had wooden doors with 0-60 metres as openings, provided with thresholds, Ummaras at the doors.
Thus carpenters and iron smiths played an important role in building these

The occurrence of a large number of perforated tiles suggests that the roofs of the Viharas were covered by them arranged one above the other on wooden rafters. The tiles recovered from the excavations at Thotlakonda were thick, well burnt and light red in colour. They had circular projections at the top and had deep grooves along the body. They were slightly convex, so that rain water could pass through the grooves easily. Each tile measured 18 x 15 x 2 cms. It had a thick edge on one side which was sloppy and its edge on the other side had a flat underside. Each tile had a deep side groove to provide better grip for the overlapping tile. Some tiles had perforation at the upper end which were meant for fixing to the frame of the roof. Similar tiles have been reported from Satanikota, Salihundam and Bavikonda [Chart VI B].

Some amenities were provided in the Viharas to meet the daily needs of the monks. A wooden peg, a bamboo, or a string was driven into the wall to hang the robes of the monks. Some cells had raised benches to keep valuable articles. Stone or brick benches called middis were allowed to be used as beds for the monks in the Viharas. Legged saddle querns with pestles have also been found in the cells.

The Viharas at Phanigiri were constructed on the hill top in different tiers. The walls were supported by brick buttresses so that the structure did not collapse and could also withstand rain water erosion. Remains of brick built Viharas raised on rubble foundation set in mud.
mortar has been exposed to view at Kesanapath and Nelakondapalli, [Plate XVIII] both datable to the 3rd century A.D.

The Viharas at Nagarjunakonda were constructed during the last half of the 3rd century A.D. They seem to have been built with definitely improved technical skills when compared to the preceding examples. They had some associated buildings such as kitchen, dining hall, store room, bathrooms with drainage facilities and some of them were connected to the Viharas with pathways or staircases consisting of balustraded steps. All the units were enclosed by a compound wall. The building materials were the same as those of the early phase of Period II mentioned above. The outer courses of the brick wall were decorated with mouldings in lime mortar at the plinth level. The number of cells in the Viharas varied from one to the other, ranging from two to thirty cells. The monasteries could accommodate nine to thirtytwo persons according to the space of the Viharas. The main change of the period was that the Viharas now had larger size cells which were also made more ornate. Most of the Viharas were of the Chatussāla type.

The walls of these cells were plastered in lime whereas the floors were paved with brick or laid with lime concrete. The roofs were laid with perforated or grooved tiles. Niches were provided in the brick walls for keeping lamps or books. A new development in the monastic buildings at Nagarjunakonda is that there were three separate chambers, two of which were circular in shape externally and square internally, the third one being oblong. H. Sarkar opines that these chambers might have been used by the senior monks, āchāryas or vināva dharas. Some technical skills were
Period II: A brick refectory with lime concrete floor, Thotlakonda, Sub-region C

Period II: Brick wall of a Vihara on rubble foundation, Nelakondapalli, Sub-region B
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<tr>
<th>S.No</th>
<th>Name of the Site</th>
<th>Sub-region</th>
<th>Situated on</th>
<th>Type of Buddhist Monuments</th>
<th>Type of Brahmanical Monuments</th>
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Key:
- O circular
- • Solid stupa
- M Mud
- □ apsidal
- ◯ Wheel shaped stupa
- L Lime
- □ square
- • Tile
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Key:
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- M Mud
- □ Apsidal
- Wheel shaped stupa
- L Lime
- Square
- Tile
involved in making these cells and these can be explained as follows. In the first stage a circle was probably marked on the ground with two diametres pointing to the cardinals being drawn. In the second stage the square or oblong shapes were derived. These arrangements needed some precision and mathematical calculations which the simple rectangular or square cells, usually arranged with set-squares, turning the quadrants at right angle triangle, did not need. This is certainly a development in how building plans were being made more sophisticated. The necessity to distinguish the dwellings of senior monks from the ordinary dwelling units of the other monks probably led to these innovations being made.

To conclude the discussion on Viharas in Āndhradeśa, it was noted that brick built ones were found situated on hills and on the plains located mainly near water sources. They were invariably constructed with brick using mud and lime as binding materials. Each cell was provided with doorways. Sills and steps ended with moon stones. Some cells had stone benches and pillows. The walls were plastered in lime and decorated with stuccos. The basements of some of the Viharas were constructed with chamfered or moulded bricks and the surroundings were laid with concrete. Wells and drains were provided. The floors were laid either by paving brick or concrete. Roofs were made with corrugated, perforated and grooved tiles. Well laid stone pathways were also noticed at many Vihara sites. Viharas of all the sub-regions had pillared mandapas. refectory, kitchen, bathroom, storerooms and other such facilities. The engineers of the period had a good fund of knowledge in structural engineering and understanding the relative strength of materials to be used for building rooms for the everyday living of the monks. According to Sarkar, the
circular plan of the early stubas might have been a copy of the existing primitive circular hutments, extant by the time of building the circular stupa. He further noted that the apsidal plan accommodated more monks inside the structure and provided a wider area than the circular one.

Structures made of brick affiliated to the Buddhist faith were contemporaneous with those of the Hindu faith in early historical Andhradesa. Based on archaeological evidence, it can be suggested that the earliest Hindu temples were found mainly in sub-region A and B, in particular, around the confluence of the rivers Krishna and Tungabhadra and distributed up to the Nagarjunakonda valley. The earliest Brahmanical temples were square and sometimes elliptical in plan, constructed of brick in mud mortar. To strengthen the walls, projected mouldings were constructed at plinth level. In the later stage of brick technology the temples were notable for their elaboration from having simple garbhagriha and antarala to the addition of mahāmandapas supported by monolithic columns. Occasionally, clusters of temples were enclosed by a prakāra wall. The floors were laid with lime concrete as well as brick and stone. Evidence has proved that the roofs were laid with thatch and tiles as a common practice, for the early historical period, i.e., Period II. The level of building technology of the early brick temples in Andhradesa can be known from the sites of their existence which have been excavated in the different sub-regions. The important among these are located at Gudimallam in sub-region D, Rangapur, Chabolu, Somasila in sub-region A, and Veerapuram, Nagarjunakonda and Chejarla in sub-region B [Chart VI B] [Map X].

Foundations of a Saivite brick temple datable to the 2nd century B.C.
has been reported from Gudimallam. In the subsequent phase assigned to the 1st century A.D. an apsidal brick temple was constructed around the Linga. This is a unique and exceptional evidence in the whole of coastal Andhra. It was probably influenced by the Buddhist structures which existed at this time in Andhradesa and both were similar in the technological aspects involved in building them. Other evidence was noticed at Chejarla in sub-region B, datable to the 2nd century A.D. where the temple was built on apsidal plan.

A good number of brick temples, datable between the 1st and 2nd centuries A.D. have been brought to light recently in sub-region A at various places. A square brick temple with a simple adhistana having upana and padmaiaqati. constructed out of chamfered bricks, has been reported from Rangapur. The flooring was levelled and paved with slabs. The thickness of the wall was 0.95 metres. The adoption of square plan to build a Hindu temple was an innovation here. The bricks were laid using the bond stones very close to each other. Their joints reveal the skill in fine joinry. The bricks were very fine in course, manufactured with local alluvial soil of the river Krishna and were well burnt. In my recent survey I have noticed for the first time, two brick temples of the Saivite faith, datable to 2nd century A.D. at Somasila in sub-region A on left of river Krishna. Both the temples had garbhalaya and arthamandapas.

At Veerapuram, in the first stage of construction of brick temples, the primitive feature of raising the wall with bricks with a footing has been noticed. All the temples in this stage had a circumabulatory passage around them suggesting an additional development in building the early
temples. They were also provided with well laid pathways to withstand the live load of the pilgrims. Temples further had drains connected to a trough, from which the accumulated water of ablution could be removed. This arrangement was made to maintain hygiene, an important aspect of consideration for the builders of those times. The adhīstāṇas were of the mañchaka type, in which the walls were provided with projected mouldings. The floors were brick paved ones on the level ground inside the temples.

In the second stage, datable to the 3rd century A.D., some significant technological advancements were noticed wherein the floorings were raised to a certain height with brick using lime mortar and the drains were lined with stones. Two more offsets were added at the bases suggesting for more strength at the plinth level. The aspects in building technology noticed in these early temples here were marked by the existence of square plans, brick floors, drains of bricks and stone and to the subsequent addition of mandapas to meet the ritual need of the congregations of people on the front side of the temples.

The last century of Period II witnesses a spurt in building activity of Brahmanical temples at Nagarjunakonda in sub-region B. The temples here were apsidal, oblong or square in plan with single or double shrines having mandapas in the front. The architects were experts in spatial organisation of temples and subsidiary temples were built within the compound walls. The thickness of the walls varied from 1.00 to 4.0 metres according to the size of the temples. The external and internal surfaces were plastered and stucco decorations were also continued to be made. The technique of the construction of walls was quite sound. Vertical straight joints were avoided and bonding was ensured by laying one header for every 461
two stretchers. The brick walls of the temples were encased by Cuddapah slabs externally, in order to buttress them and also to arrest the seepage of rain water. This is noticed here for the first time. A brick temple altogether in a different plan, i.e., garbhagriha in octagonal plan, with a rectangular antichamber alongwith some stucco decorative motifs datable to 3rd century A.D., has been unearthed at Kandi in sub-region A [Plate 81 XIX]. Floors were lime plastered, brick paved, lime concreted and stone lined. Significantly, kilns of tiles and lime pounding troughs have been noticed at the site. The technology of making multi-storied buildings as in the case of the Sarvadevadhivasa called as Srivilāsa was also known. Roofs were probably laid with bricks and tiles. The flat roofs were provided with roof drains facilitating the rain water to flow away from the roof as they knew that stagnation of water on the roof may lead to leakage. Thus by the end of Period II, the builders were found possessing sound knowledge in brick built technology and were experts in planning, organising and overcoming the defects of the earlier period. It is further noticed that though rock-cut technology had been popular around this time, free standing temples were initiated during the same period in brick technology. In addition to brick, stone was also employed side by side to encase the walls or for the staircases and the main cult objects in the temples were also of made of stone.

Building the temples with improved brick technology was further continued in Period III in Andhradesa. Brick temples of the Hindu faith have been reported from Gummadam, Keesaragutta, and Kudavelli in sub-region A, Yeleswaram, Chejarla and Siddeswaram in sub-region B, and at Pedavegi in sub-region C [Chart VI C] [Map X]. All the temples
Period II: A brick Temple on octagonal plan, Kandi, **Sub-region A**

Period III: A square brick Temple, Gummadam, **Sub-region A**
were built between the 4th and the 6th centuries A.D.

On plan, the temples were square at Gummadam [Plate XIX], Siddheswaram and Eeleswaram, whereas, the one at Pedavegi was in rectangular shape [Chart VI C]. Both square and rectangular temples were seen at Keesaragutta. In all the cases mud was used for brick masonry. The floors were arranged with bricks. Circumambulatory paths, all around them, were provided with bricks as at Keesaragutta and Pedavegi. Covered drains were provided to temples attached to brick troughs outside. This is a new development seen at Keesaragutta for the first time as the earlier temples had open drains.

The basements, i.e., adhistanas of the temples at Siddheswaram, Keesaragutta, Chejarla and Pedavegi were built with moulded bricks and sometimes with chamfered ones. A significant feature noticed at Keesaragutta was the arrangement of stone slabs horizontally on the brick basement for giving strength to the superstructure and also to transmit the load equally to the entire width of the wall. This temple is the best example for understanding the striking transition from brick to stone technology. Another significant feature of Period III was the construction of stone temples over the foundation of brick temples as noticed at Siddheswaram in sub-region B and Pedavegi in sub-region C.

The walls were built of bricks set in mud mortar with their joints. Postholes inside the temples at Keesaragutta and Pedavegi indicate the existence of thatched roofings supported by wooden posts [Chart VI C 6]. A notable development in building technology of this period has been revealed
in that the architects planned buildings to be constructed with elevated basements. By this the floor level was arranged at a considerable height from the ground level without allowing the rain water into the structure as noticed at Pedavegi and Keesaragutta.

In the subsequent phase of development from the 7th century to the 9th century A.D., temples built of brick have been noticed at Gollattagudi in sub-region A and at Pitikayagulla and Tripurantakam in sub-region B (Chart VI C 2, 7, 9) which reveal that the brick technology continued to be adopted, although magnificent stone temples were also built simultaneously all over Andhradesa. At Gollattagudi, some interesting features of brick technology have been noticed. The foundation trenches were excavated and filled with brick masonry of mud mortar, the remaining part of the foundation trench was filled with brick bats mixed with mud and finally rammed for consolidation. In the first phase of construction, i.e., during the 7th century A.D., the original ground level was raised at the temple by spreading the excavated morrum to a considerable thickness, so as to arrest the seepage of water. In the second phase, datable to the 8th century A.D., another brick temple was built, on a firmly laid stone basement of 1.80 metres in height over the rubble foundations. The foundation was then overlaid with flat dressed granite slabs which were paved all around the temple, to give an even surface for marking and building the superstructure in brick and also to add strength to it. This is obviously an improvement from the technology known in the earlier period. The walls, however were built as in the earlier examples. The brick was given a glazy finish and therefore failed to retain the lime plaster coated on it. The walls were decorated in stuccos, duly painted in bright colours. The builders overcame the disadvantages of small units in bridging spaces by using stone
for lintels, jambs, perforated windows and pillars. The temple at Gollattagudi now extant with its full view was built in four storees. Its interior was built in kadalikākarana fashion, i.e., the walls of the vimāna were built projecting inwards and leading to the top, to close the ceiling. The bricks were made out of fine and lavigated clay, well burnt and some sort of slip was given to offer a lustruous glaze visible even today [Plate XX]. This speaks of the technical achievement of the brick makers of those times. The bricks measured 40 x 20 x 7 cms. The bricks were pre-burnt and moulded according to the individual requirements. The excavator of this site is of the opinion that the necessary carved and ornamental details were chiselled out of the brick work after the walls were built. This view is however, difficult to accept.

The floors were laid with bricks and lime. A further development in the brick technology was marked by the usage of stone as an associate building material. Perforated jallis, windows, carved in style as found at the Alampur temples were fitted to the brick temples for providing sufficient lighting. The excavator, based on the style of the jallis has dated these temples to the 7th and 8th centuries A.D.

Temples built in brick were also known from Pitikayagulla and Tripurantakam, datable to the 8th and 9th centuries A.D. respectively, comparable to the western Ganga examples of Karnataka of the same period. Both sites are in sub-region B. The temple at Pitikayagulla is a square one with a simple adhistāna, plain walls surmounted by kapota, talas with a hemispherical dome. The walls and vimāna portions were plastered in lime. The top tiers were built with an outward curve on the top portion of
kapota. facilitating the rain water to drop to the bottom from the superstructure. The pillars of the front mandapa was devoid of a roof but bear close resemblance to the one found at a temple at Satyavolu, a nearby site, datable to the 8th century A.D.

The temple at Tripurantakam was also built entirely in bricks and is similar to the Gollattagudi example in all respects. Niches to keep the idols were provided for in the walls. The bricks were well moulded, set in fine mud mortar. Plastering of the walls was not observed here. As this temple has a close resemblance to the stone example of Rupala Sangameswaram temple, it has been dated to the 9th century A.D.

The above features lead us to conclude that brick technology was employed in building the temples beginning from the 1st century A.D. and continued upto the 9th century A.D. The plans were square, rectangular and apsidal. The foundations were filled with brick bats and stone. Brick and mud were the primary building materials. Walls were plastered. Stone slabs were also employed mainly on the walls at the basement level and for lintels and as jallis. The builders were experts both in the designing and execution of these structures. Many of these temples stand even today speaking of the technological skills of the people of early medieval Andhradesa.

In Period IV, though temples began to be made in stone most of the vimānas were built in brick, using light weight bricks and fine lime mortar. Mud as mortar was discarded once for all. Both chamfered and moulded bricks were used. The process of brick making was followed as prescribed in the Mavamata a medieval silpa text.
Sometimes, the entire miniature **sikhara** model was moulded solidly like dressed stone blocks which were fixed to the **vimānas** as noticed at **Palampet** and **Pillalamarri** [Plate XX] in sub-region B[Chart VI D 2, 3] (Map X). The inner portion of the brick **vimāna** was constructed in **Kadalikakarana** fashion wherein the **sikhara** was built generally by corbelling of courses of bricks overlapping each other inside, until they met and closed the opening with a stone or brick called **Mūrthnestika**. The outer faces of the brick **sikhara** were plastered with lime mortar and occasionally, decorated with stucco. Some **sikharas** were provided with **sukanāsīs** over the **arthamandapas**.

The thickness of the brick structure of the **vimana** at Adikesava temple **at Chebrolu** [Chart VI D 1] in sub-region C databale to 13th century A.D., has a wall all around, 1.50 metres in width, sometimes, even more than the thickness of the temple walls of the period. The brick work of the **vimanas** of the period was plastered with lime mortar called **vairalepa** a glue cement, made of vegetable substances mixed with several **ingredients**. The **Silpa ratna** prescribes that powder of lime should be mixed with saps of milky trees and sand in different proportions. Thus the architects of Period IV followed the **silpa** texts and possessed good knowledge of the use of brick technology which had now been refined for use in **vimanas** and **sikharas** only and these gave stature to the monumental buildings which survive even today.

Innovations in manufacturing Sun dried bricks had been made during the **last** phase of Period I as observed at Gandluru in sub-region B for the
Period III: A brick Temple with moulded bricks, Gollathagudi, Sub-region A

Period IV: Brick Vimana over Stone Temple, Pillalamarri, Sub-region B
### CHART VI C & D

**Period III: Brick Monuments**

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**Period IV: Brick Monuments**

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**Key:**
- O circular
- Solid stupa
- M Mud
- ∈ apsidal
- Wheel shaped stupa
- L Lime
- ∈ square
- ♯ Tile
- A Thatch
- X Stone
MAP-X

DISTRIBUTION OF BRICK MONUMENT PERIOD WISE

KEY: □ BUDDHIST MONUMENT ▲ BRAHMANICAL MONUMENT
A, B, C, D: SUB-REGIONS
first time, in proto-historic Āndhradeśa. It was at the beginning of Period II that brick was used **prolifically** to build **habitational**, public utility, defence and religious structures in Andhradesa and this trend continued up to the end of Period II. Building of residential, defence and religious structures in brick technology was done on a very limited **scale** because of the fact that stone technology gained momentum in Period III. During period IV, as stone became the principal building material brick became an associate to stone, and had been used to only construct certain parts above the stone roofed temple structures, i.e., the **vimānas**. It is also observed that as long as brick remained in use, thatched or tiled roofings were common for **all** types of buildings. As the brick structures needed frequent repairs such as the plastering of external surface, thatched roofings supported by wooden frames decayed and maintenance of these structures became very expensive and their life span was also comparatively short. Brick technology was therefore not found suitable to build monumental buildings which had to last long. To overcome all these disadvantages and to find an alternative building material which afforded longevity to the monuments, the brick technology lost its **prominence**. It had to give way for innovations in stone, since basements, walls, and ceilings all had to be made permanent. We next turn to discuss the evolution of building technology in stone which is described in the following section.
FOOTNOTES


8. **ARASI**. 1910-11, pp.79-82, pl.XLIII, *Fig.12*, 13.

9. Ibid. 1908-09, p.159.

10. **ARAD**. Southern Circle. Madras, 1919-20, p.34.


13. H. Sarkar, *Studies in Early Buddhist Architecture of India*. Delhi, 1966, p.80, *Fig.23*.


17. Ibid. p.58.


23. Ibid. pp.203-204.


43. ARAP, 1984-85, p.10.


50. IAR, 1973-74, p.4.
56. There are references to iron bolts and nails called *aqgalāni* or silver bolts, *rająttagalaṇī* were made as they were used for small door leaves. See *Jataka*. vol.V, no.169; vol.11, nos.276, 483.
58. Ibid, p.98.
61. The evidences of thresholds at Thotlakonda tallies with the descriptions of *Dhammapada Atakatha* as it mentions that 'Channa sleeps with this head keeping on the threshold', See *Dhammapada Atakatha*. 1.221.
65. ARAP. 1984-85, p.20.
68. A.W.Khan, *A Monograph on an Early Buddhist Stupa at Kesapalle*. Hyderabad, 1969, Pl.IV.
69. ARAP. 1992-93, p.12 (cyclostyled).
71. Ibid, pp.86-88.
A group of 13 temples have been reconstructed after dismantling them from the lower contour which were threatened by the Srisailam Project submergence at Somasila in Mahaboobnagar District. During my stay there I explored the suburbs of Somasila village and discovered these two early brick temples.

94. Ibid. Pl.11.

95. ARAP. 1971-72, p.6.

96. Ibid. 1972-73, p.8.

97. Ibid. 1971-72, p.5.


103. See Bruno Dagens, *Mavamata*. Pondichery, 1970, pp.310-311 wherein it is mentioned that to make bricks soils free from gravel, stones, roots, bones or clads had to be selected, having fine sand, of uniform colour and pleasant to touch. A lump of earth should be thrown into water and then stirred and kneaded repeatedly forty times with one's feet. Then it should be wet with waters of *Ksīra* pine, Kadamba, Amra and Abhyanksha trees barks and the waters of the three fruits Amalaka, Bahela and Haritaka and the process of kneading continued for a month. Then the bricks were prepared proportionately and were to be dried and evenly baked. After an interval of considerable time they were to soaked in water, taken out and dried completely and then used in the construction. But the method of preparing floating bricks like the ones used at Palampet temple has not so far been come across in any text.


106. At the Adikesava temple at Chebrolu in Guntur District as one of the participants in the conservation work of Vīmana portion of the same temple, I have noted these details. The temple in typical Kakatiyan style had a Sīkhara built with moulded bricks. A thick coat of plaster was observed here and there.

V.3 STONE MONUMENTS
V.3 STONE MONUMENTS

The construction of funerary buildings was initiated in monolith stone primarily by the megalithic people during Period I. Stone, because of its permanence was subsequently adopted for building stubas in the early historical period not only in northern India but also in Andhradesa. It was initially used either, as a protective measure for surrounding 1 enclosures or rail or, for structural supports. The activity of working in stone for monumental purposes began in India during the 3rd century B.C. when emperor Aśoka was responsible for selecting and employing stone as a medium for symbolic monuments in the shape of free standing pillars near stupas and for the railings of stupas.

The origin and development of building technology in stone can be studied in a variety of structural buildings like Buddhist stupas, viharas, mandapas, stone-pathways and temples of the Hindu faith, which are found in large numbers located in the different sub-regions of Andhradesa, beginning from Period II and continuing upto Period IV. It is significant to note that after the excavation of rock-cut temples, brick is never exclusively used but it is always used along with stone. Stone was almost always employed for flooring, drum and dome portions of stupas, railings, pillars, beams, steps, balustrades and for enclosing the walls of the stupas, vihāras and temples.

Some stupas were built with neatly dressed stones, encasing the solid 3 mud filled varieties as found at Guntupalli, Thotlakonda and Bavikonda in sub-region C and at Nagarjunakonda in sub-region B [Chart VII B]. The
core was also filled by stones or rubble as noticed at Vaddamanu and Gummadidurru in sub-region B. The dressed stones used for encasing the mud core were wedge shaped, which were joined closely with blade-like edges to both vertical and horizontal joints. Each dressed block was cut in convex shape vertically, to give the hemispherical shape to the stupa.

Most of the stone veneered stupas had brick body to the drum and dome portions. This method of construction of stupas in stone is a technological improvement when compared to those only made of brick. The stupas at Bavikonda and Thotlakonda were made of locally available khondalite stone, whereas the stupas of Guntupalli and Nagarjunakonda were of the Palnadu lime stone. As Percy Brown rightly opines stone was probably employed for stupas and accessories because other materials were subject to disintegrate owing to the rigours of the climate. Stone, on the other hand became the most common builders material because it was durable. Many stupas constructed of stone are found located in sub-region C and B only mainly because the geological deposits of lime stones in the Palnadu area in sub-region B and around Vizianagarm area in sub-region C were easily available [Map III]. At Pashigoan in sub-region A, the entire stupa was built with lime stone transported from Palnadu area to a distance of nearly 300 kms. The other reason why the Buddhists preferred lime stone in building the stupas was that it was easy to chisel and carve the drum and dome portions with Jātaka tales which were the common means of decoration, conveying a religious message. Lime stones could easily be cut and polished and as applied for facing the drum, avaka platform and dome of the stupas.

The drum, dome, avaka platforms of the stupas of Period II were faced
with lime stones and the railings were erected in both granite and lime stones, as observed in some of the above mentioned sub-regions of Andhradesa. The drum of the Amaravati stupa, datable to the 2nd century A.D., was veneered with decorated slabs alternating it with pilasters which were cemented to each other with strong lime mortar. The facing stone work required a frame work with enough strength to support the facing. This was achieved by the architects by introducing pilasters with vertical grooves on either side, in order to hold the casing slabs. This technique reveals perfection in structural engineering and a sound knowledge in building technology. The lime stone quarried in thick slabs from Palnadu area was transported to the workspot. The casing slabs were dressed in slight wedge shape, so as to suit to the circular body of the brick drum of the stūpa. The work of dressing was done with knowledge accumulated over generations of experience of the artists who were adept in handling the stone. The stone quarrying methods were more or less like the ones described while explaining the 'funerary structures of the megalithic tradition [Chapter IV]. Many stūpas in Andhradesa were encased with dressed slabs of lime stone, details of which are tabulated in Chart VII B.

The railings that served the purpose of protecting the religious edifices, i.e., the stūpas, were built of granite, limestone and khondalite stones, according to the availability of each variety in the particular sub-region. The stone used for the uprights of the railing at Amaravati was granite, which was quarried locally. They were carved in octagonal shape and polished by expert sculptors, by using the grinding technique, after dressing them with the help of pointed and flat chisels. There were three intermediary cross bars and these were finally crowned.
with a massive coping stone. The granite uprights bear lenticular sockets into which were fitted the cross bars recalling the techniques employed in the wooden examples. The uprights, often inscribed, bear typical Mauryan polish, which reveals that an earlier stupa was built by Asoka here in the 3rd century B.C. The railings of the Amaravati stupa also have a close resemblance to the typical Mauryan polish, noticed in the stupa railings of Vaisali and Sarnath. The huge granite slabs here, have footings at the base, in order to rest firmly on the ground, a feature noticed at a megalithic burial, i.e., the dolmenoid cist at Damaravai in sub-region B where, the outer circle was built with wedge shaped sandstones carved with bases on either side. It is observed that granite stone was used only at Amaravati in sub-region C in massive pieces, for the purpose of making railing during the 3rd century B.C. Stupas with lime stone railings, have been noticed at Bhattiprolu in sub-region C, Chandavaram and Jaggayyapeta in sub-region B. The absence of the use of granites in other sub-regions was because, it was difficult to quarry, cut, transport, dress and handle in building operations. The architects opted for lime stone which could be more easily handled and was further economical to use than the former.

The floors of the pradaksināpatha of the stupas and the inside floors of the chaityagrihas, vihāras and temples were laid with dressed stones. The pradaksināpatha around the Amaravati stupa was laid with cut limestones over the brick flooring. The floors of the vihāras at Thotlakonda and Bavikonda were laid with stone nodules covered by lime plastering. The floors around some stone stupas at Thotlakonda and Bavikonda were paved with large sized and dressed khondalite stones closely fitted [Plate XXI]. Steps and moon stones were also arranged by dressed slabs. The flooring of the pradaksināpatha at Jaggayyapeta was paved
with dressed slabs stretched across the interior of the stupa. The technique of laying the floor with lime concrete inside the refectory at Thotlakonda is interesting. The ground was first levelled and partitioned with rubble and bricks and then rammed. After that lime concrete was filled up inside the blocks in order to keep it intact.

The builders knew that the primary characteristics of a flooring material must be durable and be able to resist impact, abrasion, water, also be comfortable to walk on and finally, be easily maintained. The arrangement of floors in or around the structures described above, reveals the advancement and significant development in building technology of the period when compared to the limited longevity of clay, lime or concreted floors, noticed at some of the sites, viz., Dhulikatta, Pashigaon, Ghantasala, Bhattiprolu, etc. of the same period [Chart VII B]. The experience of the builders guided them to go for sophisticated stone floors so as to make them permanent. Some of them are still extant in good condition at sites like Thotlakonda, Bavikonda, Nagarjunakonda, and Phanigiri.

The mandapas at the Buddhist settlements were also constructed in dressed stones. The earliest mandapa in Andhradesa has been noticed at Chandavaram in sub-region B, where some interesting constructional techniques of a pillared mandapa are revealed in the excavations. On a strengthened and levelled terrace of the hill, the architects built a 16 pillared mandapa. The lime stone pillars measuring 3.0 metres in height, depicted with full and half lotus medallions, were found set up, four in each row. The pillars were found driven into the ground to a depth of 50
To prevent possible slide, a flat shale stone was inserted underneath and this in turn was girdled with construction of brick in two courses for affording stability. For fixing of the square bases of the columns, the shale bed was scooped to the required depth. The scooped slots measured 82 x 82 x 40 cms. The above points reveal that the architects were perfect in planning and utilising the hill terraces, by levelling and strengthening them so that they could hold the pillars of the mandapa. They also had sound knowledge in erecting the pillars of the mandapas, duly inserting them into the scooped ground and fixing the columns with stones, on which the brick casing could be made. The pillar bases at Vaddamanu in sub-region C were also reinforced with brick casing, datable to the 3rd century B.C. There are literary descriptions which tally with the practical knowledge as noticed in the construction of pillared halls just described. In literature, pillared halls, the mandapas are called Sthunavabandha harmva. In the Visuddhimagga, we find descriptions of the setting up of pillars in the foundations or the structural basement. They are described as being supported by stone bases and fastened to them with a kind of cement called sileša.

At Thotlakonda, excavations have brought to light a large square pillared hall, called upōsathāqāra used by the bhikkus to recite the pathimokha collectively by the sangha. This hall measured 23.5 x 23.50 metres and was situated in the centre of the vihāra. It had 64 pillars of khondalite stone with 8 pillars in each row. The hall had a raised platform constructed 25 cms in height above the ground level so that the rain water would not enter inside.

The foundation details of the pillars throw some light on the
engineering techniques known to the people. The pillars, 4.25 metres in height, were kept on dressed stone bases cut to a depth of 10 cms. inside so as to insert the base of the pillar. This arrangement, reminds us of the so called 'underpinning technique' employed for the foundations of the pillars at Thotlakonda [Plate XXI]. The depth of the foundation of the pillars at Thotlakonda was 60 cms. and this was fixed with rubble and earth tightly in the ground. Since the khondalite stone itself was quite porous and as such a monolithic pillar could not be extracted from the quarry, two stone blocks were fixed one above the other. Sockets were cut on the top portion of the pillars for fixing the wooden rafters to lay the roof covered with tiles. The pillars might have been extracted either from the area where the rock-cut cisterns were made or the local quarry, and were erected with a minimum number of people, using scaffolding and wooden pullies with ropes and also earthen ramps. A rare evidence of pillars carved with a capital comes from a ruined mandapa at Salihundam. Arrangement of capital in '+' shape is a technical advancement facilitating to receive the beams.

Mandapas constructed of lime stone pillars which are square from bottom to top, fluted in the middle section, were noticed at Alluru, Ghantasala, Ramatirtham, Salihundam in sub-region C and at Chandavaram, Vaddamanu and Nagarjunakonda in sub-region 8 [Hap IX & Chart VIII B]. We do not have any report of their existence in sub-regions A and D probably because the pillars were mostly made of lime stone here and this had to be transported from such a long distance to places like Dhulikatta or Nandaluru in sub-regions A and D respectively. These were two important Buddhist sites situated very far away from the deposit.
Period II: A stone veneered Stupa, Thotlakonda, Sub-region C

Period II: Foundation of a pillar in 'under pinning technique', Thotlakonda
quarries of sub-region C. The use of lime stone here was hence restricted only to decorate the drum and for a certain portion of the dome of the stupas. Slabs intended for encasing were generally thin sheets whereas the stone blocks for pillars were heavy and lengthy needing extensive expenditure and labour in transporting over a long distance. However, at Thotlakonda the availability of local khondalite stone, though not of a fine quality, was able to resist stress and strain. The technology of quarrying the heavy blocks was by the 'tongue and groove' method. The techniques that enabled the erection of menhirs in Period I were probably the same ones employed by the Buddhist architects in erecting the massive pillars of the mandapas.

Foundations and basements of the brick built viharas were constructed of rubble stones. The viharas at Chandavaram were constructed on shale stone foundation and artificially made terraces supported by retaining walls which were provided with stone and brick steps. The viharas at Thotlakonda, Nelakondapalli, and Nagarjunakonda were built on rubble foundations [Chart VII B]. Stone benches were provided in the viharas. The inner walls of the viharas at Nandaluru in sub-region D were encased with shale stones. A bathroom of the Buddhist establishment at Nagarjunakonda, constructed during the 3rd century A.D., had a stone trough, which was connected to an underground drain, built of Cuddapah slabs which was once again connected to a soakpit formed by alternate courses of rubble, pebble, sand and lime. This can be considered as a model specimen for even a modern sanitary engineer. Drains constructed with dressed stones and set in lime mortar are noticed at Salthundam in sub-region C and at Nagarjunakonda in sub-region B. Each vihara cell at
Bavikonda was provided with a stone threshold with sockets to fix the doors.

The most important engineering technique employed was in laying the pathways connecting the internal structures of the vihāra complex at Thotlakonda. The stone pathway was paved and buttressed with dressed stones with a revetment on either side [Figure 9]. The end of the pathway at each level was connected by means of steps preceded by moon stones, since different levels of the terraces had to be connected. At the beginning or, end of each, a pair of balustrades was fixed on either side. The balustrades with rounded tops and rectangular shafts, served to denote the level of a pathway to accordingly step up or step down. The protuberances were dressed evenly and the depressions were filled with rubble and earth and paved with flat stones, to obtain an even surface. A pathway paved with flat boulders and a stone revitment on either side was laid from the tank to the vihara at Thotlakonda. The building technology in laying the pathways involved at the first stage was to level the rocky surface by cutting and removing the undulations. In the next stage the levelled surface was pitched up, with dressed stones close to each other and the gaps between the stones were filled up with lime mortar. In the third stage, on either side of the pathway, vertical dressed stones were planted as buttresses and also, to act as a revetment in order to withstand the side thrust of the pathway. Stone pathways were also reported from Salihundam [Chart VII B, 19] Pathways were paved with stone blocks dressed on top, side and their bottoms were roughly hewn. The faces of the stones are large in area than the bed. Lime stones, Khondalites and shale had average abrasion resistance. Thus, the technology used to build
A stone pathway connecting the Vihara and kitchen complex.
Thotlakonda, Sub-region C

(Reproduced from V.V. Krishna Sastry, et al Thotlakonda. A Buddhist Site in Andhra Pradesh. Hyderabad, 1992, Fig.No.8)
pathways and roadways was considerably developed in Period II.

Stone as a building material was employed in association with brick construction to temples in Andhradesa from Period II onwards. The earliest evidence comes from a temple at Gudimallam where a sivalinga of black basalt stone, was set on the polished buff stone rings and enclosed by a square railing of lime stones. The carved slabs of the railing around the linga were fixed on each side into socketed vertical stumps, which, in turn, stood on flat anvils at the foundations, recalling the 'underpinning technique'. This technique might have been adopted by the architects from a similar tradition found in the Buddhist structures specially, since it had a vedika around it. This is a unique evidence to note, in case of a Brahmanical temple. The lotus medallion of the stone upright and artistic features of the linga and other associated finds have facilitated scholars to date it to the 2nd century B.C. Cuddapah slab floors were laid for the temples at Veerapuram, Chejarla and Nagarjunakonda [Chart VII B].

Massive and tall Dwajastambhas and pillars were delicately extracted from the local quarry, by the 'tongue and groove' method as found at Nagarjunakonda. The Dwajastambhas were cubical at the bottom, octagonal in the centre, cylindrical and tapering at the top and fixed over a high pedestal. This bespeaks of the fine geometrical knowledge of the architects. The brick core of the temples at Nagarjunakonda were encased by Cuddapah slabs externally, in order to buttress them and to protect them from the entry of rain water. This is an important technological advancement employed during Period II. In order to protect the temples from floods, stone walls were raised abutting the river banks.
## Chart VII D

### Period II: Stone Foments

<table>
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<tr>
<th>S.No</th>
<th>Name of the Site</th>
<th>Sub-region</th>
<th>Situation on Plains</th>
<th>Type of Stone</th>
<th>Stone Used in Buddhist Monuments for</th>
<th>Brahmanical Monuments</th>
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<td>Granite &amp; Lime</td>
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**Key:**
- ![Diagram](chart_d0.png) stupa
- ![Diagram](chart_d0.png) Torana
- ![Diagram](chart_d0.png) Enclosure
- ![Diagram](chart_d0.png) Mandapa
- ![Diagram](chart_d0.png) Floor
- ![Diagram](chart_d0.png) Vihara
- ![Diagram](chart_d0.png) Roof
- ![Diagram](chart_d0.png) Temple
- ![Diagram](chart_d0.png) Pathway
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Key:  
- Stupa  
- Torana  
- Enclosure  
- Mandapa  
- Floor  
- Vihara  
- Roof  
- Temple  
- Pathway
In Period III the sole use of stone in constructing the entire temple can now be focussed upon. The temples at Gummadam were enclosed by a prakara wall constructed of dressed shale stone [Chart VII C]. For the pranala, lengthy stone with a channel cut on the top side was employed. The architects took care in selecting stone for the pranāla so that the water did not percolate into the brick structures causing damage to its structural stability. This has been noticed at Siddeswaram in sub-region B [Chart VII C, 20]. At Keesaragutta a brick temple of the 5th century A.D. was visible up to the basement only over which rectangular stone slabs were placed for giving strength to the superstructure [Chart VII C, 8]. This is a significant development in building technology and it is here that we notice a slow transition from brick to stone.

The prakara around the brick temples at Pedavegi were encased with dressed sandstone blocks to the brick walls. This feature was continued in Andhradesa from the 3rd century A.D. onwards. A brick temple termed as No.2 in importance by the excavators at Gollattagudi, datable to the 7th century A.D., was constructed on a rubble stone foundation of 1.80 metres below the ground level. This as well as the door jambs were dressed in granite stones [Chart VII C, 4]. Here, both brick and stone temples were built side-by-side in the same period.

From about the 7th century A.D. onwards, a large number of temples in stone were built. This is seen in almost all the sub-regions. In an unprecedented manner, royalty as well as officers and wealthy individuals and dedicated men donated materials to build these temples. Our concern is not with giving details of achievements of individuals/dynasties and this
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contd...

Key:  
- Stupa  
- Small stupa  
- Torana  
- Enclosure  
- Mandapa  
- Floor  
- Vihara  
- Roof  
- Temple  
- Pathway  
- Storeyed mandapa

483
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Key:  
- Stupa  
- Torana  
- Enclosure  
- Mandapa  
- Floor  
- Vihara  
- Roof  
- Temple  
- Pathway  
- Storeyed Mandapa
patronage of temple building activity, nor, is it with discussing how these temples can be attributed to a particular King or his successor. In fact, it is of some significance to note that no temple under study can be attributed to have been entirely constructed by a single King. On the other hand most of the temples were constructed with revenues from different royal lineages and sometimes even from local Chiefs and functionaries of the area, where they were located. In some cases funding came from local wealthy people of the community at large. Thus, to attribute the foundation of temples to a single authority is difficult to establish on the basis of the empirical evidence available. Further, apart from funds in appreciating the large scale operations involved in building such monuments, their planning and organisation was in fact in the hands of skilled and unskilled craftsmen and workers.

Important temples built during the 7th century A.D. were the Navabrahma group of nine temples and the Kudalisangamesvaram temple in sub-region A. These were built in red sand stone brought from a nearby quarry, located just on the other side of Alampur town and on the opposite bank of river Tungabhadra at Satanikota in sub-region D. A good number of carved and uncarved stone slabs are still seen scattered at Satanikota indicating that this was the source for the sand stone. Inscriptions denoting a guild of architects called as Utpattipigaru, datable to the 7th-8th centuries A.D. are seen at both Alampur and Satanikota, also attesting the fact that there was considerable construction and stone cutting activity in the region. The same quarry must have been used for the Kudali Sangamesvaram temple, built at the confluence of rivers Krishna and Tungabhadra.
On close examination, it has been observed that the temples of the period were built on a levelled surface, after having duly filled the foundation trench with heavy blocks of stones called Adharasila which served the purpose of being equivalent to a concrete bed of modern times. Above this, a basement of neatly dressed slabs was raised to a height of one metre with off-sets on either side, so as to diffuse the load of the superstructure on to the foundation slabs. This phenomenon is clearly observed at Alampur, in case of a dilapidated tempe built in Chalukyan style. Since it is not a protected monument, its plinth was opened by us by laying a trial trench on the rear side of the temple, to observe how the foundation was laid. The study of foundations of early temples is a much neglected aspect, because, in usual circumstances, the foundations were buried in the ground and therefore, it is never possible to study them. A piece of research on the subject for northern Indian monuments was carried out by V.H. Joshi. Thus the data from Alampur and suburbs, reveals important details of how the foundations of the early stone temples were made. As the temples at Kudali Sangamesvaram and Papanasi, built during the 6th to 8th centuries A.D. were threatened by the waters of the Srisailam Hydro Electric Project, they had to be removed in order to reconstruct them at a higher contour. This opportunity also offered us a chance to examine the foundation in detail, even below the ground level after the temples were completely dismantled up to the plinth level. In this regard scholars like N.C. Ghosh and I.K. Sarma furnish very valuable and hitherto unknown information on traditional methods of how the foundations of early temples were laid. According to I.K. Sarma, the ground at the foundation level was levelled at a depth of 7.45 metres and the foundation trench was filled up with compact brown earth, alternated by
roughly dressed shale stone slabs, for the garbhagriha portion, to a depth of 3.90 metres [Figure 10]. The foundations were made strong for the garbhagriha because of its heavy load and for the pillared mandapa on the front side of the temple, they were narrower, in thickness because of its comparatively less weight. A similar feature of laying foundations was noticed at the Papanasi temples, where the foundations of the temples were laid in horizontal layers of shale stone and brown earth alternated to a thickness of 1.00 metre below the upana, the first layer of the temples. This suggests that the sthapathis of the 6th-7th centuries A.D. had followed a uniform pattern of laying the foundations to temples. To limit the actual temple plan, the upana layer had to be marked with a linear drawing by chiselling in an incised manner, so as to check the plumb line of the superstructure. After that, dressed stones were placed one above the other closely fitted with their joints duly cramped, with iron dowels to keep the layer intact and enable a structural stability. After this the foundation course and the basement called adhistāna was built.

In a discussion on the walls and ceiling of the early stone temples it is noticed that the walls were mostly in single course for the garbhalava, the arthamandapa, and the enclosure wall, in case of the sāndhāra variety of temples. In contrast to this pattern, an early stone temple datable to 7th century A.D. at Pondugula [Chart VII C, 16] in sub-region B, was built in two storeyes having a great basal width, i.e., a wall with greater thickness denoting the stage of experimenting with stone. At Alampur screen walls, i.e., latticed windows were provided in different sizes and shapes for allowing sufficient light inside the temple. After the walls were built, the next aspect that was taken up was, erection of pillars set
Foundation details of a stone temple, Kudavelli, Sub-region A

Reproduced from I.K. Sarma, 'Alampur Temples: Rare Evidences on Constructional Modes and Consecrational Rites' in A.V.N. Murthy, I.K.Sarma (eds), Ramachandrika, t (O.Ramachandraiah Felicitation Volume), Vol.1, Delhi, 1993, Fig.No.24)
in line with the help of scaffolding material. This also enabled the laying of the roof, over the walled and pillared structure. The garbharāva was provided with a flat roof, supported by four pillars apart from the walls. This is a distinct feature noticed in case of the early stone temples of this particular sub-region and is found at Panchalingala and Alampur which were built during the 6th to 8th centuries A.D. This arrangement of laying the roof supported by pillars in the temple, denotes a sound technological knowledge of the early sthapathis. They wanted to distribute the superstructural load of the stone vimānas built either in Rekhanāgara, i.e., parabolic style or in Kadamba nagara, i.e., stepped pyramidal type on to, not only the walls, but also on to the central four pillars, affording structural stability to the entire structure. Here, it should be noted that the vimānas were also built of stone with massive walls.

Earlier, in the section on brick technology we had noticed postholes in and around the brick temples at Nagarjunakonda in sub-region B datable to 3rd-4th centuries A.D. and at Keesaragutta in sub-region A datable to the 5th century A.D. The post-holes found inside these early brick temples were meant to erect wooden posts to support the thatched roofs which were of light weight. Now these were totally replaced by stone and being heavy their load had to be properly distributed. The roof of the mahamandapa was sometimes elevated and a sloped bent roof was provided for free flow of rain water from the top of the temple. Lime mortar was used for filling the gaps in between the roof slabs on top side. A layer of lime concrete, a mixture of lime, sand and small river rolled pebbles was laid as a waterproofing course, on which lime plastering has been done so as to make it
leakproof. This was noticed at Alampur while dismantling a 7th century
temple; an aspect found on the main temples at Alampur as well. The
Mukhalingam temples, however, differ from the Alampur examples in terms of
the treatment ceiling. The Mukhalingam temples have no ceilings on the
inside, but instead there is a corbelled roof above. Visible only from
inside, the corbelled arch was arranged over the lintels of the doors
evidently planted to relieve the heavy load over it as in case of the
Orissan temples of the same period. The same technique was followed by the
local architects who built the Mukhalingam temples. The mahamandapa called
as Jagmohana had a flat roof with sides of its outer surface slightly
sloping from the centre so as to drain out the rain water. The temples
during the period were enclosed by stone prakaras as seen at Alampur.
Every care was taken to releive the load bearing on the door frames and it
was well planned to distribute the same on to the vertical pillars arranged
inside the temple behind the door jambs. All these features of building
technology are seen at Alampur, Kudavelli, in sub-region A, and at Rupala
Sangamesvaram temples [Plate XXII] in sub-region B, at Mukhalingam in
sub-region C and Mahanandi and Panyam in sub-region D [Map XI & Chart VII C].

Construction of double storeyed mandapas was an innovation of Period
III. The double storeyed mandapa at Panchalingala in sub-region A was
built with roughly carved plain pillars of shale stone. The pillars of the
first floor were erected and set exactly on the ones of the ground floor,
based on centre line and the plumb line method. To erect the pillars, roof
and sun shades of the first floor of this storeyed mandapa, an earthen ramp
must have been probably laid in a sloppy manner, which facilitated the
builders to climb to the top of the ground floor.
During the 9th-10th centuries A.D. some new elements in temple building activity, such as building temples on apsidal plan with barrel vaulted roof and in two storeys with an access by staircases have been observed. The temples at Chilamakuru in sub-region 0 have been built on apsidal plan during the 9th century A.D. The temples at Attirala, Gudimallam, Kanipakkam and Ramagiri in sub-region D, Papanasi in sub-region A, Pushpagiri in sub-region B have been built on apsidal plan [Chart VII C]. In sub-region C this plan was conspicuously absent for stone temples. In the same sub-region, temples were built in a new way, i.e. in two storeys on the inside as seen at the Pañchārāma sites, viz., Amaravati, Draksharama, Palakollu, Bhimavaram and Samalkota. The ground floor of these, was neither functional nor solid and the upper storey was reached by a flight of steps from either inside the ground floor or from the outside. This arrangement was done, in accordance with the height of the tall linga and to offer worship from the first floor. The garbagriha and pillared halls in the upper floor were provided with windows on the sides. Absence of the central four pillars in garbagriha is noteworthy which was a feature widely prevalent in the case of the temples, built during the 6th-7th centuries A.D. in sub-region A and B. Roofing was done with flat ceiling slabs.

During Period IV, from the 10th century A.D. onwards a spurt in the activity of building temples in stone upto the roof level and sometimes the entire temple has been observed. Above the superstructure of stone temples, the vimānas were some times built in brick. However, temples built to a remarkable height with extended mandapas built prolifically in
stone have been noticed during the period.

Gopalareddy has classified the temples of the period into four categories, viz., ekakuta dwikuta, trikūta and mandapas. Recently, Sivanagi Reddy and Subrahmanyam have reported another variety, called pañchakūta temples at Ramanujapuram and Atmakur in sub-region B. Ekakuta temples are seen with garbhālava and arthmandapa; dwikūta or vugala type consist of the temples either facing each other or standing side-by-side in 'L' shape or facing each other connected by a common mandapa noticeable at Mallesvaram in sub-region A. In the trikūta variety, the main shrine is supposed to be in the centre, the remaining two constructed on either side are connected by a common rangamandapa. Another variety of trikūta has three shrines all in a row with a common mandapa as noticed at Kusumanchi. In pañchakūta variety, two more temples, each on either side to the existing trikūta plan are added with another common mandapa.

Earlier, scholars like Yazdani, Murthy, Ramarao, Sarma, Srinivasan, Rajendra Prasad, Prasada Rao, and Ramanaiah, have all dealt with the art and architectural form of the temples of this period describing the details in all their grandeur. However, a focus on only their technological feats is still a dessitram. The architects of the period preferred a combination of various building materials like sand, stone, brick, lime, iron and wood, depending on the properties of each item. The geology of each sub-region played prominent role in building the temples. The architects used sand for filling the foundation trench and in preparation of lime mortar and concretes. Sand bed foundations were provided for the temples at Nidikonda, Palampet, Hanumakonda in sub-region B and at Nagunuru and Mantheni in sub-region A. Granite and sand
stone were chosen for almost all the exterior and interior of the temples whereas, the load bearing components like pillars, beams and floor slabs were carved in basalt stone. Basalt stone was also used for decorative purposes such as the door frames, bracket figures, ceilings and sculptures. Certain temples were constructed either in red sand stone or white and pink granite stones exclusively. The temples at Jakaram, Ramanujapuram, Ghanpur, Palampet, all in sub-region B, and those at Nagunuru, Mantheni and Ranjala in sub-region A were constructed in red sand stone during the 13th century A.D. The temples at Chebrolu, Kanchikacherla in sub-region C; at Kothupalli, Kalabgur, Tumukunta and Kaluvakolanu in sub-region A were built in granite only. The Keerthi toranas and Swayambhu temple at Warangal were 97 built in pink granite stone. The temples at Nagulapadu, Nidikonda, Hanumakonda, Palampet, and Ghanpur were constructed in a combination of basalt with sand stone and granite. Sedimentary rocks or shale stones were also used in construction of temples at places like Malleswaram in sub-region A, Siddesvaram in sub-region B and Pushpagiri in sub-region D [Chart VII D]. Use of stone slabs of massive size was the characteristic feature of the building technology of the period. Different types of stone were preferred to other materials because of their being able to withstand the vicissitudes of the climate and seasonal variations. Timber, bamboos and ropes were brought for scaffolding. The craftsmen of various categories, viz., the Chief architect, Sthapathi, stone carvers, blacksmiths, masons, painters and ordinary workers became full time workers in temple building.

Selection of suitable site was an important criterion in temple construction. The architects of the period seem to have followed the
# CHART VII D

## Period IV: Stone Monuments

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<th>Sub-region</th>
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**Key:**
- **Buildings:**
  - Stupa
  - Torana
  - Enclosure
- **Structures:**
  - Mandapa
  - Floor
  - Vihara
  - Roof
  - Temple
  - Pathway
  - Storeyed Mandapa
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Key:
- stupa
- Torana
- Enclosure
- mandapa
- Floor
- vihara
- Roof
- Temple
- Pathway
- Storeyed mandapa
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Key:
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- 🏫 Temple
- ⇑ ⇑ Pathway
- 🏫 Storeyed mandapa
principles laid down in the *Arama* and *Silpa* texts in this regard. Though the traditions were known earlier many of these texts were written down during this period. The temples were constructed near the confluence of rivers, in the tanks, on the tankbunds, in forests, on hills and hill slopes and on the plains. Before the construction work was taken up, the fitness of the soil was to be checked according to the *Silpa* Sastras. A pit was to be dug and the dug out earth was to be filled again into the pit if it exceeded the height of the pit soil was of good quality. In another method, water was put into the pit and observed the next morning and then the quality of the soil was adjudged. The soil thus selected was to be tilled and levelled. Details of how foundations were to be laid have also been described in texts. According to them, the foundation pit was to be dug to a depth of one man's height with raised hands, or should be dug until the rock bottom or water level was met. The pit was then to be filled with fine earth to a height of 8" on which a layer of mud concrete, a mixture of stones and wet clay, was to be laid to a height of one hasta followed by sand. It was then to be cured with water duly trodden by elephants and levelled with rammers. The next course upto the height of the pit, was to be packed with the same concrete described above and this was finally followed by stones and bricks as the first course of the temple. Some other texts prescribe only stones for filling the foundation pit. On this course, called the *ādhārasīla*, stood the entire temple. Medieval texts on temple architecture, viz., the *Manasara* and the *Mavamata* have prescribed certain norms for laying the foundations of the temples. The use of a saturated sand bed has been mentioned in these texts. The architects of the medieval times in Ḍāndhradeśa followed the same methods for the temples that were built at
Nidikonda, Hanumakonda, Palampet, Ghanpur and Nagulapadu in sub-region B. The foundation trenches at Jakaram and Ramanujapuram were filled up with fine earth, collected from the rivers or tanks as mentioned in the Mūnasara. In the Marīchisamhita, the construction of a wall, called Khatakudya in the foundation pit has been mentioned over which the plinth of the temple was to be constructed. Had the architects followed the method in the building of the above mentioned temples they would not have collapsed.

After the foundations were laid, stones quarried for the temple varqams were brought to the site. Some of the quarrying methods of the period have been observed by us at places like Ramanujapuram, Katakshapur, Palampet and Hanumakonda in our field survey. Heavy to medium sized stones were extracted from the selected local quarry, after marking the sizes in linear drawings in red oxide. This was followed by chisel marking on the bouldery surface. Iron chisels, with flat tips of considerable size, were then inserted with groves already made on the line and were hammered out one by one progressively to get the stone cut to the required sizes. This was done in the conventional 'blocking technique' which was followed by the 'ridge and groove technique'.

In another method of extraction, wooden wedges were placed in small holes, carved in the rock and then swollen by sprinkling of water to cause splitting of the rock. Instances of lines of small holes prepared for this purpose on boulders are a very common sight at the quarries of Ramanujapuram and Palampet [Plate XXII]. Stone was commonly extracted from the surface of the rock exposed to the open air, against the principles laid down in the Silpaśāstras which prescribes that those stones were to be
Period III: Stone Temple built on a levelled foundation wall, Rupala Sangamesvaram, Sub-region B

Period IV: Stone extraction by 'ridge and groove technique' at a medieval quarry, Ramanujapur, Sub-region B
selected which were buried in the ground in order to overcome the weathering effect. The stones thus obtained were transported by wooden carts drawn by oxen or elephants. The technique of transportation of heavy blocks from the quarry to the site has been clearly depicted in a linear drawing on one of the walls of the Raichur fort, the wall being datable to the 13th century A.D. [Figure 11]. Mention has also been made in a Jaina chronicle to this practice referring to the transportation of the temple vargams in an ox-drawn cart for the construction of the temple at Mount Abu.

The stones thus brought to the site of construction were dressed as per the plan and elevation. The stones intended for making architectural members like upana, jaqati, pillars, beams, eve slabs, latticed-windows, etc. were first marked with red oxide and then chiselled with pointed chisels of varied size in order to get deep marks. Different degrees of dressing have been noticed. In the second stage, flat chisels were used to smoothen the surface and later on, they were polished with grinding stones specially made for the architectural members such as door-frames, pillars, beams, ceilings, floor slabs, and other vargams. A small wooden cart drawn manually was employed to transport the finished ones from the workshop to the actual spot of construction. While dismantaling the Kakatiya temple at Ramanujapur in Warangal District we have used a small wooden cart to shift the temple vargams in the same method [Plate XXIII]. For lifting and arranging the stones of the adhistāna and mandapa, an iron pully block with ropes had to be used. An earthen ramp according to the required height was also used for building the walls and the sikharas. According to a local legend, the great temple at Tanjore was constructed by laying an earthen rampart as well as wooden scaffolding. Brick work over the roof was
Period IV:A linear drawing of transportation of heavy stones on a wooden cart, Raichur, Sub-region A

PLATE XXIII

A small wooden cart drawn by men to transport the Temple Vargams within the site, Ramanujapur, Sub-region B

Period IV: Adharasiia layer, Godisala, Sub-region A
attended to by wooden scaffolding and for finishing the bottom sides of the ceilings and eve slab, shiftable wooden ladder-scaffolding was put in use.

Temporary ramps such as the one that remains at Bhojpur must have been erected at the sites of all the large temples to facilitate the transportation of the huge stone blocks from the work sites to their place on the monument. The ramp at Bhojpur is a long sloping structure, raised behind the temple, built of semi-dressed slabs of the local sand stone, topped by compact earth and sand. It rose from the natural ground over three hundred feet away in the immediate vicinity of workshops and sloped gently upwards to attain a total height of forty feet. One method used in case of the Lingaraja temple at Bhuvanesvar was an inclined earthen plane, which was constructed towards the west, whose remains are still to be seen on casual digging. Generally, the ramps at the work sites must have been removed or dismantled after the completion of the construction as is evident in the case of the temples of the Kakatiyas.

The stones for construction of the first layer, upana, of the retaining wall pradakshinapatha were long, heavy and broad. The average stone measured 10'-0 x 3'-0 x 1'-0. Each stone had an uneven bottom, levelled surface on the top, fine finish on the front side, while the rear side was left unchiselled. The uneven bottom was provided to obtain a firm grip over the sand bed against lateral movements. According to the plan, after paving the first layer of stones with fine joints, over the sand bed foundation, it was again filled with sand to the height of the first course. The sand was pounded and packed beneath this layer. Iron dowels were cramped at the joints after obtaining the uniform level of the layer. At the joints, the stones were grooved to a considerable depth so as to
insert the iron dowels. The clamps thus inserted were hammered in red hot to ensure that the joints had fixed firmly. The iron dowels have been found intact on some of the inside layers of the temples in sub-region A and B as noticed at Nidikonda, Jakaram, Ramanujapur and Godisala visible even today. A similar method of construction was employed for all the layers, up to the first terrace or pradaksināpatha. Corresponding to this level the floor slabs of the pradaksinapatha and the ādhāraśila of the adhistāna were arranged over the saturated sand bed. Fine mortar of mud was used under the floor slabs in order to avoid the tilting of the slabs in the future and also to fill the gaps inside them. This was clearly noticed while dismantiling the temples at Nidikonda.

The technique in shaping the ādhāraśila stone was quite interesting [Figure 12]. In cross section, most of the stones were more or less semi-circular having a broad upper surface and a blunt projected under surface. The layer acted as a catalyst or a shock-absorber while transmitting the superimposed load directly to the ground. The adhistāna layers were constructed on the adharasila in the same manner as explained in the case of the Pradaksinābatha. The adhistāna here acted as another retaining wall for the saturated sand bed, filled inside, on which the floor slabs of the garbhālaya, arthamandapa were arranged for the second terrace, i.e., the actual flooring of the temple. In some cases the sand stone slabs used for floor beams were subjected to a very high bending force, which resulted in a tensile strength of about 150 kg/sq.cm. Infact, the sand stone floor beams could not take such a high tensile load and invariably failed under tension. The same was the case with columns as in case of the mandapa at Palampet. On a prepared platform of stone slabs, kept on the sand bed,
Period IV: Sectional elevation of a Kakatiya temple, Nidikonda, Sub-region B
The columns were erected at suitable places taking care to see that their load was distributed on to the sand bed through the floor beams by raft action. The columns, as well as the walls, of the temples were not provided with deep foundations as noticed in case of Nidikonda, Jakaram, and Palampet temples in sub-region B. Pillars are carved out of long slabs which were extracted horizontally in the quarry and then installed vertically. In some case as observed at Jakaram and the Thousand Pillared temple, the stone became prone to disquamation and vertical cracks.

The columns were carved out of granite, dolerite and redsand stones. Dolerite stone was used for pillars where the intensity of load was found high in case of the Kakatiya temples. It is observed that the compressive strength of granites ranged from 1000-2000 kg/sq.cm while the tensil strength varied from 80-160 kg/sq.cm. For the dolerite rocks, the compressive strength varied from 2000-3000 kg/sq.cm. The Chelvai sandstone strength was found to be ranging from 600-1000 kg/sq.cm while their tensil strength varied from 50-80 kg/sq.cm.

The outer wall of the temple started over the adhistāna kapota layer, whereas the inner wall was raised from the floor level. The door-frames were also erected at this stage. The inner wall was constructed with heavy stone blocks in horizontal courses, whereas the outer wall had both horizontal and vertical slabs. The pādavarga was usually made of two parallel facings of stone slabs placed on edges, with a filling of earth in the space between them. This was a rule for this entire period. The thickness of the wall varied from 1.00 mtr. to 1.50 mtrs. as noticed at Ramanujapuram, Ghanpur and Nidikonda in sub-region B whereas the
Venkateswara Temple at Somasila in sub-region A, was constructed with a single course of wall only. There were thorough-stones called as bonds in some cases as observed at Somasila temples built with two layers. No mortar was used for joints in the walls, a common feature for all temples of the period. Another interesting feature noted at some temples of Period IV was provision of stone bulbs on the exterior surface of the stones of the wall portion which were used to lift and lead the stones during construction of the temples, as seen at Kusumanchi in sub-region B or Somasila in sub-region A. These stone bulbs were chiselled off after the construction of the temple is over in all respects [Plate XXIV]. This is considered as an important aspect of the stone technology of Period IV.

Further, the stones were placed one over the other and the monolithic action was achieved by counter weights in the form of the other members being placed on them. Dowel bars were used to attain the monolithic action. As soon as the layer of stones had been set up, stones for the next layer were cut into shape, carved and marked with members and kept ready for erection.

The vertical monolithic wall of the temples in general was superimposed by phalikāpadma and podika layers. At the roof level both the inner and outer layers were levelled equally. The hearting portion was filled with earth, sometimes with stone chips. Simultaneously, erection of the rangamandapa pillars over the floor slabs in grid pattern was done. Then, the beams were placed on the pillars, as well as on the inner walls and on the uttaram layer so as to obtain a uniform level of the structure.

The roof inside the garbha griha, Arthamandapa and the central span of
Period IV: Provision of stone bulbs on the walls used to lift and lead the stone during Temple construction, Kusumanchi, Sub-region B

Period IV: Double storied pillared Mandapa and Temple built with stone sikhara, Panagal, Sub-region B
the **rangamandapa** were arranged in **Lupa-vitana** type, wherein the first course of four triangular stones, **kōnavattas**, were arranged over the beams in rhombus shape. Similarly, the second course of four slabs **chadaravatta** were formed into a square over which the central roof slab was placed. Probably, this type of roofing was designed to reduce the unwanted load, instead of placing heavy stones, for spacious spans of the **garbhagriha** and **arthamandapa**. This arrangement also gave an **impressive** look to the visitors. In case of shorter spans, flat roofings were opted for, often with a single slab. In some cases, the roof was arranged in an inverted bowl shaped, cusped and coffered central ceiling. The **plan** and moulding of the ceilings such as the **adhōpadma**, figure bearing belt, teeth course and the central **padmakesara** and drop are noteworthy. Such an arrangement has been noticed at **Palampet, Jangaon, Mantheni** and **Chandravalli** temples. This type tallies with the description of the construction of roof in the **Vāstuvidva**, a medieval text. Over the **uttaram** layer, on the outside, massive and ornamental eave slabs called **Kapota**, projecting beyond the plinth (roughly 5'-0 to 7'-0 in width), were arranged all around. To prevent the cornice from falling down by its own weight, a layer, **vyāla**, was placed as counter weight and sometimes, a parapet wall containing **śālāgāras** was also provided for, on the inner edge of the **kapota** as noticed at **Palampet, Pangal and Pillalamarri**. The functional aspect of the **kapota** layer was not only to drain off the rain water but also to serve as horizontal bond which sealed the hearthing portion in between the inner and outer walls of the temples. The roof slabs of the temples at Palampet, Ghanpur, **Jakaram** and **Ramanujapur** are of pink coloured medium grained Chelvai sand stone with **silicious** matrix, and for the temples at Katakshpur, Hanumakonda, **Kothapalli**, Nidikonda and **Nagulapadu**, it is
granite stone [Map XI & Chart VII D]. The visible bottom sides of the slabs were well-dressed and polished, while the other side was left undressed and kept as it is and joined together by lime mortar on top side.

Every stone of the ceiling was carved separately and fitted together temporarily on the ground. Then the stones were hoisted upon to the roof and arranged in position so that they were interlocked. The designs were complex and a great deal of skill and patience must have been required to produce and finish them. The roof concrete of good resistance was laid over with a mixture of bricks, lime and pebble. While dismantling of roof concrete at Ramanujapuram and Jakaram, it was observed that brick masonry in lime mortar was constructed as a level course upto the vyāla layer and finally, it was sealed with lime concrete using brick bats and small pebbles.

After the construction of the temple upto the roof level, the vimāna portion either, stepped pyramidal or in the Dravidian style with kutakōstās. was started as we notice at Palampet. During this period, the vimanas were constructed both in stone and brick. Temples with stone sikhara are few at places like Palampet, Panagal [Map XI & Plate XXIV], and Nagunuru.

In addition to the temples, separate mandapas were also constructed during the period, based on the trebeated system, in which there was the use of columns and beams in short spans. The individual pillared mandapas constructed in this system have been noticed at Hanumakonda, Aihole, and Ghanpur. The contemporary Hoyasalas had also constructed these mandapas.
DISTRIBUTION OF STONE MONUMENTS
PERIOD WISE
at Belur, Halebid and Somanathpur in this system. The architects of the period also knew the technique of building double storeyed mandapas. Following the centre line method, the pillars of the upper storey were positioned on the same alignment of the ground floor pillars. The double storeyed mandapas of the period have been noticed at Mallesvaram, Duddeda, Bandaramesvarapalli, and Ghambhiraopet in sub-region A; and Panagal [Plate XXIV] and Kodavatur in sub-region B [Chart VII D, 20, 5, 3, 6, 26, 15].

Though the technique of erecting free standing torana was initiated during 11th century as seen at Mallesvaram and Vallala in sub-region A, it was improved during 13th century A.D. The toranas at Warangal and Ainole were arranged with double vertical pillars. On the top of the pillars the lintel beam, in three pieces of stone was arranged over which a decorative Makara Torana was placed as counter-weight. Single pillar Toranas at Hanumakonda, Ramagundam and Kolanupaka were provided with single lintel [Chart VII D, 9, 28, 16].

Enclosing the temples and mandapas the architects of the period constructed prakaras with neatly dressed stone slabs in single or double courses and decorated them with a coping stone. The foundation to the prákāram wall was provided with massive dressed slabs with 3'-0 to 4'-0 in width. The prakaras at Ramanujapur and Bandarameswarapalli have the best examples of the mandapa-dwāras. The primary purpose in erecting a prakara wall round a religious edifice was that of protecting it from entry into its precincts of undesirable agents like cattle or any enemy. The prakaras of the period range from 5'-0 to 12'-0 in height and 3'-0 to 4'-6" width.
in thickness. They were constructed with huge well-chiselled blocks of stone. The compound wall at Palampet was constructed with double layers of dressed blocks of stone, some of which measure 21'-0 x 3'-6" x 3'-6". They fitted each other in such a way that even a small pin could not be inserted. The top stone was dressed with coping for protection against the rain water. The space between the two layers of the compound wall was filled only with earth. The architectural stability and the artistic excellence of the prākāra walls of the period have been extolled in an inscription found at Kondaparthi dated to 1241 A.D. It is of absorbing interest to note that in some cases, apart from the stone prakaras, massive earthen embankments have been found raised round the temple complexes to safeguard them. Examples of this type were found at Ghanpur, Katakshapur and Kondaparthi in sub-region B [Chart VII D, 7, 14, 17].

Each component of the temple was so technically designed as to serve both a functional and decorative purpose. For example, the bracket figures were designed not only to receive the superimposed load, but also to add aesthetic grandeur to the structure on the whole. Bracket figures were provided to support the corresponding beams and had been carved with human and animal figures, madanikas or vyālas. The bracket figures have been seen employed at Palampet, Ghanpur, Jangaon and Mantheni in sub-region A and at Tripurantakam in sub-region B.

Regarding load distribution, an important factor in building technology, the architects had been careful to design their structures to be distributed on the temple walls and pillars. In some cases, load was laid on the door frames, which resulted in the breakage of the lintels and collapse of the door frames as has been noticed at Jakaram and
As per the load distribution calculations, the main columns at the Ramappa temple at Palampet, with a spacing of 4.75 mtrs, carried a maximum load of 45 tonnes. This rested directly on floor beams with a cross section of 90 x 40 cm. In turn, the floor beam rested on the sand filling. It is noteworthy, that with its superimposed load, its bending stress went up to 180 kg/sq.cm. against its usual bending stress of 110 kg/sq.cm on non-uniform section of the floor slabs. This is the reason why they have succumbed to heavy pressure and have broken. The observation of the distribution of load on four inner columns of the temples like the Ramappa temple at Palampet, clearly shows due to the high intensity of the load transmitted, it collapsed, once it went above the usual stress permitted.

While dismantling the temple at Nidikonda, it was observed that the total load of the inner walls of the temple which consisted of the roof, beams, and the self weight of the walls was concentrated over the inner floor slabs of the garbhālava and arthamandapa. The load of the rangamandapa was received by the four central pillars which concentrated on the floor slabs that corresponded to the floor level of the temple. The load of the prastara, padavarga and adhistana was transmitted on the adhārasila, corresponding to the floor level of the pradaksinapatha as noticed at Nidikonda.

The architects here provided deeper foundations to the outer wall when compared to the inner walls of the temple. The technical aspect to note here is that, the two vertical distributing load points transmitted the loads directly to the sand bed, downwards as well as in the lateral directions.
The important technical device employed here was the balancing of loads by providing massive retaining walls. The inner retaining wall of the *adhistana* acted as a curtain wall to stop the outward thrust that emnated from the inner wall and facilitated that the load be carried smoothly and directly to the ground. Similarly, the outer retaining wall or *pradaksināpatha* played a major role in transmitting the entire load of the superstructure to the foundations arresting the lateral pressure from the *adharasila* and the *rangamandapa*. The entire load of the structure was balanced in equilibrium, over the compact sand bed and it was achieved by their perfect method of the joinry of massive stones.

The builders were successful in the joinry technique of the massive stone slabs [*Figure 13*]. Heavy and massive slabs were used in order to minimise the number of joints. The joints of the exposed faces, both vertical and horizontal, were chiselled in such a manner that even a thin fibre could not pass through them. As mentioned earlier the joint was cramped with iron dowels. The architectural skill and workmanship of the architects of the period particularly in stone joinry, dressing and construction of temples has been elaborately described in the Kondaparti inscription of Ganapatideva’s reign. It is mentioned that the *prakāra* around the *trikuta* temple at Kondaparti was constructed with blocks of stones closely fitted and uniformly chiselled and it appears to have been hewn out of a single huge stone block. It seems that the architects followed certain guidelines prescribed in the *Silpa* and *Agama* texts in the joinry of beams, layers and pillar accessories.

The corner stones of each horizontal layer were arranged in the form
Period IV: Types of joinry in stone Monuments Sub-region B
of a nandvāvartha joint, i.e., the stone placed in the east was to project towards the south and likewise. In some cases the stones of the horizontal layers and the accessories of the pillars, i.e., kudam, phalika-padma, podika were arranged in a sukaraghrāna joint. In this case the upper stone would have a triangular bulb/projection whereas a suitable groove would be dressed to the lower one, like a socket and cylinder, also called as boar-snout system. The temple vargams at Nidikonda, the rangamandapa pillars at Palampet, Hanumakonda, Jakaram and Ramanujapuram were given such treatment. Sometimes the corner beams were provided with mallabandha type of joint as seen at Nidikonda, Jakaram, Katakshapur, Ghanpur and Palampet temples. This is also called as the halved joint because the ends of the stones at joint were cut half horizontally and fixed.

At Nidikonda it is also observed that a few granite slabs, heavy in size, were planted vertically at the inner corners of the layers at plinth level. A trial trench below the lower most layer revealed the occurrence of a compact sand bed mixed with stone chips to a depth of 2'-6” and exclusively with sand to a depth of 2'-0, below which a layer mixed with sand and morrum was continued in the foundation pit, revealing a well planned practice of laying foundations known from the 10th to 14th centuries A.D.

The temples at Mogilicherla and Somasila were constructed in sandhara type with closed pradaksināpathas and without latticed windows by the side of the vertical door frames. Later, nirandhāra type of temples were constructed during the period, having half curtain walls
called the *kakshānas* or *asanapattis* on the *adhistanas* with a provision for latticed windows on the door frames. This facilitated the reduction of the self weight of the door frames and also allowed sufficient light into the sanctum sanctorum. Such windows were arranged on the door frames of the *arthamandapa* and *rangamandapa* walls as seen at Jakaram in sub-region B and Mantheni in sub-region A.

The architects of the medieval period exhibited their skill and mastery in maintaining architectural refinement, unity and *compatibility* in the spatial organisation of temples. The classical example of this type is the Thousand Pillared temple at Hanumakonda. In the distribution of the principal architectural members, viz., the temple proper, *nandi pavillion* and the *mandapa*. Besides these units, other structures like *pachanālava* the kitchen, beautifully designed well called *Pushkarini*, a small unicelled shrine and a pillared *mandapa* were also judiciously distributed around the main temple.

Certain drawbacks in building technology of the period have been observed by us. The detailed investigations conducted at different temples of the period in sub-region B have revealed that the architects of the period relied on sand box method for laying the foundation. Further, the load bearing walls and columns were directly constructed on the floor slabs which were resting on the sand box, without taking the foundations till the hard strata was met. However, taking an overall view of the various technical aspects while dismantling the temples constructed during the 11th-13th centuries A.D., it needs to be concluded that the architects possessed high standards of technical skills, in building massive and *magnificent* religious edifices.
The above discussion leads us to conclude that stone as a building material was selected for its strength and stability right from Period I onwards and its use was prolific during the Period II in almost all the sub-regions particularly in the construction of religious edifices such as stūpas, vihāras and temples, as also in their accessory units. Stone technology proved to be an improvement when compared to mud and brick technologies. It also substituted the rock-cut technology since the latter could only be confined to hilly areas or where suitable rocks were available. Foundations, basements, floorings of the early stūpas, pillars, beams and roofs of the mandapās all came to be constructed with stone. Rubble stone was used for foundations and filling the inner core of the stūpas as noticed at Dhulikatta in sub-region A, Nagarjunakonda in sub-region B, Thotlakonda and Bavikonda in sub-region C. Most of the brick stūpas were encased with lime stone panels joined closely. The stūpas at Dhulikatta, Nagarjunakonda, Amaravati, Chandavaram, Ghantasala, and Nandaluru, have been built with lime stone slabs as casings to the outer walls, a technique employed to arrest the entry of rain water into the structure. Railing of the stūpa at Amaravati was built with granite stone whereas at Thotlakonda the stone was khondalite. The early Buddhist mandapās at Guntupalli, Ghantasala, Nagarjunakonda were built with lime stone pillars in contrast to the local khondalite ones, as noticed at Bavikonda and Thotlakonda. The pillars were erected on a well laid foundation of stones in the 'underpinning technique' and the basements were encased with brick as seen at Chandavaram. In case of the building of the vihāras, stone was employed for foundations below the ground level, affording structural stability; a development in building technology of the
period when compared to the ones which were built directly on the ground. The brick walls of a vihāra at Nandaluru were also encased with shale stone. Pathways were laid with dressed stones which led buttresses on either side. The technology of building the railing consisting of upright pillars which were connected by crossbars inserted into the mortices were also employed to enclose a Śalvaṭe linga at Gudimallam, and stone was invariably used for cult objects in Brahmanical temples during Period II.

Above the sloped roof of the mandapas, a thick mixture of lime concrete was laid to arrest the seapage. Another notable innovation was building the double storeyed mandapas in plumb and centre line method with the help of an earthen ramp. This was initiated at Panchalingala. With this knowledge, the sthapathis of the period from 9th century A.D. onwards built the stone temples in a new and distinct style with two storeys as in the case of all the pāñchārāmas in Andhradesa.

It was during the Period IV that temples were prolifically built with stone technology all over Andhradesa. Brick was also used to build the sikhara above the stone structures. More elaborated mandapas, temples with twins and triple cells and even five celled ones under one common roof began to be built. Massive toranas and prakaras have also been built using heavy blocks of stone quarried nearby. An important feature of the building technology consisted of sand box foundations for the stone temples. All the sides of the sand box were revetted with massive stone slabs, which served as retaining walls also called as upapeethās that have been found at Hanumakonda, Nidikonda, Palampet, etc. Floors were also laid with stones. The walls had two layers whose hearting portion was filled with mud mixed with stone chips. No binding material was used and grip was
ensured on the top of each layer by providing vertical grooves so as to fit
in the stone bulbs carved on the bottom of the layer that came above the
previous one as observed at the Nidikonda temple.

From the beginnings of Period III stone was used to build compound
walls around the brick temples as at Gummadam. The same was employed for
the pranālas as seen at Siddhesvaram and as a level course on the basement
as noticed at Keesaragutta. These are significant developments in building
technology and one can notice a slow transition from brick to stone. From
the 7th century A.D. onwards, stone was used exclusively from foundations
to the finial. First experiments in building the temples in this way has
been observed at Alampur in sub-region A and Pondugula in sub-region B
using red sand stone and shale stone respectively. Foundations were laid
to a depth of 7.45 metres and filled with shale stone slabs alternated by
compact earth. The depth of foundation and filling varied from temple to
temple according to the load calculation of a particular portion as seen at
Alampur and Papanasi group of temples. Single and double course walls were
employed. Stones in both horizontal and vertical layers were cramped with
iron dowels to keep the layer monolithic and this was an innovation in
building technology of the period. Since the use of stone was in an
experimental stage, the sthapathis built the walls with great basal width
following the brick traditions, a feature found at Pondugula temple.
Another point of engineering which speaks of the sound technological
knowledge of the sthapathis was the balanced distribution of the load of
the superstructure, i.e., vimana to the four central pillars arranged in
the garbhāgriha, a special feature noticed at Alampur and its suburbs. The
roof slabs were plain in case of Alampur temples for the garbhālayas
whereas they were corbelled at the Mukhalingam temples.

In case of most of the temples built between 12th-13th centuries A.D., the load bearing and receiving components were of dolerite stones. This can be seen at temples of Ghanpur, Kusumanchi, Palampet and Warangal. To ensure sufficient light inside the temples in the case of closed mandapas, stone windows were provided to the walls and on either side of the door frames of the arthamandapas. Perforated jallis with gonetra and swastika design have been found at Jakaram, Mantheni, Ramanujapuram and at a good number of other temples. The arrangement of tiered roof slabs diagonally for spacious spans speaks of the sound knowledge in structural engineering. Brick technology was also put to use to build the vimānas to reduce the unwanted load over the roofs of the garbha grihas, a feature that has been noticed at Palampet, Pillalamarri and Chebrolu. Water seapage was overcome by arranging the lofty and wider eve slabs to drain out the rain water and the roof was laid with lime concrete. A thick concrete of 2'-0 in depth which was dismantled by us at Jakaram and Godisala temples indicates its prolific use. The sthapathis had employed different joinry methods for joining the various architectural members. All the above achievements are testimonials to the technological expertise of the traditional builders of the temples who were well-trained in temple building activity right from the selection of the site to the consecration of the temple, following the prescriptions of traditional texts and treatises on temple building.
FOOTNOTES

5. ARAP. 1983-84, PI.12.
6. AI, no.16, pp.68-70.
25. *EI*, vol.XXVII, p.3.
33. ARAP. 1993-94 (typed report).
37. T.N.Ramachandran, 'Nagarjunakonda', *MASI*. no.71, Delhi, 1953, pp.4-6.
38. Ibid. 1953, pp.4-6.
41. JAR, 1983-84, p.7.
43. Ibid. p.59.


51. *Ibid.*. p.16.


59. Myself and Sri Gadiyaram Ramakrishna Sarma of Alampur, have opened the plinth of a deprotected and dilapidated Chalukyan temple in our survey during April-May, 1992 to observe its foundation below the ground level.


62. I.K.Sarma, 'Alamour Temples: Rare Evidences on Constructional Modes and Consecrational Rites' in A.V.N.Murthy and I.K.Sarma (eds), *Sri Ramachandrika* (Prof. O.Ramachandriya Festschrift). Delhi, 1993, pp.352-368, Fig.23 and 24.


68. This feature has been noticed by me at the time of dismantling a twin temple connected by an 'L' shaped front Mandapa, datable to the 7th century A.D. The temple was built on the left bank of the river Tungabhadra one kilometre away from the main temples at Alampur, See E.Sivanagi Reddy, 'A note on the dismantling of Picchukagullu group of temples datable to the 7th century A.D. at Alampur', an unpublished typed paper submitted for inclusion in the Annual Report of the Department of Archaeology and Museums, Hyderabad for the year, 1993-94.


75. Ibid, p.4.


77. Ibid, p.21.


79. N.S.Ramachandra Murthy, Personal Communique.


81. Ibid. p.42.


94. J. Rama naiah, Temples of South India. Delhi, 1989.
100. Brihat Samhita. L.11, 90-92; Bhavishya Puräna. Ch.CXXX, 45-46.
102. Iśānasivaqurudeva Paddhati. III, Ch.XXVI, 40-41.
105. Ibid. II, XII.3.

108. See Raghu Nath Bhattaraya, (ed.), *Marichi Samhita*, Madras, 1927, Chapter 6. *(Jalāntam Silāmtam vā khanītvā. śalvāpōhva. Valukābhīrābūrya. Hastibādena ghattam kritvam)* and also the details of the foundations are also dealt in *Isana Sivaapurudeva Paddhati* as follows:

"The depth of the foundation pit should be equal to the height of a man standing with raised hands or should be dug to the rock-bottom or the water level according to the geo-physical conditions of the site. After the pit is dug, it should be filled with pure earth, 8” high; on this layer another one is placed of one cubic height which is composed of layers of strong stones each embedded in wet earth and separated one from the other by sand and earth; it is moistened with water, trodden by elephants and levelled with heavy wooden stampers. Then the temple plinth is started".


115. Ibid. p. 181.


118. I have dismantled this Kakatiya Temple during 1983-84 because of its dilapidated condition.


124. J.Ramanaiah, Op. Cit.. 1989, p.120.
125. Ibid. p.108 & 125.
138. Personal Communique with G.Venkata Ratnam, Epigraphy Assistant, Department of Archaeology and Museums, Hyderabad.
141. Personal Communique with N.Rama Krishna Rao, Asst.Director, Archaeological and Museums Department, Warangal.
143. Personal Communique with Dasarath Reddy, President, Youth Association of the Village.
145. Ibid. 1964, p.30.


150. Hyderabad Archaeological Series. no.13, pp.16, ff. V.42.


155. Ibid. Pl.104.


160. The Temple at Nidikonda in Jangaon Taluk of Warangal District was dismantled in 1983, under my supervision, It was thoroughly documented from the roof to the plinth level.


173. The temples at Nidikonda, Jakaram, and Ramanujapuram have been dismantled under my supervision by the Department of Archaeology and Museums, Hyderabad, during the years 1983, 1989 and 1990.