CHAPTER V

CONSTRUCTION AND DETAILS

We now come to those aspects of the subject which are of a more technical nature and concern the problems of structure, carpentry and detailing. This technical part forms an extension and deepening of the theoretical aspects already discussed earlier, and can only be understood within that larger context. Because of the link between the two, it is useful here to briefly re-capitulate those theoretical conclusions before proceeding to their details.

It was established, by survey and analysis, that structural wood in Gujarat appeared in three main categories:

(a) Full Half-Timbering: This prevailed over the whole of South Gujarat and some parts of North Gujarat
south of Broach. It originated among the indigenous, tribal people of the region and was to begin with a fully wooden construction which gradually evolved into a half-timbered one. Being in a region relatively rich in natural wood, it used the maximum amount of structural wood and a greater amount of thin brick partitions to supplement the construction. It was basically a light structure of very primitive design and showing poor skill in carpentry. Wherever better quality carpentry was met with, as in doors, windows and ceilings, it derived from North Gujarat.

(b) Partial Half-timbering: This was the dominant type over the major part of North Gujarat and since this region was the original home of the culture known as 'Gujarati', it may be considered the true representative of the structural technique. The system originated in the urban areas as a response to two factors: pressure on urban space leading to multi-storeyed buildings needing greater stability; the use of bricks of small size coupled with mud mortar which by themselves did not provide the stability needed. Wood was thus added as a reinforcement to the brickwork to strengthen it. Since the region was not rich in wood, the system used a moderate quantity of structural wood, but in due course, as wood became more plentiful due to better supplies by ship and railway, it began to be used as a status-symbol. This process was encouraged by more peaceful political conditions, particularly British administration. The woodwork and carpentry was of exceptionally good quality, as also the carvings, and these became the model for the whole of Gujarat.
(c) Timber-bonding: This type appeared mainly in Saurashtra and it was dictated by the scarcity of wood, coupled with the fact that the local stone-work was of poor quality. It used the minimum quantum of wood, in small sizes, and the details of carpentry were those of North Gujarat. The technique of construction had similarities with West Asia dating back to very ancient times.

In all the three categories, the use of structural wood combined with bricks or stone was an urban phenomenon associated with the multistoreyed building. The structure purely in wood appeared only among tribal people living in remote, hilly areas of the state, or on the periphery of towns as landless labourers. This tribal use of wood was closely related to category (a) and was its generator. Despite the differences in structure in the three categories, the remaining constructional details were in every case remarkably similar. For example, the details of doors, windows, ceilings, columns, finishes, were in all of them similar in the better class of buildings, and it was obvious that the tradition of carpentry was the same. Since the sub-division which had the most superior carpentry was that of North Gujarat, we may confidently assume that this was its original home and that it spread, along with Gujarati culture, to the rest of the state. It will be shown later on that this tradition of carpentry had some relationship, and influence on, the tradition in stone and this is itself one of the significant findings of this study.

After this preliminary summing up, we may turn to the structural details and begin with category (a) as that is the most primitive and easy to understand. Category (c) will then be taken next for it too is a basic technique of
great simplicity. In category (b), which is the most important, we find a synthesis of both the other techniques coming together leading to certain complexities, and therefore it is taken last. The description of the structural systems will then be followed by descriptions of the individual details under sectional heads such as Columns, Flooring, Stairs, etc.

1. **FULL HALF-TIMBERING**
   (Category a)

   As already explained, this system of construction originated among tribal people who today can be identified as living in the hilly eastern fringes of the state and in scattered settlements on the outskirts of towns and villages. The original system was fully in wood and other products of the forest, and it gradually evolved in the urbanized settlement into the regular half-timbering. Because of these stages of development, it is necessary to first describe the fully wooden tribal structure before coming to the main topic of this section, namely the urban system of half-timbering. Included in this description of tribal houses are some which are of a mixed character, having partial woodwork and partial mud supporting walls. These have been included because they contain a very substantial amount of wooden construction, and also because the mud is an alternative to what was once a fully wooden structure. They are thus modified wooden architecture.

   In all of these examples the technique of construction was determined by two material factors: easy availability of wood, which meant that it was found in areas where forests had once flourished and the material was thus freely procurable; and the availability of *straight-growing* timber,
which meant chiefly teak-wood so far as western India was concerned. The technique of construction which originated in the hilly forests was then transported into the plains and continued even though the materials were no longer as freely available. Teak and bamboo were not plentiful in the plains and yet the technique of using them persisted. On the peripherie of towns and villages the landless labourer would either receive material assistance from his employer for house-building, or he would scavenge around and steal wood from living trees; in either case he would retain a technique of construction deriving from the forest;

The method chosen for describing the various types of construction is to commence with that which is most primitive and cheap and proceed to that which is more complicated. In one sense it can also be described as proceeding from a scanty use of wood to a more prolific. Important from the structural point of view is the use of the wooden column as a supporting element. Because of this we have adopted a sequence in which we begin with a structure which is columnless namely the Bunga or Kuba of Saurashtra, and follow this with structures which utilize a greater number of supporting columns in their system.

(a) The Bunga/Kuba or Columnless Structure:

The Bunga or Kuba is made in those parts of Saurashtra which have very little tree-growth and whatever is available is stunted and bent, so that it is only bent wood which can be used for the structure. The people who are compelled to make them are so poor that they cannot afford a single straight piece, dependent as they are on
scavenged material for their dwellings. In addition, their employment as casual labour is always uncertain and to make any kind of more solid and permanent shelter would be impractical. The use of waste and scavenged material is, therefore, very sound policy in their case. However, the Bunga is also made by another group of people, in Banni, who are much better off and make these dwellings as a matter of tradition and prestige (see pages 703 ). The untidy Bunga becomes, in their hands, a work of skill.

The main problem in constructing a dwelling, any dwelling, is how to erect a roof; once that problem is solved, to enclose the remaining space with 'walls' of some kind is not so difficult. Given a supply of straight timbers, it is easy to make a roof using posts, purlins and rafters covered with thatch. But if all that is available is a collection of bent pieces of wood, then this traditional method is not possible. The solution found is as follows. The collection of bent pieces are arranged in a rough circle on the ground in such a manner that they lean diagonally on each other forming a tent-like structure of low height. A creeper or strip of bark is then entwined around and through these pieces and made tight. A series of such rings of the pliant material is made at regular intervals tying up the whole collection. The technique used here is identical with basket-making. There too one set of pieces go in one direction and meet at a point, while another set of pieces from rings in the opposite direction. In the Bunga the bent pieces are diagonal, the creepers horizontal. Once the tying is complete, the whole structure can be lifted bodily up and placed upon a previously prepared earthen ring. An opening in this ring is the entrance. Finally, on top of the roof is placed strips of grass, hay
or thatch loosely tied here and there with string to the wood. The dwelling is now complete (Ill. 947-950).

In the Banni area of Kutch, the method of making the Bunga follows the same basic principle, only that instead of bent wood a more straight branch of a local bush is used and this permits a very regular arrangement of the parts. These individual members are nailed onto a round disc at the top and the intervening spaces between the branches are filled out with thinner reed-like neat branches of the same bush, giving to the whole a very delicate and appearance (Ill. 964). The mud walls are also raised to a much greater height and finished to an excellent smoothness, and sometimes painted with patterns, while the thatch is laid with more care and tied down with ropes (Ill. 965). A final version of this process of refinement can be seen in Illustration 965. Where the whole inner surface of the roof is finished with strips of planed wood and gaily painted. The junction between roof and wall is effected by means of a wooden fork fixed with spikes to the main frame and it straddles the wall (Ill. 960). As already explained, none of these Bunga roofs ever get blown off in a storm because they permit the wind to blow through their crevices. They resist over-turning simply by their own weight.

The maximum span which such a roof can have depends on the material available and the strength of the horizontal binders. The Banni dwellings were about 4 m in span, while those of the labourers were less.

It will be noticed that the Bunga is not half-timbered, since the supporting material of the roof is the mud wall. It is nevertheless included in this category because it seems to us that in its original condition the roof was
allowed to rest simply on the ground and the inmates crawled into the den, i.e. it was once a fully wooden structure in which the 'wall' and the 'roof' merged and became one.

(b) The Single-Columned Structure:

This type of dwelling appears predominantly among those large groups of landless labourers in South Gujarat who live on the fringes of towns and villages, and are provided with the materials for their dwellings by their employers as also the land on which to build. Their existence is precarious but not so much as that of the Bunga-dweller, for they have regular employment and, in rural areas, they have been on the same sites for generations. Being nearer to good supplies of timber, and also being able to utilize the waste products of the farm, their dwellings are much larger than the Bunga and almost as good as those of Banni. What is particularly interesting is to find, as already mentioned, that the system of construction used by them is identical with that used by the more sophisticated Dangis of the hills. This system has merely been reduced and merged into a diminutive form because of the poverty. Where the Dangi uses a score of tall columns for this house, the local landless Harijan (also called a Halpati) has to make do with a single column. But both houses are hipped (i.e. have a roof which slopes down on all the four sides) and all the wooden structural parts in them correspond to each other.

The basic system of construction is that there is a central column taken from a tree with a fork and left unfinished. This crude piece of timber is planted into the ground and on top of the fork is tied with rope a short, horizontal length of wood meant to serve as the ridge. Tied to this ridge are a number of bamboo rafters and
these now descend at an angle all around the central column and reach out to the circumference of the plan (Ill. 885). At the lower ends the rafters can be supported in two ways. If the surrounding wall or enclosure of the dwelling is of mud, then the rafters simply rest upon the upper surface of it without any further fixing. If the enclosure is of brushwood, then a separate supporting system is required which is described further on. The height and form of the roof is determined by the short ridge and the span and inclination of the rafters. In this matter no specific rules are followed and each family makes it according to its own requirements and resources. The waterproofing of the roof is done by placing over the rafters a layer of split bamboo battens which are tied with string to the rafters; over this comes a layer of twigs and small branches and finally the thatch of grass and/or palm leaves (the latter is plentiful in South Gujarat). To hold the thatch in place, long bamboo poles are stretched across over the material and tied through the thatch to the rafters (Ill. 899).

The remainder of the dwelling, in this case, is of mud. The enclosing walls reach up to the eaves and are generally low, so that one has to bend in order to enter such a house. The other features in mud are: the flooring, the hearth, the small platform before each house serving as an open Çölö, and, interesting for South Gujarat, a container similar in design to those of Kutch (Ill. 886). All of these mud features are made of ordinary clay mixed with straw, left unburnt, and coated with cow-dung. The workmanship in mud is excellent and betrays long experience and skill. When we questioned these people (in village Munsard,
district Navsari) why they used so much mud, they said they could afford nothing better. But it seems to us that this answer is not accurate. Their skill in its use indicates a tradition which is in contrast to that of South Gujarat, for in this sub-division mud architecture is rare and is replaced by that in wood and brushwood.

The above description of the dwelling will show that it is not an example of half-timbering, but it is one of wooden construction combined with mud. However, it is striking that the two materials do not work together but are kept structurally apart.

In most of the houses of this type, the mud wall does not exist, instead its place is taken by an enclosure made of posts and brushwood in the following manner. The enclosure is in two parts: one part to support the ends of the rafters; the other to provide the enclosure. The supporting system consists of a series of forked posts of low height (eaves' height) placed at intervals along the perimeter of the rectangular plan. Over the forked ends there runs a bamboo piece which functions in one sense as a beam and in another as a roof-purlin. To this purlin are tied the ends of the bamboo rafters. In order to provide the enclosure, a number of strands of brushwood (meaning stray bushes, reeds, bits of waste material lying about) are stuck upright into the ground along the periphery and adjacent to the forked posts. They just reach up to the eaves and enclose the interior space. This is in the most primitive case. In somewhat better examples the enclosures is made of bamboo wattle over which is hung a layer of palm leaves, and the inside is plastered with mud (Ill. 878). A small opening in the enclosure forms
the entrance, and it is closed with a crude shutter made of the same materials as the enclosure and hung with rope to one of the posts.

A variant of the above type of dwelling was found in the Dangs and it provides a link between the regular Dangi house and the modified house of the Harijan. In this case the basic features remained the same, namely the use of a single central column and surrounded by a number of shorter posts on the periphery of the plan. What was novel was that the plan of the dwelling was circular (Ill. 905). The owner of this dwelling had just moved into the area (village Pimpri, district Dangs), and as he had not yet had time to settle down, he had constructed what may be called the 'minimum house' for himself and his wife. The geometrical shape which occupies the minimum space is the circle; it is also the easiest to construct so far as the roofing is concerned, for all rafters and slopes are of equal magnitudes.

Another novelty in this dwelling was the manner of fixing the upper ends of the bamboo rafters to the fork of the central column. A small hole was drilled through each of these ends and a thin shoot of bamboo was threaded through the openings and tied into a ring. This whole collection of rafters, now interconnected by the ring, was draped over the central fork and it stayed in place by its own weight. It did not collapse because the diameter of the ring was smaller than the width of the fork, and so it could not slip down. All the remaining details of construction were as before (Ill. 907).

The technique of joining together pieces of material by threading them with a second, more pliant, material is typical for the Dangs (we shall meet with it again), and is derived from the practice of threading together the large
leaves of the teak tree to make vessels and even umbrellas. It is distinct from wattle which derives from basketry and involves the weaving together of two materials. We thus get a combination of two basic techniques here: threading and weaving; it is completed by the technique of plastering by which the mud is coated on the inside. It is very interesting to find that all of these techniques were probably invented by the women!

There are a number of points of interest about the above dwellings. Firstly, they are made of materials which were once available in plenty and were virtually free. All the materials are used in a primary condition without any elaborate processing; all are light, easy to work with, and easy to transport if the need arose. Secondly, all of them are of short durability, given the way in which they are used. Even the teak-wood is not properly curved or carpentered but stuck into the ground to be attacked by organisms and dampness. A house such as this is not designed to last, and it indicates two things. The materials of which it was made were plentiful and free and so there was no point in seeking for durability. Any part which had deteriorated was simply exchanged with a fresh one. But this could only be done conveniently if the various parts were themselves loosely tied together and not firmly joined by carpentry! In other words, the very necessity for frequent changing of parts dictated a primitive and simple method of joinery — and this is precisely what we find. The simplicity of the carpentry was, thus, not necessarily a product of ignorance but at least that of convenience.

The second point is that it indicates a nomadic existence where the dwelling was by its very nature meant to be abandoned after a short stay. As already mentioned,
the original occupation of a forest-dwelling people was hunting, food-gathering and shifting cultivation (slash-and-burn), and a permanent stay in any one place was impractical. In accordance with this necessity, the dwelling was deliberately made of flimsy materials which were procured free from the locale itself and used without much additional labour. In short, the dwelling, its materials and design, were all tuned to the life-style.

Thirdly, the choice of such flimsy materials shows that the purpose of the dwelling was quite different from what one normally assumes. The protection which was sought within the dwelling was not so much for life and property but rather for shelter from the climate. A secondary protection was for the sake of privacy. All of these objectives could be achieved in stages. It was possible to first erect the roof alone and begin to live beneath it. The erection of the enclosure would follow as circumstances permitted, and the coating of mud to the interior could be done last of all. During survey all the stages could be witnessed within any one group of houses and there was no feeling of discomfiture if one house was inferior to the other.

The various points enumerated above may be kept in mind for they remain valid for almost all tribal housing which follows in this study.

(c) The Multi-Columned Structure:

With this we come to the standard tribal house which can be seen repeated in numerous examples where forests still exist, and which forms the foundation of the urban house of South Gujarat. There are basically two variants to this type: one, that which has a pitched roof and since it
is predominantly made by the Bhils, may be called by that designation; two, that which has a hipped roof and is made chiefly by the Dangis. The only difference between the two variants is in the form of the roof; all the other structural details are identical and it is necessary to describe only one set of them. Since the pitched roof is the more common variety, it is this which is described more exhaustively.

(i) **Variant with the Pitched Roof**:

The pitched roof is one which has two sloping sides which meet at the ridge; the lower edge of each slope is called the eaves, the inclined edge is called the gable. Since the eaves are low in height above the ground, the height of wall or enclosure below it is also low and sufficiently protected from the weather. It is the high gable end of the house which is exposed and liable to damage by rain, and which also permits rain-water to splash in through chinks in the enclosure. Because the gable end is so exposed, the pitched roof is practicable only in a climate which is relatively dry – such as in North Gujarat and Saurashtra. It is unsuitable in wet areas like South Gujarat. The relative disadvantage of the pitched roof is, however, made up by the greater simplicity of its construction. There is only one junction to be taken care of (at the ridge); in the hipped roof there are five, and that creates many structural problems.

The overall shape of the roof is determined by the plan, but, as already explained earlier (page 189), since valleys were not made in the past, this meant that the only kind of plan which could be suitably covered by a roof without valleys was either square or rectangular (the
circular has already been dealt with). This conclusion can be put differently; since valleys were not made, the only kind of pitched roof which could be made had to be either square or rectangular, and in accordance with this the plan was fitted in. In so far as tribal houses are concerned, the second proposition was the correct one. In constructing a house, it was the roof which was first erected and the enclosure added afterwards. This was necessitated both by structural considerations and convenience, meaning that once the roof was up the remainder of the dwelling could be added on part by part as circumstances permitted. This linkage between shape of the roof and form of the plan, namely that both had to be related to each other and both had to be right-angled, is very important because it had a decisive influence on the architecture. It is the shape of the roof which was the reason for the great majority of the houses, not only of tribals but throughout Gujarat, being right-angled.

(A digression: There is yet another kind of right-angled roof known as the lean-to. It is so called because it is usually made as an extension to an existing house and 'leans' against one side of it. But it can also be made as an independent structure, and resembles the pitched roof cut in half along the ridge. The reason why the lean-to is not used for permanent residence is because it has three exposed sides: the two gable ends and the new eaves high up at the height of the ridge. With the same effort a more efficient pitched roof can be constructed and hence the lean-to is only made for inferior purposes.)

The structural system in its simplest form, and some of the technical terms needed to describe the parts, is shown in Fig. 35. Basically the system uses forked columns which are planted into the ground at intervals and distributed
in rows in two directions. One of these directions is parallel to the face or width of the house, and the distance between two neighbouring columns in this case is called the Span or Gara (the indigenous word). The other direction is parallel to the depth of the house and the column distances are called Bays. The columns are of unequal height, the tallest being placed in the centre of the depth in order to produce the ridge, while the shorter ones are placed along the periphery of the plan. Wooden members called purlins are placed across the forks of two columns parallel to the width, i.e. spanning the Gara. The purlin at the highest point is also called the ridge to better identify it and distinguish it from the other purlins. At right-angles to the Gara and descending from the ridge are placed the rafters which rest upon the purlins. The upper ends of the rafters are spiked to the ridge to prevent them slipping off, and it is very likely that in earlier times they were tied with creepers or bark. The columns, purlins and rafters constitute the basic structural system of the tribal house. It will be noticed that the purlins are of greater thickness than the rafters, this is because they have to not only span a greater distance but also to carry a greater load. In other words, the Gara dimension is always greater than the Bay dimension, and corresponding to this difference the timbers that span them are different in size.

If a larger house is wanted, the increase in size can be achieved in two ways: by either increasing the number of Garas or the number of Bays. But an increase in the Bays is only possible if the initial height of the ridge is substantial, otherwise the height at the eaves will be too low and inconvenient (inadequate head-room). The increase
of Garas is easy for the additional columns which have to be added create no structural problems. In fact, the extension of the house along the Gara can be continued indefinitely. The two methods of creating more space result in completely different interiors. An increase in Bays produces the deep interior which we saw in the Koli dwellings; an increase in Garas produces a shallow and wide interior which was more common among the Bhils. It was, however, usual to increase both Bays and Garas simultaneously so as to retain the general proportions of the interior space. (This was possible in the free-standing tribal house.) One problem which arose in this general increase of both Bays and Garas was that the number of internal columns also rose and these obstructed the efficient use of the internal spaces. Particularly when cattle were also to be stabled inside, a relatively column-free space was preferable. To achieve this, a very skilful solution was adopted. Some of the intermediate columns were left out at ground-floor level and continued only at first-floor level, supported on the beams which were already there to carry the loft. Since this solution is linked to the construction of the loft, it will be described further on along with that topic. At the moment the remainder of the roof has to be explained.

The structural system of the roof being complete, it now needed water-proofing, and this was chosen according to circumstances. The poorest tribal covered the rafters with a layer of brushwood and placed over this the thatch, and weighted it down with additional pieces of timber or bamboo which were tied through to the rafters (Ill. 899). In the better houses, the primary layer was made of split bamboo battens, tied with string to the rafters, and then covered either with thatch or the usual round country
tiles. The manner of placing the tiles was identical with that prevalent all over India, namely that a layer of up-turned half-tiles, the whole mass of tiles retaining its hold on the battens only by friction. At the critical junction of the ridge only a double set of down-turned half-tiles were used, embedded in mud to prevent them being blown off by winds, and to seal the joints. The usual slope given to the pitched roof was about $28^\circ$. There is clear evidence that in the past, when forests were more accessible, before placing the thatch there was inserted a layer of teak leaves sewn together with wooden pins just over the battens. The quotations from Bishop Heber given earlier (page 341) proves this; and we ourselves could observe this technique still in use among the Dangis (Ill. 903). The very large size of the teak-leaf lends itself very well to producing such a flat, impervious surface.

It has already been mentioned that every tribal house had a loft, and to construct this a separate set of forked columns of shorter height (the height of the eaves columns) was erected, generally adjacent to the roof columns, thus producing the typical twin-column pattern seen in all the plans. The reason why the existing roof-column could not be simultaneously used for supporting the loft was due to the inability to make an effective junction with the beam of the loft. This beam could be supported by the existing column only if it had a second fork at exactly the required eaves height, but since this was quite impractical this traditional method of supporting beams did not work. The alternative method was to stop the roof-column at eaves height, rest the loft-beam upon it with a tenon, and add a second short column over the junction to hold the
purlin. But such a wooden junction has no stability at all. Stability could have been imparted to it by the addition of diagonal struts (as was done in northern Europe, the system being called triangulation), but this technique was not employed. And so the only solution was to continue with the traditional method and duplicate the forked column. The number of such duplicate columns depended upon the size of the loft. If the loft was small, then only four such additional columns were sufficient; but in larger dwellings where up to half of the space was covered with a loft, many more would be added. It was these additional loft-columns which now permitted a very interesting and skillful structural solution to be adopted for the elimination of some of the internal roof-columns in order to get a column-free space.

The short loft-columns were placed along the periphery of the plan and along the central row of ridge-columns. Over them were placed long beams running the depth of the dwelling. These beams could be used for supporting the loft. But over them, at exactly those places where an internal column had been eliminated, were placed short columns called Tir which rested upon the loft beam at their lower ends and at their upper forked ends supported the purlins (Ill. 876). The purlin was now supported by two kinds of columns. One was the normal roof column which went straight down without interruption into the ground. The other was a short Tir which passed on its load to the loft-beam which transferred it to the loft-column. The objection which will be here raised is: How can the Tir function when the junction with the beam is so weak, as already presumed above? The answer is
that the junction of the Tir is indeed weak: it is simply spiked to the beam and can transmit direct loads but it can at the same time rotate slightly at its junction. The reason why it does not tilt over and collapse is because it is being held by the purlin which, in turn, is supported firmly by the roof-column. The Tir can only tilt if the purlin also gives, and this is prevented by the frictional force which holds the purlin firmly in place to the fork of the roof-column. From a structural point of view, the stability of the whole structure is guaranteed by two factors. One, the stability imparted to the main roof-columns by being embedded deep in the earth—this prevents over-turning. Two, the purlins are forced onto the forks by the weight of the roof and friction prevents them from any movement, so that they remain stable even though they are not fixed to the forks in any way. The stability already imparted to the purlins by the main roof-columns is already adequate and all that the Tir has to do is to prevent bending of the purlin. The rotating junction of the Tir is sufficient for this. This technique of using the Tir to produce a column-free space is also utilized in the veranda of the rural house and we shall again meet with it.

The remaining construction of the loft was simple: rounded joists (resembling rafters) were spanned from loft-beam to beam, over these were placed bamboo battens with very close spacing, and finally came a thick layer of mud to produce the flooring. Entry to the loft was by means of a removable ladder.

Coming now to the enclosure, there were various methods to effect this depending upon location. The most usual technique for closing in the lower level of the dwelling, i.e. upto the level of the eaves all round, was
to fix wattle (woven strips of bamboo or reeds strengthened at intervals) to the outer row of columns and insert the lower ends partly into the earth. This could be left as it was, in which case it did not provide very efficient water-proofing, or it could be coated on the inside with mud, sometimes outside as well (Ill. 92-22). In those areas where palm leaves were available, namely in the plains, the outside of the enclosure was hung with leaves to produce a very effective water-proofing (Ill. 878). The treatment of the enclosure above the level of the eaves, namely towards the gable ends, was different. It must be remembered that this upper part of the dwelling corresponded to the space above the loft and it was only used for very inferior purposes, never for living. There was thus no compulsion to enclose it as effectively as the areas below the eaves. The usual method was to suspend palm leaves tied to the gable-rafters and to bamboo crosspieces and to leave it at that. These palm leaves could sway in the wind, let rain-water in, and were generally very poor protection. In some of the better houses they were regularly laid somewhat like thatch over bamboo framework, in which case their efficiency improved enormously (Ill. 878). Where palm leaves were not available, some kind of brushwood was tied between the columns. The careless manner in which the loft enclosure was always made is a clear indication of its inferior usage, and it is interesting to find here the same prejudice which obtained in the urban house, namely to treat the upper level of the dwelling as inferior.

The internal partitions of the dwelling were made in the same way as the enclosure and went up the same
height, except that no palm leaves were used. Since they needed support, they were always aligned with, and fixed to, any one row of columns. Because of the manner in which the dwelling was used (see page 331) the major internal partition was always just below the ridge, thus dividing the interior into two equal halves along the width. No door was ever provided anywhere in the partition, it merely stopped short at some point and the gap which was left was the entrance. The main entrance to the dwelling was a similar opening, closed in this case with a flimsy shutter made of wattle and bamboo framing, and hung by a strap made of rope to one of the short columns or to a post specially provided. There was no method to lock it except to hold it in place with another strap. The enclosure had no windows or ventilators because the crevices of the material let in sufficient air, and light never seemed to have been particularly desired. The smoke from the hearth found its way out in the same way as the air came in.

The tribal house as constructed above was not a finished product made once and for all. Frequent changes were made in it to suit changing circumstances. Partitions could be added or removed, by moving the front side of the enclosure inwards by one Bay a front-veranda could be produced (III. 896 from the Dangs). The loft could be extended by adding more joists. And by adding various lean-to roofs to the sides of the dwelling extra enclosed space could be created for purposes such as the lying-in, keeping goats, extra storage, etc. The photographs of tribal houses
(III. 886 to 924) thus show all of these combinations and permutations, but since no new structural principles are involved there is no need to describe them. Some of the richer tribes had begun keeping cattle in a separate structure and for this the same house was constructed except that instead of an enclosure of wattle there was an enclosure of wooden bars (III. 914). The great freedom to innovate derived from the fact that the individual house was free-standing and could therefore expand in any direction, and because the materials required were plentiful, free, and needed little labour to be used.

(ii) Variant with the Hipped Roof

The hipped roof slopes down on all four sides and has thus four eaves sides and no gable ends. The continuous low eaves all round the house give it greater protection from the weather and because of this the form appears mainly in the wetter parts of South Gujarat. Our examples are from the Dangs. The basic principles of the construction are the same as already described. The structure consists of roof-columns which carry the ridge and purlins, the manner of effecting the waterproofing is the same except that teak-leaves form a regular custom here because of the much greater rainfall as also the greater availability. The method of making the enclosure and partitions is again similar, except that in some parts where bamboos are rare, a kind of reed is used for producing the wattle (III. 912). The construction of the loft combined with the Tir is also similar. In view of all of these basic similarities in construction it is unnecessary to repeat the
details, and we give below only those features which are novel or different.

The most important difference concerns the presence of the low eaves on the two short sides of the plan, and the construction of the hip. The shorter eaves needs a structural member equivalent to the eaves purlin on the longer sides, and since this spans at right-angles to the normal purlin it may be called an eaves-beam to distinguish it from the normal purlins. A glance at Ill. 876 will show how the system works. The two longer eaves-purlins and the two shorter eaves-beams form a rectangle at eaves height all round the building. A similar rectangle is formed at the level of each of the upper purlins. The corners of these rectangles carry a special diagonal member called a hip-rafter. The hip-rafter is fixed at its upper end to a part of the ridge which projects slightly beyond its supporting roof-column (Ill. 695) while its lower end is fixed to the corner of the eaves-beam/eaves-purlin. On top of this new structural element can now be placed the additional rafters which are required to cover the extra portions of the hipped roof. The remaining details of the roof, i.e. the use of battens, teak-leaves and thatch, weighted down with timber or bamboo, is as before.

The main problem which arises in this case concerns the corner junction between the eaves-purlin and the eaves-beam. We saw earlier that the method of supporting the purlin was by means of the
fork. Now, the fork, being uni-directional, can carry a member only in one direction; the member coming at right-angles to this and needing to form a junction is obstructed by the forks. In other words, the fork no longer serves the purpose of carrying structural members. To solve this, a regular carpenetered joint has to be made (Ill. 902) in which over the corner column there is first placed a capital which then supports the two members as they meet and join by overlapping each other (i.e., half of each end is cut away and the two ends then fit into each other, as shown in the illustration). The junction between capital and column is by tenon-and-mortice. A similar capital is used for the roof-column carrying the ridge (Ill. 895). All of these carpenetered joints are simple, but still they represent a great advance over the normal tribal practice, and it is interesting to note that the Dangis are able to do all the carpentry themselves using only simple tools. What is not clear is whether the discovery of the carpenetered joint arose because of the need for the hipped roof, or whether the joint was borrowed from elsewhere and made the hipped roof possible. At any rate, what is certain is that the details of the joint are similar to those used throughout Gujarat and it is only a crude version of the carpentry of North Gujarat.

Two variants of the above corner joint can be seen in Ill. 893 and 887. In the former case, the level of the eaves has been lifted higher up over the loft by means of Tirs which are distributed all round the peripherie, and in order to make the junctions more
stable a diagonal strut has been added to each, anchoring the Tir to the eaves-beam. The reason for this interesting detail is the following. By raising up the eaves-level and creating a gap between eaves and loft, it becomes possible to insert additional rafters of a lean-to and fixing them to the loft-beam. In this way the addition of the lean-to is made more efficient as it gets cover from the roof at the point of junction, and lean-to roofs can be added all round to greatly increase the original house. The structural arrangement is shown in III. 890, and the actual raised portion can be seen in III. 891. In the second case, to avoid three structural members meeting over one support a very original device has been employed. The two purlins which appear at the intermediate level between ridge and eaves are supported by Tirs at a point set back from the corner, so that they then cantilever out from the Tirs towards the corner. At their meeting they are joined by overlapping and the hip-rafter rests over it without any further cutting. It will be noticed that the purlins are of teak while the hip-rafter, and all other rafters, are of very large bamboos. All of these details reveal the skill in carpentry and construction which the Dangis possess, and all of the parts of their houses are made with great care and superior finish, as the photographs show.

It has been mentioned earlier that in front of the Dangi house is generally a porch or Mandwa for storing hay (III. 537). The construction of this Mandwa is exactly like that of the loft and it is in fact its precursor. The loft inside the house is simply the Mandwa taken indoors with its own set of forked columns.
The last detail which has to be described is shown in Ill. 834. Here we see rafters coming from two sides and meeting over the ridge. To hold them in place they are threaded through with a bamboo shoot at their upper ends, and the whole linked set of members is allowed to hang over the ridge without any further fixing. It will be recalled that an identical technique was employed in the circular Dangi house of one column described earlier. This method of suspending members can, however, be employed only when the spans are small and the weight of the parts is light; the bamboo shoot could never support heavy timbers. It is a delicate kind of construction ideally suited to bamboo and not for teak.

(d) **Urban Full Half-Timbering:**

Having completed a study of the more primitive stages of the tribal house which preceded the urbanized house, we now come to the main topic of this section, namely the fully half-timbered house of South Gujarat. It has already been mentioned that the community which originally utilized this system in the more prosperous villages of the plains, and which contributed to its evolution into the finished form, was that of the Kolis.

The basic features of the system are soon described for they are now well known. In its simplest form the structure consisted of the customary forked columns placed now in great depth over numerous Bays; across each pair of Bay-columns was placed a purlin carrying the usual rafters, battens and thatch or tile roofing; and the enclosure and partitions were made of wattle and/or leaves mud-plastered on the inside. The loft was inserted into this covered space on its own set of forked columns placed adjacent to the roof-columns.
As the family grew prosperous, it gradually replaced in stages the wattle with brickwork which at first filled in the intervening spaces between the Bay-columns, and then later, as the brickwork became thicker, fully encased the columns on three sides leaving only one face exposed. An embedded column such as this is technically known as an attached column. Once this final stage had been reached, the system of half-timbering had come into basic existence and it could now only be refined. The refinement occurred in the town, and its stages were as follows (Fig. 9).

It will be recalled that the stability of the columnar structure depended upon the column being deeply planted within the ground; it was this which prevented it from over-turning under load. This primitive and inefficient system was transformed in two ways. Firstly, each column was inserted, at its lower end, into a stone base and this base was embedded within the flooring made of brick-bats and lime mortar. By this means any dislocation of the base was prevented. Secondly, it was discovered that the thick brick wall which now surrounded the whole house and columns on the outside was itself a very effective stabilizing factor. The brick wall of adequate thickness has a very great weight which is resistant to over-turning as long as it is connected to other cross-walls and party-walls. This connection was provided by the normal cross-walls at the short ends and by the system of columns and purlins along the depth. In other words, the brick walls, by being linked to each other, provided the stability against over-turning to the columns. These, no longer deeply planted into the ground, would have otherwise had a tendency to tilt over and collapse. On the other hand,
the brick walls by themselves (without the woodwork) had a tendency to crack under loads and then fall apart. This was prevented by the columns which took the load off the walls. The whole structural situation is rather complex and bears more theoretical explanation.

The vertical load of the house, consisting mainly of the weight of floors and roof acting concentratedly at certain points where purlins and joists occurred, had to be somehow brought down to the ground. If these point-loads were allowed to act directly on the brick walls made with mud mortar, then bending moments would have been produced within the brickwork which it could not have resisted. Cracks would appear and possible collapse of the wall. But if instead of this, the point loads are brought down upon the wooden columns, then the walls are relieved of such loads and can perform other functions. The wooden column is very resistant to the point load and no danger threatens on this score. The danger comes from different source, namely from over-turning. Being light in weight and resting upon a very small base it tends to rotate under slight lateral loads (arising from either wind forces or unequal settlement) and this can lead to tilting and collapse. This danger of over-turning is well resisted by the brickwork on account of its mass and linkage. In this way each material, if acting by itself and liable to an inherent weakness, receives support from the other precisely in a way which overcomes that weakness, and the resulting composite construction is stronger than either. The situation is analogous to that of reinforced concrete where also the strength derived from steel and concrete acting together is greater than if each were to
act alone.

The next stage of development occurred in the design of the supporting system of the first-floor. The primitive method had been to have a separate set of columns for the loft and as the loft progressed into a first-floor the latter continued to be supported by the duplicate columns. This ungraceful system was replaced by the following. All the columns were made short, reaching up to the ceiling of the ground-floor, and their tops were connected by horizontal members running in two directions; parallel to the Gara and parallel to the Bay. The Gara connection was made by means of beams which joined up each pair of Gara-columns. The Bay-columns were joined up in series by a long member embedded within the brickwork—called a wall-plate. The wall-plate was almost identical in location with the earlier, primitive loft-beam. By the addition of these various structural timbers, all the columns were linked to each other forming a 'cage', and this system is known in modern practice as framing. The two-way frame is a very efficient structure able to bear great loads. The system of joinery of the wooden parts was by mortice and tenon, details of which will be given later. Apart from providing general stability due to the framing, the beams and wall-plates served to support the floor-joists of the ceiling. Over the joists came a layer of planks, over these a layer of bricks, and then the final floor finish made of either mud or lime mortar. A floor made in this way was extremely solid and heavy (III. 469). Now, in the first-floor a fresh set of short columns were introduced, aligned with those of the ground-floor, and their feet
were embedded (with or without bases) into the solid flooring previously described. The tops were again connected by beams and wall-plates which in turn could now carry the second-floor, and so on. The columns of the first-floor were secured against over-turning in precisely the same manner as the columns of the ground-floor. In other words, each floor duplicated the structural conditions of the floor below and between any two floors there was the layer of solid flooring but no link or connection between the two sets of columns. The discontinuity of the woodwork between individual floors is very characteristic of the system and was dictated by structural necessity. A vertical link between columns was useless (as it was equally so in the tribal house) because of the weakness of the junction. The structure of the multi-storeyed house was thought of as a series of layers which duplicated themselves vertically, until at roof level the same technique of construction was brought in which already existed in the simple village house, namely columns and purlins. The only difference was that now the timber was not left crude and unfinished, but instead was properly planed and polished and all the junctions were made according to rules of carpentry. The details of this carpentry were identical with those of North Gujarat and hence will be dealt with more exhaustively there. The individual differences will be discussed under the sectional heads.

Regarding the system of making partitions, the original method of inserting a thin brick wall between two neighbouring columns was retained. The thickness of the brickwork was adjusted to that of the columns,
nearly it was either made flush with the column face or was slightly set back from it (Fig. 9). A problem was how to ensure that there was a bond or structural link between the brickwork and the columns, as otherwise there was nothing to prevent the brickwork from being knocked out from its position by some unforeseen pressure. The subject of bonding between brickwork and woodwork belongs to carpentry, and since the methods followed were those of North Gujarat, the details will be given under the sectional heads at one place.

The third stage of development occurred with the use of thick internal walls in place of the previous thin partitions. As long as the partitions had the same thickness as the columns against which they abutted no problems arose, but the situation changed when the wall became much thicker than the column. In this case, the column could be so placed with respect to the wall as to be entirely encased within it, or to be situated to one side at the corner of the junction. Both of these alternatives were found in various houses, but the solution which eventually emerged as the preferred one was to duplicate the column. Two identical columns were used, one on each side of the wall and located at the corners of the junction (Fig. 9). The Gara-linkage was now effected by duplicate wall-plates instead of beams. There was no structural necessity for such a solution and it was wasteful in material, but it conformed to the tradition already established and became the standard for the better class of structure. The two chief characteristics of this solution were the twin columns clasping the wall between them, and the location of columns at the corners of junctions of walls. It will be seen from the plans that the class of buildings which
employed this solution most rigorously was that constructed by the Marathas, and this would indicate that it originated in the Deccan (III. 426).

We now turn to a structural situation which was exceptional and required fresh thinking on the part of the designer: the large columned hall. It has already been described that such large halls had begun to appear in a number of buildings, for example the Kacheri, and they created a new kind of structural problem. In these halls for public gatherings the general character of openness and accessibility had to be established, and this was done by having as few enclosing walls as possible. The reduction in brick walls resulted in a lack of stability, for, as already explained, it was the presence of massive brickwork which imparted to the columnar system one essential kind of lateral stability. The open hall, by its very nature, was not very stable. To solve this structural problem without spoiling the design, the solution adopted was the following. At some part of the layout, usually to the back or one side, a very massive single wall was constructed of double or treble the usual thickness. Using this as a solid anchor, the remaining parts of the woodwork were all tied in to it by various beams, and stability was restored. It was as if all the missing walls had been concentrated at one place to produce the desired effect. And this extra thick wall was then used to contain within it the solid stairs! Here we have an example of great skill in structure. It must, however, be added that these large, columned halls mainly appeared in Maratha and Muslim buildings, or in those inspired by them, and
that the structural system already existed in Moghul buildings. For example the famous Panch Mahal at Fathpur Sikri is a perfect example of such a columned hall accompanied by a massive wall to one side of it. It is not possible to decide whether the indigenous craftsman had by himself discovered this technique, or had borrowed it from elsewhere. But since there is clear evidence that there were columned halls in the temples of ancient Gujarat, it seems that he already knew how to solve this particular problem.

2. TIMBER-BONDING

The historical and geographical distribution of timberbonding has already been described, and it is clear that the system derived its origin from the necessity of holding together a wall of brick or stone which was inherently weak. Had timber been plentiful, it is certain that it would have been more intensively used to produce the regular half-timbered structure. But because it was scarce, it was introduced sparingly and placed only at certain critical intervals in the construction. In those regions which had a very dry climate, such as Saurashtra, the timber could be placed externally without any particular protection from the weather. The detail of this system was very simple. A length of timber was inserted horizontally into the body of the stone wall in such a way that only one face was left exposed. It was secured to the wall by means of hold-fasts which will be described later along with the carpentry. Two such timbers meeting at the corner of the building were lapped to each other in such a way that a small portion of each timber projected beyond
the junction (Ill. 736 and Fig. - ). The projected portion served to prevent the one timber from slipping off the other and obviated the need for pinning them together by dowels. The weight of the wall above the junction forced the timbers onto each other and as long as the projected ends held, the joint would remain secure. It is significant that a joint such as this was not effected by using any metal straps, spikes, dowels or tenons, but relied on mere weight to hold the parts together and on a projected length to prevent slipping. The technique is typical of the archaic quality of the carpentry employed.

If the timber-bonding is closely examined, the question arises: What does it actually prevent? One answer is the following. In the event of an earthquake there would be a tendency for the walls to be rent at their corner junctions; and this was prevented by the bonding-timbers. Timber is very resistant to tension and as it is the tensile force set up by the earthquake which destroys the wall, this danger was effectively countered by timber-bonding. The behaviour of the timber within the wall was analogous to that of the steel within reinforced concrete; both were meant to counteract tension. The second answer is that, given a weakly bonded wall, there would be a tendency for parts of its to disintegrate and fall. The quantum of wall which would fall away at any one time would be restricted to the portion between two bonding-timbers. Therefore, the more the number of such timbers, the greater was the safety of the construction. The survey of parts of Saurashtra showed that the bonding-timber was placed generally at a vertical spacing of about 120 cm and that...
they were thus numerous over the elevation of the building (III. 752, 765). One timber was always placed half-way along the frame of doors and windows and tied up with it, and another at that level where struts of balconies met the wall (III. 751). It was not necessary to have an external timber at the level of the floor because there was anyway an internal wall-plate at the level which had a similar structural effect. The placement of bonding-timbers had, of course, to be done while the wall was in the process of being built, and wherever possible a tie was effected with other wooden members which happened to be present. The custom of using external bonding-timbers to tie up the building was so established in this sub-division that it was employed even when it was not required, as for example in the Mahalaxmi temple (Mahuva) and the Durbar-gadh (Bhavnagar), both of which had lime mortar (III. 736, 761). But in wetter areas it tended to disappear.

The bonding-timbers were repeated on the inside of the building at similar intervals as on the exterior, but now two different functions had to be performed. The one function was the same as before, namely to hold the wall together but this was performed in a different manner. Between each pair of external and internal bonding-timbers there were placed at intervals short lengths of timber running at right-angles to them and linking them together (III. 756). This technique of linking together the bonding-timbers was rare in the case of stone walls but became very common with brickwork, and it became a regular and important feature of the system of partial half-timbering found in North Gujarat. For
this reason its further details will be given there.

The second function of the internal bonding-timber was, at ceiling level, to receive the load coming from the floor-joists. It should, however, be emphasized that this function was quite different from that performed by the wall-plate in the southern system of full half-timbering. As already explained there, the purpose of the southern wall-plate was to, firstly, link up with Bay-columns and form the structural cage; and, secondly, to transfer the loads coming from floor-joists to the attached columns. In the northern system, the wall-plate was meant to receive the load from the floor-joists and distribute it evenly along the length of the wall. This particular distributive function became absolutely essential in the case of the brick wall and for the following reason. During the construction of a brick building there would come a stage when the floor-joists would have to be laid upon the wall and each individual joist would come to rest upon one, or at the most two, individual bricks. The brick wall is strong when loaded as a mass, it is relatively weak in its individual parts, so that the concentrated load of a joist would tend to fracture the individual brick upon which it rested. This danger is well known in modern practice in the case of beams resting upon brickwork and the usual solution is to place a short wall-plate at the point of junction. The solution adopted in Gujarat was to place a wall-plate the full length of the wall to receive the floor-joists, and where beams were concerned to place an attached column below. The technique of using wall-plates to distribute joist loads has been observed in other parts of the subcontinent,
for example in Nepal (1) and Himachal Pradesh (2) and was thus a common practice.

3. **PARTIAL HALF-TIMBERING**

The system about to be described was the major structural system of North Gujarat and by virtue of its importance may be considered the true representative of Gujarat as a whole. Partial half-timbering arose out of a synthesis of the two other system, namely full half-timbering and timber-bonding, and it appeared strictly in association with brickwork. The critical aspect of the matter was to find means to support those two elements of the structure which carried substantial loads and brought them upon the walls: floor-joists and beams. Under normal circumstances both of them would never come together upon the same wall, for if the beam spanned in one direction then its corresponding joists would span in the other. Thus, two different solutions could be employed in each case. Where only joists had to be supported the bonding timber was inserted, and where a beam appeared, an attached column and capital was inserted below it. The functions of these two structural members were contrary to each other. Whereas the function of the bonding-timber was to bring the load down upon the wall and distribute it evenly, the function of the attached column was to relieve the wall from load and divert it to itself. This dual method of tackling loads derived from dual traditions. The southern full half-timbering had begun by supporting every beam with a column and then developed this into a frame which completely prevented any load whatsoever coming upon walls. The northern timber-bonding had originated in a region
using rubble stone which could in many cases support even the load of beams, but there had begun to appear the attached column below beams as a precautionary measure. Once the material of construction became brick, the attached column below beams became mandatory because brickwork could not safely support the beam. Thus, a composite structural system using both timber-bonding and the attached column arose which combined features of two systems but was different from either. It is this composite system which has been called partial half-timbering.

Its distinguishing characteristics were the following. The structural woodwork was not extended to form a frame at all points even though this would have increased its efficiency. Instead, the frame was partial and appeared only below beams. In all other cases recourse was taken to timber-bonding. The absence of a general two-way frame meant that there were no corner columns and, consequently, also no twin columns clasping the brickwork. Instead of columns appearing in profusion in the interiors, they were distributed sparingly at critical points. It is quite obvious that what determined the choice of solutions was the availability of wood. The size or timber needed for a wall-plate was far less than what was needed for a column, because while the former was only distributing load, the latter was concentrating it. In a sub-division relatively far from sources of straight timber the greater economy lay in a greater use of the bonding-timber. Thus, the character which emerges is of an architecture which used timber-bonding profusely and the attached column sparingly. And diagnostic to the system was the absence of the corner column.
The above general situation was later modified by a change in the attitude to wood. Either because of greater availability of the raw material, or because of a greater sense of security, we find wood gradually being used in ever increasing quantities and this showed itself particularly in the use of columns. Now the attached column was introduced in a manner identical with the southern full half-timbering but, along with it, the whole northern technique of multiple bonding-timbers was retained, and the final product was a structure which displaced an incredible quantity of woodwork out of all proportion to the needs. The most prominent example of this is the Haveli at Vaso (Ill.375-6). Wood had become a means of displaying wealth and status.

It is interesting to find, however, that while all of these great changes in woodwork were taking place at the lower levels of the house, the construction of the roof remained identical in principle with that of the lowly village house. In both Saurashtra and North Gujarat the typical system of purlins, bamboo battens and country tiles was employed irrespective of whether the residence was of an aristocrat or of his attendant. One important reason for this was that the weight of the roof was far less than that of a floor, and hence no special precautions had to be taken to support the purlins. They could rest directly upon brick walls if the span was not too great, or be supported by simple attached columns of small girth and left unfinished. The only improvement which the roof experienced was in its outward show at the eaves, and these will be described later.

So far we have spoken only of the attached column within the structure, and now something must be said of
the free-standing column which appeared in verandas (Otlae) and passages around the Chowk (Baveshis). It has already been explained that the danger to the column came from its weak joint at the base and this had to be counteracted by stabilizing it with the brick wall. This device was not possible in the case of the free-standing column and to provide the necessary stability it was tied by means of beams to the wall behind. Since the spans in such cases were usually small, the load which the beam had to carry was also small and its main function was more to tie up the structure than to support loads. Because of this it could, in the more ordinary house, be left to rest directly upon the wall (Ill. 91) or be supported by short wall-plates within the brickwork, or, in better houses, be supported by regular attached columns tied in to the wall. Since it was clearly realized that the purpose of this attached column was not the usual one of transferring a load but only of tying in a structural member, to save on wood the attached column was often made into a half-column (Ill. 308, 331). It will be seen that the column was here being used in the manner of a vertical bonding-timber. This once again illustrates the fact that in any structural difficulty the solution adopted was sought to be related to the tradition of timber-bonding which was characteristic for the sub-division. To further save on wood, the vertical tying in was done not at every column but at greater intervals (Ill. 746; here the last two columns are only tied in). Where large balconies were introduced, the system of tying in was very elaborate, and the whole front view of such an elevation was full of attached columns and bonding-timbers embedded within the wall facing the road. It was this which gave such a richness to many of the houses (Ill. 324, 748), while
just behind the front wall there might again be plainness.

Regarding the general stability of the system, it will now be clear that what the composite structure was seeking to do was to meet two dangers to the building. The one arose from the loading via heavy beams which, if allowed to work directly on the walls, would produce vertical cracks. The other arose from the fact that while it was known that the brickwork was weak, there was no alternative to using it and all that could be done was to strengthen or reinforce it with timbers. The reliance on bonding-timbers indicated that the danger most apprehended was a tearing apart of walls and hence this had to be met by tying together the parts with a horizontal frame of timber. Since the climate was not conducive to many external and exposed bonding-timbers, more reliance was placed on internal timbers which nevertheless were so anchored into the walls that they pulled them together from the inside. Where possible, cross-pieces ran through the walls from the internal timber to the external, and where not, then hold-fasts inserted into the brickwork and projecting from the internal timber produced some kind of bond between the two materials and increased the stability. But it must be added that the internal bonding-timbers were not a good guarantee against a part of the wall falling away outwards. Very possibly this danger was not great because of the settlement pattern. With houses placed next to each other in tight rows, the party wall between two adjoining units was so wedged in that there was little chance of collapse. The only danger was to the walls was at front and back and this was met in two ways. The back wall was made thicker than the usual wall (it was in any case a defensive wall of the Khadki), but still we saw examples of how this wall had collapsed in two cases. One
was the Dhamdhere Vada in Baroda, and Illustration 579 will show how it was repaired. Vertical attached timbers were added to the outside and anchored to other timbers inside and the wall was secured in this awkward manner. An identical accident had occurred in the Nagarseth Haveli in Surat and was repaired in the same way. In the case of the front walls, these were always framed partitions at the upper floors (III. 408) and were therefore firmly held by the woodwork and could not fall away.

It is instructive now to make a comparison between the partial half-timbering and the full half-timbering with reference to the process of construction, meaning the stages of work. In the case of the fully half-timbered structure, it was possible (and was often done) to first erect only the timber framework right up to and including the roof, and then to fill in the walls later. A rural house being constructed in this way was seen in district Navsari. And it was a southern house which Sir George Birdwood must have seen in Bombay in 1880 when he observed that it was put up completely in wood 'before a stone or brick was laid'—quoted on page 95. The northern house could not be built in this manner. Since there was no complete wooden frame which could stand by itself, it became necessary to build the brick-work and woodwork together, i.e. as the work progressed the process of brick-laying and laying of bonding-timbers i.e. was done simultaneously. No beam could be placed upon the attached column until its stability was ensured by the presence of the surrounding wall. We were fortunate in being able to observe an ancient Haveli being demolished in Baroda (that of Sureshwar Desai) and the process of
construction could be deduced from the details seen. In the placement of doors and windows, as the later descriptions will show, the walls had to be erected along with the wooden parts for they closely fitted into each other. The door lintels, for example, were not parts of the wall but parts of the door, and until this was put up the portion of wall above it could not be continued. Throughout North Gujarat this close structural association between wood and brick was the rule and this explains why woodwork was such an essential part of the system.

Regarding the individual details of the various parts, for example the flooring, the column bases, the partitions, all of these will be dealt with separately under the sectional heads and in all the descriptions what will be mainly shown is the construction of North Gujarat.

Before leaving this general description of the system, something must be said about its local distribution. It has been mentioned that the partial half-timbering was a synthesis of timber-bonding and full half-timbering. Now, the degree to which the synthesis occurred was not the same all over the sub-division. In those parts which were nearer to Saurashtra, both geographically and culturally, there was a greater use of timber-bonding and less of the attached column. In those areas nearer to South Gujarat, and hence nearer also to supplies of wood, the attached column began to dominate the structure and timber-bonding became rare, being restricted often to only the wall-plate. The manner in which the two distinctive features combined in different proportions within the sub-division clearly indicated that they had different origins. And, furthermore, it could be seen that the use in North Gujarat of the corner column and the twin-column was a direct
intrusion of the practice from South Gujarat. The fact that such an intrusion took place shows that even though North Gujarat had the dominant culture, yet in the architecture important influences from the south had emanated. And one of the principal carriers of such influence were the Marathas. All of their structures show a southern system of full half-timbering in great regularity which is very striking.

4. THE FRAME

The word frame is used to designate that structural element which arises when beams and columns, either attached or free-standing, are joined together to form a supporting system. Basically, we can distinguish two kinds of framing in the Gujarati house: the massive frame and the light frame, and these will be dealt with separately.

(a) The Massive Frame:

The massive frame is required only when the span is large and the accumulated load is so great as to necessitate the use of a beam. The presence of the beam at once requires the attached (or free-standing) column to support it and the combination of the two produces the frame. The largest span in the house was generally that of the Ordo and it was here that the largest frame occurred. The shape of the Ordo was always a rectangle and here a curious discrepancy could be noticed in the placement of the frame. In modern practice it is the rule to span the beam in the shortest direction and to have the joists above spanning the longer direction at right-angles to the beam. But in the Gujarati Ordo the reverse was the case; the beam spanned the longer direction, i.e. it was parallel to the Gara, and the reasons for this unusual practice could not be ascertained
by questioning carpenters. Our own examination of the matter showed two clear possibilities.

It will be remembered that the first-floor of the house had originally evolved out of the loft which was inserted into the rear of the enveloping space (page 134). At that occasion there were as yet no internal divisions within the dwelling and so the only supporting walls available had been the two external walls on either side of the layout. The loft-beam was spanned parallel to the Gara. When the loft became a first-floor and the Ordo became enclosed with a thick wall the traditional location of the beam continued and produced the situation described.

The second possibility was that the long beam served to save material. In order to understand this we have to look at the manner in which the joists were spaced. In modern practice it is the custom to have a relatively large spacing between joists and to cover these with planks. The flooring thus produced was light because only light loads were expected upon it. In Gujarat the demands on the flooring were quite different. As already explained, one very important function which the floor had to perform was to provide a solid mass into which the base of the first-floor column could be embedded. To produce such a mass, it was customary to lay a heavy layer of bricks and mortar over the joists, partially supported by planks, and the heavy load which thus arose necessitated a close spacing of the joists. The quantum of timber thus required for close-spaced joists was for greater than the quantum of timber which went into the beam. A long beam automatically meant short joists and, vice versa, a short beam meant that the span of the joists was lengthened. A comparison
of the two situations will show that if the intention
was to save on wood, then the longer beam was more
economical - given a close spacing of joists. This,
then, was another strong possible reason for the place­
ment of the Ordo frame. The long frame and joists can
be seen in Ill. 468, 471.

The remaining details of the frame were the following.
The beam used was almost always square - and this is again
contrary to modern practice which has discovered, by
calculation, that the strength of the beam is greater if
its height is greater than its width. Our own assessment
of the square beam is that since it was cut out of a single
tree, once the bole had been trimmed what emerged was
naturally a square piece of timber, and this was brought
into the market. To now produce a rectangular beam out of
this square piece would have meant either halving it,
which would give two weak beams, or to further trim its
sides and thus weaken it and waste the wood. It was much
more practical to use the wood as it came on the market
and waste none of it by trimming.

The usual size of the beam was between 30 and 40 cm
in cross-section and between 500 and 550 cm in span. An
attempt was made to try and discover what relationship,
if any, existed between these two dimensions. In other
words, was the carpenter working to some rule which
determined the ratio between cross-section and span. A
large number of measurements and observations were made
but no conclusions could be drawn. The same size of beam,
for example, was used to span 550 cm as also 360 cm. Within
the same house, in two identical Ordas, beams of different
sizes had been used. Over large parts of North Gujarat it
could be observed that beams were not even fully trimmed
but had unfinished surfaces which curved into the body of the timber. In one very old house in Patan (that of the well-known Barot family), a whole tree trunk had been inserted in its natural condition. All these observations showed that what determined the size was not so much the opinion of the carpenter as the condition of the market in timber. It should be recalled that timber was procured either locally from inferior trees or imported from teak forests at a great distance. Under such circumstances the wood was used as it came and the best that could be done was to match it as far as possible. Particularly in the older houses the discrepancies in size were more striking. It was only in a few of the very magnificent Havelis that anything like complete uniformity in size could be enforced.

One point of special interest is that whenever the two sides of the beam were unequal, say 37 x 34 cm, the beam was always placed on its deeper side, so that the width of the cross-section was always greater than the height. Here again it is contrary to modern practice. The reason for this seems to have been firstly, to create a larger bearing surface for the beam so as to make it more stable against over-turning, and, secondly, to shorten the span for the joists. Throughout Gujarati carpentry a similar tendency can be observed towards creating stability by utilizing the broader side of timbers for bearing loads.

The height of the frame varied from floor to floor. It was a universal custom to decrease the height of each succeeding floor, and this practice is already recommended in the āśātric texts. The exact measurement of frame heights was disturbed by the fact that in many cases the traditional mud flooring had been replaced by lime or stone,
but even where the mud had been retained, the successive layers of mud applied year after year had raised up the level of the floor and no original base-line could be established. The measurements taken were therefore in situ and do not reflect the original position. In general, no common floor heights applicable to all houses either in the same sub-division or in the same town could be observed. The height of the ground-floor frame fluctuated between 240 and 280 cm, measured from the finished floor to the upper surface of the beam; this would give a clear height of between 215 and 250 cm. The lower figure is due to some exceptionally low beams appearing in a few cases. The close range within which the measurements fluctuate is nevertheless revealing and it seems that this again reflects the market conditions. Even though the timber came often by sea it still had to be hauled by carts over the remaining distance, and the loading capacity of the bullock-cart would automatically determine the size of the available timber. This, rather than gastic rules of proportion, would dictate the ultimate dimensions.

The height of the first-floor frame was between 1/9th and 1/14th less than that of the ground-floor frame, but these reduced heights were only regular in the case of those houses which had already a substantial ground-floor height. Where the latter was small to begin with, then the reduction in the first-floor was marginal. The standard house was only of two floors (plus roof) and these typical data will therefore suffice. (The individual dimensions are given in the chart at the end of the text).
We may now make a comparison with some of the śāstric prescriptions, but to do this it has first to be decided what the unit of measurement is in centimetres. The classical unit was the Angula which was expressed in multiples of the barley corn or as being equal to the finger of the carpenter or the owner. It has been estimated that the Angula comes to about 3/4 inch or 2 cm (3). Twenty-four Angulas made the Hastha of 48 cm and this was the unit of measurement for buildings. The Samarāṅgaṇa-sāstrīdrāma gives the recommended widths of the Śāla or room (4) in three variants, Jyestha, Madhya and Kanyāsa (meaning the superior, median and inferior), as 17, 10 and 5 Hastha, and this would come to about 816, 480 and 240 cm. Eight metres is an impractical span for timber, and this is reduced to a more realistic level by the Frāmāṇamāṇjari (5) which gives the range from 5 to 13 Hastha, i.e. 240 to 624 cm. It will be seen from the sizes mentioned earlier, and from the chart, that the room sizes in Gujarat do indeed fall within this range very closely and we have here an interesting co-relationship between prescription and actual construction. But it should, therefore, not be automatically assumed that the carpenter was following the text. It is far more likely that the prescription was following the availability of timber and current practice when it was written. Within the available range of timber, the carpenter could then select the particular dimension which suited his need, but as we saw, there was no fixed set of dimensions which he was using. Within the same house, two Ordas would show a significant difference in width, and it could not be established that among the various dimensions being used in situ any particular figure was a constant. The lack of constancy on site, when compared with the constancy of prescription, makes it very doubtful
if the rules were being carefully followed. All that can be said is that there was a general co-relation but not of great accuracy.

The textual recommendation for the heights in the *Samarāṅgana* (6) was that to 1/16th of the house-width should be added 4 Hastha, or alternatively, the three variants were: 5, 6 and 7 Hastha. The last three give us 240, 288 and 336 cm, and if to our own readings for the frame the floor thickness of about 30 is added then the heights in situ are between 270 and 310 cm. Once again there is a close similarity between prescription and datum. If the former rule is followed for the two dimensions of 5 and 10 Hastha, then the corresponding heights are 207 and 222, which are obviously too low.

The height of the first-floor was specified in the *Pramāṇanāmārangajīrī* (7) as 1/12th of the ground-floor, and this figure also falls within our data.

These few examples will show that while there was certainly a co-relation, it is not possible to say that the rules were being minutely followed. If we assume that instead of written prescriptions, the artisans were simply following a body of orally handed down rough-and-ready rules which allowed a substantial flexibility in the observance, then the assumption would be closer to recorded fact.

Continuing now with the subject of the frame, it was observed that when two frames belonging to adjoining Ordas were situated back to back with only a party wall separating them, then they were linked together in a novel manner. This can be seen in Ill. The method was
to make the bracket-capital of the two attached columns in common so that it pierced the party wall and held both columns pressed together against the brickwork. The feet of the two columns were similarly joined together by means of a thick plank of wood which was embedded within the flooring and also pierced the party wall. We see here once again how the massive brick wall was made to serve as the stabilizer to the woodwork. One important reason why this had to be done was that the two-way frame of South Gujarat was missing in this case.

A different kind of junction of frames was effected when there was a free-standing column at either Chowk or Otlo. Here the absence of brick walls made it essential to find some other means to stabilize the system. The usual method in the Chowk was to let the beams run through as continuous members upto attached columns in the next wall. At the junction of the beams the joinery was by lapping. In some cases only one beam ran through and the two other shorter ones were notched into the main beam. In the Otlo a different procedure was adopted, shown in Ill. 511. It will be seen that here only one beam can run through, parallel to the Gara, and the other one has to stop short. The danger in this case was that the part of the short beam which formed the lap could eventually be sheared off in case of any unexpected movement. To prevent this, the end of the short beam was projected beyond the junction and, ipso facto, it projected beyond the face of the building. This projected beam-end looked ugly and so it was carved into a fantastic shape (Ill. 281). But in many examples the projection was made even greater and supported by struts running diagonally from the column (Ill. 334), and on to this useful projection
was placed either a balcony or a partition wall of the floor above. This device secured two advantages simultaneously: it produced extra space on the floor above; and by exerting a counter-weight on the projected end of the beam it prevented shear.

Those internal spaces which had relatively small spans, as for example the Parseal, had no beams (or frames), and the ceiling rested simply upon joists which spanned the full width and did the duty of beams. But here again, some exceptions were seen. In some houses additional beams were introduced into the Parseal, with or without attached columns, and made to run along the depth of the space, i.e. parallel to the joists! Under normal circumstances such additional beams, duplicating the work of the joists, was quite unnecessary, and the reasons for it was as follows. In the better dwellings a swing was often situated in this part of the Parseal and the beam was meant to support it. Another reason was that, after eventual partition between brothers, the beam could be used to support a partition wall across the upper Parseal. In one or two examples two closely placed beams were found in place of one, and these were obviously meant to support a more solid wall above at some future date. These are shown in (Ill. 14) It will be noticed that where there was no attached column, the end of the beam was made to rest upon a short wall-plate inserted in the wall. These short-wall-plates were extremely common in the older houses but had given way to attached columns in the newer. This was clear proof of increasing southern influence and increasing supply of timber.
It will be recalled that one of the typical features of the southern two-way frame was the twin corner columns clasping the wall. When the wall concerned was a thick internal wall running the depth of the building, then since each corner had to have a column, there would arise here at this one point an accumulation of four corner columns (III. 424). The rigidly applied rules of construction would permit nothing else. To tie up all these corner columns two closely spaced and parallel beams would be required and when these happened to continue out towards balconies, then to support their ends two closely spaced columns would be required. This is the feature which can be so prominently seen in many of the Maratha buildings (III. 424, 553) and also in others (III. 358).

Having described the typical frame and the beam, it is now necessary to turn to the other important element of the system, namely the supporting column. The details of a typical column can be seen in III. 534. In its fully developed form it consists of four parts: at the feet is a base usually of stone but sometimes of wood. This base rests upon, and is slightly embedded into, the flooring. Here a very interesting point must be mentioned. If the flooring is of stone, then it is not necessary to embed the base but it can be permitted to simply rest upon the stone slabs. When the artisans were questioned upon this peculiarity, namely that there was a danger of the base slipping away under load, we were informed that once the column had been loaded, the friction between the stone base and the stone floor was so great that it would never move. Some minor experimentation on site proved the truth of this assertion, and it revealed a new aspect about stone construction. If the normal friction in stone was so strong
it would easily explain why the stone temples used the material without any mortar and very few dowels, but simply rested one slab upon the other and produced a stable structure. Gravity and friction would safely hold up the construction.

Above the base of the column is the shaft, of wood and circular in section, and above this come two pieces which together form the capital. In order to distinguish the two we have used the technical terms used by Edmund Smith of the Archaeological Survey (7), namely capital for the lower member and bracket-capital for the upper. The reason for these two members is the following. Timber consists of 'grains' which run parallel to the direction of growth and wood is very resistant in the direction of the grain. It is less so at right-angles to the grain. When a junction occurs between column and beam, the load upon the column is parallel to the grain and so the wood resists it well, but the beam is loaded at right-angles to the grain and at the point of junction there is a tendency for the upper end of the column to press into and dent the surface of the beam. To prevent this, the additional pieces are introduced, so that a broader base comes into being at the point of junction. It is not the narrow tip of the column which now presses into the beam but a broad capital. The individual parts are illustrated in Ill. 534.

The method of joining all of these parts to each other was the simplest possible, namely by either mortice and tenon or by dowels. The shaft was inserted into the base and the capital by tenons, and the capital was fixed by dowels to the bracket-capital. The bracket-capital could
be a single piece if it was mounted upon an attached column, or it could be two lapped pieces if the column was free-standing. Since this junction was very critical to the frame, the lapping was modified in such a way that the two pieces could not be pulled apart in the horizontal direction. This was achieved by an ingenious looking system of tongue-and-groove which was on different sides of the lap. The example in Ill.540,778 is from a junction in which only one beam is present. The extremely complicated nature of the carpentry will now become clear. This detail alone indicates the great skill which the indigenous artisan had developed in wood-working. But, ultimately, it depended on weight to hold the parts together. Each piece could be lifted out of the groove vertically, so that as long as it was loaded it remained firmly in place. This technique of making joints which depend upon vertical weight to make them stable was ideally suited to building construction, and it differs from that used in furniture design. It will be seen from the same illustration that there were two projecting dowels inserted into the bracket-capital which fitted into mortices in the beam.

Where there was a strut, its manner of fixing was as follows. The upper end was tenoned into the projecting head of the bracket-capital (made longer in this case to match the projecting beam-head above), and after this had been effected, the lower end was fitted into a very slight groove in the face of the column, and a long wedge was then driven into a specially prepared mortice in the column (Ill.403,503). The reason for this different kind of fixing was to enable the strut to be installed even after the column and bracket-capital were in place. And it was this same reasoning which led to the invention of the strut in
the first place. It must have occurred in actual practice that under load the bracket-capital was found to sag with time; and to restore its stability the strut was added as a subsequent measure. The proof of this statement can be seen, for example, from Ill. 721. Here there are no struts, but the mortices for them have been left in the bracket-capitals for later insertion. A similar practice was found in numerous examples and must have been a common practice. It should here be added that the strut was generally used, not in the European fashion to support a normal beam, but only under cantilever beams. The angle of the strut was about 60°.

The cross-section of the column differed from situation to situation. The free-standing column was generally round at the shaft up to 2/3rds of the height, from there onwards it was square (Ill. 534). The square cross-section was necessary to fix the strut. The capital and bracket-capital were respectively square and rectangular. The details of a typical shaft are shown in Ill. 505, and of a typical base in Ill. 478. The attached column was always half of, and matching in design to, the free-standing column. The portion which was embedded in the wall was left rough and was fixed by a crude wooden hold-fast to the brickwork (Ill. 776). All the columns of upper floors were generally square if they were located in the interiors, and round if in balconies. The reason for the square column was not only to save on cost but also to make it easier to abut partitions on to them. These upper floor columns also generally had no base but were simply embedded into the flooring.

Regarding the dimensions and proportions of columns, these were naturally determined by the frame heights.
Column widths varied between 17 and 22 cm generally, and in general the height of the whole column (including capitals) was between 11 and 14 times the width, taking the measurement of that portion of the column which was visible. The portion embedded within the flooring was not accessible.

We may now attempt to discover whether the typical wooden column conformed to śāstric rules, and for this purpose the Ṛṣaṇānaṁanjarī was selected since it deals almost exclusively with woodwork. The general rule (8) was that 1/6th of the shaft (stambha) was taken as the unit of measurement for dimensioning the other parts, and half of this unit was to be the height of the capital (bharana) and a half-unit the bracket-capital (sirsa). Our own measurements showed a different rule being followed, namely that the bracket-capital was generally either equal to twice or one-and-half times the capital. In other words, the bracket-capital was normally much greater in height than the capital. But in Saurashtra the position was different (Ill. 73). Here the two parts were generally equal in height! This proves that the Ṛṣaṇānaṁanjarī must have been written in accordance with the practice prevalent in that sub-division. And the reason for the smaller size of the bracket-capital in Saurashtra was the scarcity of timber.

The textual rule (9) regarding the projection of the bracket-capital was that it should be $1\frac{1}{2}$ to 2 times the height; the former rule was followed in North Gujarat, the latter was approximately that followed in Saurashtra. Another rule faithfully followed was that regarding the base (kumbha) (10), namely that its height should be $1\frac{1}{2}$ times the column width and the base-width equal to the
height. Some of these proportions can be seen in the structural details accompanying the buildings described, but for the sake of convenience a few are specifically cited. The bracket-capital is in Ill. 534 and the base in Ill. 511. It should be added here that a great many of the rules deal with the decorative elements of the column and these are excluded from this examination of structure.

So far we have been describing the typical frame of North Gujarat in all its details. Something must now be said about the frame of Saurashtra because it showed some important differences to the former. The system in Saurashtra was to have one main beam spanning the longer span, and at right-angles to this and above a second set of beams which might be two or even more, and of a smaller dimension than the main beam (Ill. 72). The need for two sets of beams was partly because frequently the spans were large, but the chief reason was the fact that beams of large cross-section were not easily available in the sub-division. Saurashtra being far from the sources of timber, it was not economical to import large sizes, and all of the structural members seen in the subdivision were on the average smaller than those of North Gujarat. The solution adopted to meet this situation was what may be described as the two-way frame, one formed by the main beam, the other by the subsidiary beams. The difference to South Gujarat was that whereas there the beams and wall-plates of the system were all on the same plane, in Saurashtra they were on two planes above each other. The reason for this structural difference was the difference in spans. The rooms in Saurashtra were throughout larger than those of the typical house of South Gujarat (the southern house being long and narrow), and these larger
spans needed beams which were not reduced in cross-section (and thus weakened) by notching the subsidiary beams onto them – as would have been necessary to bring them all to one level. The double-tier of beams was clumsy but it saved material. The gap between the two sets looked ugly and was filled in with thin fillers, as can be seen in the illustration. All of the other details of the system were the same as North Gujarat and need not be detailed.

Yet another variant system was that found in parts of North Gujarat which were adjoining to, and had links with Saurashtra. In this case, instead of spanning the longer width of rooms, there were two beams spanning across the depth (Ill.102,153). Not only this, they very skilfully made use of the existing door-frames to support themselves and thus saved the cost of an extra pair of attached columns! This can be seen clearly from the plans and illustrations. The twin beams frequently ran the full depth of the house and joined up with the two columns of the front otlo. This was actually a very good structural solution and it is strange that it was not adopted everywhere. It is found specifically in Patan and Siddhapur, and in the former it is found particularly in the houses of the Muslims. There is a distinct possibility that it represents some old and forgotten style of Muslim construction which was once general in Patan, and from it where it spread to neighbouring areas. Since it resembles the Saurashtra twin-beam pattern, the origin is debatable.

With the above, the principal framing systems of the north are completed, and we may now turn to the southern frame. In general, it is noticeable that the southern
frame is lighter than that of the north; the reason, already hinted earlier, was that the average spans of rooms was less. The narrow Garas of the south were barely 400 cm in width as against 500 cm and above in the north. The Bay distances were also less, so that the load on each structural member was less and the cross-sections could be light. This was very curious, for it was precisely those parts of Gujarat which were nearest to supplies of timber which had the lightest woodwork, while North Gujarat, which was so far away, had the heaviest. The decisive factor was the planning of the house and the sizes of the spaces; and also perhaps because the north had the greater resources.

The general details of the junctions were also simpler, as also all the carpentry (Ill. 850). One reason for this was that a great many of the houses in this sub-division were recent, and the more recent the building the more plain was the woodwork. It was clear that there had occurred a decline in workmanship of the traditional kind.

One very significant variant of the southern framing system was that which appeared in the Muslim and Maratha buildings of Baroda, and in those towns which imitated this style. It was distinguished by the fact that the junction of beam and column was effected without the use of any capital at all (Ill. 425, 578). This was not sound carpentry, and was to some extent compensated by the head of the column being wedged in slightly into the under surface of the beam. In trying to discover the reason for this unusual kind of detailing, two possible factors seemed to be relevant. One was that throughout this system there was a preference for using two beams placed directly one over the other (and not at right-angles as in Saurashtra), as the
illustrations show. The lower beam had the smaller cross-section and was clearly subsidiary to the upper beam which was the main load-bearing member. The lower beam had approximately the height of a capital, and if it is thought of as a continuous capital connecting all the columns and supporting and linking the upper beam, then the situation becomes more logical. This member may be called in that case by a new name: capital-beam. The capital-beam was at exactly the same height and matched by the corresponding wall-plate (Ill. 433) which was joined to its attached column in a similar blank manner. The wall-plates and capital-beams formed a continuous ring of members connecting all the various columns, and over this ring came the actual structural beams. The visual appearance of this arrangement was strikingly different to that normally found in Gujarat, and reveals its alien character—probably Deccani.

Since there was no regular capital, there was no transition from column to beam in stages, and instead it was abrupt. To overcome this, the width of column and capital-beam was made exactly equal, and the column was always square and plain. The main beam was slightly larger in cross-section than the capital-beam and projected beyond it. (It is curious to find this detail showing complete identity with the method of arranging beams in the Ionic entablature of Greece.) It was this general plainness of the Maratha frame: the absence of projecting capitals and carved work associated with it, the complete absence of struts, which made the European traveller call it "mean and shabby". There were, however, some examples where the double-beams were combined with regular capitals and carved struts, and the appearance was then more
The second factor possibly responsible for the above detailing was that, in general, the spans between columns were far smaller than in the normal Gujarati house. This can be seen from the various plans (Ill.51a,425). The small span derived from the planning system described earlier in which the Gara and Bay were both usually small. The close spacing reduced the loads per column and beam, and so the absence of the capital as a link between the two did not have any serious consequences. Strictly speaking, the junction was more related to furniture design than building construction (the joint between table-frame and leg is without capitals because of the light loads), and that could have been its origin.

The close-spacing of columns and the use of double beams gave to these buildings the appearance of an overwhelming mass of woodwork - more so than in the normal Gujarati house.

We may close this sub-section with some minor details. In those cases where the wall-plate was not long enough to span all columns of a row, it could be joined on to another wall-plate and the junction was as shown in Ill.459, right. It can be seen that the intention was to prevent the two members from slipping off each other, and at the same time to lock them together. To effect this, a wedge made of very hard wood was hammered into the centre of the junction. It is this joint which was possibly called malla-bārdha by Mānasāta (11).

The manner of joining the bonding-timber to the attached column was by mortice and tenon. But there was a
refinement practiced in the better houses. The cross-section of the column was provided with a rebate on either side (Ill. 775) meant to take the plaster of the wall. The bonding-timber was now inserted behind this rebate (being flush with the plastered wall) and it was thus doubly held in place.

(b) The Light Frame:

This was the frame used to make the thin internal partitions of the house; a similar light partition generally appeared in the front portion of the upper floors for the following reason. The front of the house had an Otlo constructed of columns and beam. This single column and beam could not support the load over-head of a regular thick brick wall, and so only a light partition was erected instead on all of the upper floors facing the road. Now, the thin partition was not sufficient safeguard against driving rain, so to protect it a very elaborate, wooden weather-shade was placed over it at first floor (Ill. 797). In one example at Patan a single enormous weathershade projecting some two metres beyond the face of the house was erected on the second floor and gave protection to the whole front (Ill. 66).

The method of constructing the light frame was to join up a number of thin horizontal and vertical members (Ill. 410) by mortice and tenon and to fix the whole frame to the main structural frame at various points. The hollow spaces between the woodwork was filled in with specially made thin bricks of about 12 cm width or even less, and plastered over. Since these fronts always had many windows in them, the window-frames formed part of the general framing, and the whole arrangement was made at one time and inserted into the structure.
It could be observed that in many cases the junction of two members was additionally secured with iron straps nailed to the woodwork (Ill. 218). The use of iron in Gujarati construction was rare because it rusted the wood and damaged it. It was introduced only when no other method suggested itself.

One important problem associated with the light partition was how to prevent the brick infilling from falling out of the frame. A number of alternative methods were employed. One was to make the usual rebate to either side of the vertical post of the frame and file the end of the brick to fit into it. A second method was to drive spikes into the sides of the frame and while brick-laying to see that each spike came to rest inside the mortar joint of the bricks. The spike acted as a hold-fast to the infilling. A third method was to nail small wedges to the sides of the frame and file the bricks to fit into them. All of these techniques are shown in Ill. 777.

A different kind of light frame, and one mainly found in Ahmedabad and its environs, was the all-wood frame mentioned earlier (Ill. 212, 215). It consisted of vertical posts to which were fitted, by tongue and groove, wooden planks of various widths. The front of each plank and post was heavily incised with ornament while the back was left severely plain (Ill. — ). The upper and lower ends of the planks were similarly grooved into the horizontal members of the frame, and it is obvious that all the parts had to be finished in the workshop before hand. In other words, it was not that first the structural posts were erected, the panels inserted, and the fixing done by beads on site. Everything had to be prepared to the last detail in advance, just like in
furniture design, and fitted together at one time. And, as already mentioned (page 223), this kind of wooden screen seemed to be of Muslim origin. It is interesting to find that carpentry derived from furniture making appears on so much of Muslim woodwork, while the typical carpentry of Gujarat is much more robust and is derived from building construction. The difference between the two techniques seems to us to be diagnostic in identifying various structures.

As a last item in this sub-section, we may consider the frame used to support the roof. In many cases no frame was necessary and the purlins could be supported directly on the walls (the weight of the roof being much less than the floor). But framing was also used, and in this a number of unfinished columns placed adjacent to the external walls supported the purlins via capitals of simple design. The location of these lightly loaded columns was not always aligned with those of the lower floors, i.e. they rested upon floor-joists. Stability to the frame was provided by the enclosing wall.

Where the building was of great width, and the area of the roof was without cross-walls, an alternative system was used. Long beams were placed parallel to the depth and supported by attached columns at the back and partition columns at the front, and over the beams were placed the structural members called Tir. This is shown in Ill. 713. Stability of the Tir was guaranteed by the purlin abutting onto the external walls.

The hipped roof was generally rare in domestic practice, but it appeared in some Haveli temples and in a novel form. All the four sloping sides met at a point (i.e. there was no ridge). The four hip-rafters met in
the centre on a large, cylindrical piece of wood and were tenoned into it. Their lower ends were wedged to the floor beams, and if the span was long, then they were additionally supported by Tirs in the middle (Ill. — ). The central junction was possibly the one which, in the Manasāra, is called vanu-parva and refers to five pieces forming the joint (12). The method of covering the original roof could not be seen because in all cases it had been replaced with corrugated iron.

5. THE FLOORING

Flooring can be distinguished according to four categories: that of the ground-floor, that of upper floors, the loft, and the terrace. These will be considered separately.

(a) Flooring of the Ground-floor:

The ground-floor is nearest to the dampness emanating from the soil and foundations, and so there was always a general need to make it impervious to moisture. In open areas such as verandas and courtyards this was even more essential. The courtyard was always paved with stone, and the Otlo and Haveehi as well in the better houses. The stone slabs were laid upon a brick layer below and embedded in lime mortar. In the more sheltered spaces, a regular floor of lime mortar was made and given a smooth polish, but whether this had always been part of the original house or added later, it was not possible to say. In some cases a colouring matter was added, usually a pale yellow or red, to make it attractive. Very seldom marble was used. In parts of North Gujarat, and particularly in some
Muslim buildings, the flooring was of a doubly-baked brick about 20 cm square and of a dark maroon colour. The double burning made it very hard and resistant to wear. In the traditional Ordo, even in rich houses, the floor continued to be of mud mixed with cow-dung for reasons which have already been discussed. The mixture was applied by hand and renewed about twice a year, or at particular festivals. The mud floor was warm to the touch in winter and cool in summer and was an ideal material for sleeping upon. It was remarkably resistant to ordinary wear and tear (since no shoes would be used within the dwelling there was no danger to it), and always presenting a very clean and inviting appearance. Due to the constant renewal, its level would rise over the years and after some time it would have to be dug up and completely renovated.

(b) Flooring of the Upper Floors:

In the upper floors the material used was generally either lime mortar or mud, laid upon a soiling of brick which was supported by wooden planks resting upon the floor joists (Ill. 469). The junction of two adjacent planks was covered by a wooden bead nailed to the planks. The joists themselves were inserted into the surrounding walls and rested there upon wall-plates. It was naturally not possible to examine the inside of floors still in use, but much information could be gathered from parts of houses which had fallen down or were being torn down, and these served to give the typical picture. In the following is reproduced details from one such typical house, namely the famous Haveli in Baroda of Sureshwar Desai, seen during its demolition.
First-floor       Second-floor
Lime mortar     11 cm         12 cm
Brick soling    15 cm         12 cm
Planks          2 cm thick x differing widths ranging from 15-20 cm
Cover bead      1x4 cm unrebated  1x4 cm rebated to joists
Joists          9x ca 13  12 cm gap 9.5 x ca 12  12 cm gap
Total thickness 38 cm         35.5 cm

The above details are shown in Ill. 469 and 471. It will be seen what great thickness the flooring had and the load it exerted can well be imagined. The lime mortar had been laid in two layers and while demolition each layer came away separately. The bricks had been laid in mud mortar. The joists were placed, as in the case of beams, with the height being less than the width. The reason was the same, namely to provide a larger bearing surface for the load above, and to ensure against over-turning. The placement of the cover bead was in one case rebated and the manner in which this was done is shown in Ill. 469. Each joist had a rebate cut into its upper edge and between two such rebates the cover bead was simply dropped into place. The planks were then placed over the beads in such a way that their edges met over the head and were hidden by it from below. This procedure must have been very cumbersome, for each rebate had to be cut in accordance with the width of the planks, and since these were not uniform all the work had to be done in situ. The rebates are clearly visible in the photograph, as also the nails to secure the planks. A point of interest here is that the sizes of both planks and joists were by no means uniform. A variety of sizes had been used, and it will be recalled that the same thing had occurred with the beams of the frame. What these measurements clearly prove is that timber was used exactly as it became available; it was too
costly to trim and waste. In one of the rooms the joists had rebates cut into the lower side! Since there was no need for this, it could be easily guessed that these were joists belonging originally to some older, and demolished, house and had been bought and re-used in this Haveli. The family who had built this mansion were one of the leading citizens of the town and the size of the house clearly showed their wealth, yet such second-hand timber had been used. It once again proves the scarcity of timber at this time.

At the place where the joists met the wall-plate, an ugly gap was left between each joist and to close it another kind of covering piece of filler was used (Ill. 469). A thin piece of wood, with wedge-shaped ends, was slid down into grooves cut before hand into the joists. When all of these fillers were in place, it looked as if a second solid wall-plate was running above the lower one. A similar treatment of the joists occurred whenever they met a beam (Ill. 469). These details show what great pains were taken by the carpenters to create a neat visual appearance. Incidentally, in one house in Ghogha this cover piece was hinged and hid a secret cavity! (Ill. 755).

The great thickness of the floor created no aesthetic problems when it abutted against a wall, but when it terminated at Chowk or Otlo then some means had to be found to give it an attractive frontage. The usual method is shown in Ill. 424. The solid part of the flooring was closed off with a kind of wall-plate which had a very finely curved profile. It was fixed to the floor by wooden hold-fasts. Below it, at the level of
the joists, came a very interesting detail. The head of each joist was joined to a carved piece resembling an elephant's head, and these now revealed themselves on the elevation as a decorative frieze. Between each joist-head was inserted the cover piece described above, and this time its front was carved out into the form of a bird. The magnificent effect of this can be seen in Ill. 315, 508 and variants showing other figures can be seen in Ill. 304. If these decorative fronts are now compared with the royal Sarkarvada of Baroda (Ill. 428) the difference will be immediately apparent.

Some minor variants to the above typical flooring must be mentioned. In the one case, instead of wooden heads to cover the planks, a long strip of iron was run below the connecting edges of the planks and over numerous joists simultaneously. The joists prevented it from falling even though it was not otherwise fixed. The reason for so much precaution was that if there was no cover bead then tiny fragments of the brick soling and mud mortar would trickle down through the edges and land on the people below. The use of the iron strip was to save on wood, and it appeared more frequently in the extreme north of Gujarat. In Saurashtra, surprisingly, the wooden bead was very common and in some examples was transformed into an intricate form of decoration (Ill. 739). Here the one set of beads is actually needed to cover the edges, the other diagonal set is pure decoration. A similar design can also be seen in Ahmedabad.

In a number of houses, particularly of Muslims, instead of using cover beads, the whole under surface of the ceiling would be covered with a painted piece of
canvas stretched across from wall to wall. This preference for painted fabric was, of course, traditional in Islamic countries and it had, in the wooden context, other consequences. This was the introduction of a decorative panelled ceiling. There were many varieties of panelling but the main were the following. The simplest kind was that in which planks were nailed below the joists, at right-angles to them, and over the edges a beading was fixed with rosettes made of metal. Around the ceiling an additional bead was applied (Ill. 536). The planks and woodwork were then painted. A slightly more complicated variety was made by having one set of planks fit into the other by tongue-and-groove and placing them at two levels. This produced a coffered effect (Ill. 510,527), and was common in Maratha buildings. A further development of this was to have the two sets of planks parallel to each other, and to carve one of them with flowers in high relief while the other was plain (Ill. 50,55). This contrast was very effective and produced a rich pattern. Its most luxurious manifestation was in the Muslim houses of Patan (Ill. 50). Finally, the most magnificent of them all was what we have called the fretted ceiling (Ill. 263,264). Here the planks were cut into undulating strips and joined together diagonally (Ill. - ). Over the whole surface was super-imposed an intricate pattern made up of thin pieces of wood looking like fret-work and painted white to contrast with the dark background. Sometimes flowers in white were added. The impression was as of ivory decor over ebony. The whole pattern extended without interruption from one end of the ceiling to the other and has a striking resemblance to a carpet suspended across the surface. And there can be no doubt that this was the origin of the design.
Some comparative analysis will make this clear. M. S. Mate, in his "Deccan Woodwork", speaks of the low-relief treatment as follows, "The fascia but more especially other flat-surfaces like panels and ceilings, that received carpet-like treatment in the typical Islamic fashion could not brook deep relief", and further on he describes one such ceiling but calls the technique pinning rather than fretwork, "As a concomitant to the above and also as an independent method by itself, pinning or superimposition claimed a lion's share in panels and ceiling. In almost all cases where the surface to be decorated was plain and spacious, pinning was used" (13). The actual use of ivory inlay in this connection is then mentioned, "The earliest extent and recorded of these, is from the Ashar Mahal at Bijapur, where ivory pieces were placed to cover the 'ground' ... The pinned stripes were dark black ... and provided a striking contrast to the white ivory ground. The other known instances belong to the late Maratha period ... Ceilings of large halls were decorated either in the same technique as that of the Bijapur example or by affixing ivory pieces on a dark timber background" (14). Once again we find Maratha and Bijapur work inextricably combined and having its repercussion in Gujarat. The ceiling just described and that illustrated are undoubtedly from the same sources.

Henry Cousens had surveyed Bijapur extensively before this and wrote on the Gagan Mahal, "The ceiling of the great hall was entirely of wood ... " (15), and illustrates one of the ceilings in Plate XXIV. It will be seen from this that Bijapur work, dating from 1560, was indeed similar to the ceiling illustrated, and since no such work in Gujarat is of such an early date, Bijapur must
be presumed to have been the source. He adds elsewhere "All the timber-work ... was cleared away by the Marathas, the beams and brackets being ruthlessly torn from the walls" (17). This would explain, to some extent, how the Marathas acquired some of the Deccani style.

Another important indicator of origin was that in all of the specimens seen in Gujarat the pattern was throughout mainly geometrical and floral; figure-work, so common elsewhere, almost never appeared. The fretted ceiling was much copied in the richer houses (Ill.309,513-19) and a great variety of designs were produced, but they all had these non-figural characteristics, and it becomes quite certain that the origin was Muslim. It should be added that even in its carpentry the ceiling showed alien elements. The use of minute pieces of wood fitted into each other with small nails (called pins above), the lack of solidity in the concept, these were not traditional to Gujarati woodwork. The ceiling itself had a serious weakness: the nails driven vertically into the supporting structure above frequently came loose and fell by gravity, bringing down the attached pieces. A Gujarati carpenter would never have been guilty of such flimsy work. This can be judged from what follows.

Regarding the method of constructing the fretted ceiling, unfortunately no exact details of the superstructure could be examined because such ceilings were either intact and hence inaccessible, or they had vanished. However, one variant technique was discovered which seems to offer a clue. In this method a large number of round logs of timber (called Ballies) were
were thrown across the span almost touching each other. To these, from below, were nailed thick planks and the spikes were made to completely pass through the Balli and its upper, projecting end was turned down forming a rivet. Now the plank would never fall by gravity alone. The edges were concealed by the usual beads (Ill. 544) shows the remnant of such a ceiling from the famous Haveli of Haribhakti in Baroda; and Ill. 537 its structural details. A similar system was found in many Havelis.

Another variant to the above can be seen in Ill. 495. Here the timber of the Balli had been cut in half, thus giving it one straight face and one rounded. The straight face was fashioned to look like a plank and a series of such timbers placed adjacent to each other looked exactly like a panelled ceiling even though there were in fact no panels. It was a very clever method of saving on timber and labour; but this technique was only possible with small spans.

(c) Flooring of the Loft:

In those cases where the loft had remained in its original condition, i.e. was not developed into a regular first-floor, the flooring was extremely primitive. A number of joists carried thin planks of wood, and that was all (Ill. 743). In many houses, instead of planks the battens of bamboo had been used, and this method was common in South Gujarat in even well-to-do houses. The reason for this stark simplicity was not only that the loft was considered inferior, but also because there was no necessity to embed the column bases above into massive flooring. The only column which came above belonged to the roof, and having light loads to support, with
stability guaranteed by the walls, a light flooring was sufficient.

(d) The Terrace:

As already mentioned, the terrace was the critical area of the building. It was here that the first, and inevitable, signs of collapse occurred because of inadequacy of the detailing. The method of construction was as for massive floors, namely using joists, planks, brick soling and lime mortar. But it was apparently not realized that the lime mortar had a very limited durability given the severe fluctuations of the local climate. It developed tiny cracks in course of time which permitted rain-water to percolate through, and this eventually rotted the structural timber, leading to collapse. In all the collapsed houses seen during survey, it was the terrace which had started the process. By a strange coincidence, in Baroda, three important Havelis collapsed within a few years of each other: those of Sureshwar Desai, Haribhakti and Lallu Bahadur. All three had been bankers and revenue farmers to the Gaikwads at about the same time, and the simultaneous collapse seemed to indicate that all three had been constructed at roughly the same time. This would give about 250 years (plus minus 50) as the period required for a normal terrace to collapse under the prevailing climate.

One other serious defect in the construction was that very often a heavy parapet wall of solid brick was erected at the edge of the terrace and resting on the beam below. This very heavy concentrated load often caused the beam to bend and ultimately give way. These various defects in
construction were clear indicators that the indigenous craftsmen were unfamiliar with the design of terraces.

There were usually two methods employed for dewatering the terraces. In case the water was intended to be collected in an underground cistern, then a down-water pipe was made of pottery in which each short length of tapering pipe was inserted partially into the next and so on. The whole down-pipe was embedded within one of the thicker walls and opened out into the head of the cistern. A whole range of these pottery pipes is shown in Ill. 521 and the placement within the brickwork can be seen in Ill. 484. In order to close off the pipe when no further water was to be collected, there was a wooden lid which fitted into the opening at terrace level. Another variant was to have the pipe opening below into a small recepticle in the Chowk from where a second pipe connected with the head. By placing a metal channel in the recepticle, the flow of water could be diverted into a gutter which carried it out into the road.

The second general method was by means of a metal spout, usually of copper, placed at the junction of the terrace and its parapet wall. This threw the water some distance away from the face of the building. The copper was used because it did not rust (Ill. 588).

6. THE ROOF AND WEAHERSHADE

These two are considered together because they have similar functions. The normal method of constructing the pitched roof was by means of purlins as already described under frames. Over the purlins was placed a series of close-spaced rafters made of very inferior timber of small size resembling poles rather than structural timber.
To these were tied with string a layer of split bamboo battens and upon these were placed the rounded country tiles. The poor quality of the woodwork can be seen in Ill. 419. It was not only the poorer house which had this inferior timber, but the same thing occurred in the better houses as well, as can be seen from the example of Fateh Muhammad's Haveli in Bhuj and the Munshi house in Broach (Ill. 636). In both these houses the accompanying photographs will show the fine quality of the remaining woodwork. The real reason for this inferior treatment was that the interior of roof, along with the loft, was the relatively disused part of the dwelling and was thus rarely seen by visitors. It continued to retain the primitive character which it once had in the village because there was no social occasion to change it. The typical details of one such roofing system are shown in Ill. 780, and the appearance of tiles can be seen in Ill. 351.

The rounded country tile used for water-proofing the roof was made by the potter as a tapering cylinder turned on the wheel, and then it was cut with a thread vertically down the middle to produce two equal halves. During laying, work always proceeded from the eaves to the ridge, and first there was placed a row of up-turned tiles and covering the joints a row of down-turned tiles. The taper of each tile permitted it to be inserted into the next. The function of the up-turned tiles was to throw off rain-water onto the down-turned ones which acted as channels to carry it to the eaves. The potter generally made only this one kind of tile and it had to serve for covering the ridge as well. The ridge tiles were embedded in mud to prevent dislocation by wind. The remaining tiles needed no particular fixing but remained in place.
by their own weight, and were prevented from slipping down by friction. In many cheaper houses there was no fascia board at the eaves, but this had become a standard feature in the town house.

The board forming the fascia was fixed to the rafters as shown in Ill. 780; its purpose was to hold in place the edge tiles and prevent them slipping off. The water of the roof often damaged the fascia boards and they had to be replaced at intervals. Another source of damage derived from the fact that the slots which were made at intervals to receive the ends of the rafters were so numerous that they tended to split the board horizontally. To prevent this, a strap made of metal was bound around the fascia between each slot (Ill. 780). In those rich houses which wanted to make an external show with their woodwork, the fascia and eaves were now transformed with decoration. The most common feature was a brass rosette which was nailed through the fascia to each rafter-head; to this could be added a wooden fringe suspended from the board; and finally, at the corners, was suspended a cylindrical piece carved into an attractive shape. The palace at Halvad (Ill. 708) shows these decorative features in full magnificence.

It has already been mentioned that it was important to have a large roof over-hang in order to protect the woodwork from rain. Now, this could not be achieved by the usual, inferior rafters for they could not take a large cantilever beyond the last purlin at the eaves. To produce the large over-hang a special technique was applied. An extra purlin, which may be called the flying-purlin, was introduced and supported much beyond the face of the
building by means of a cantilevered strut and bracket-capital (Ill.238). The strut was fixed to the wall with a short bonding-timber.

The problem of not being able to make valleys in the roof has already been discussed at length (page 189), and here it is only necessary to briefly recapitulate the details. Each up-turned tile acted like a channel and carried one stream of water down to the eaves. But at a valley a number of such channels would debouch their streams and the accumulated water had now to be transported down. There was no single tile which could do this; and the use of metal flashing or gutters was not customary. A special tile could have tackled this problem but it was never invented. And so, instead, the valley was never made in the traditional house, and the consequences of this have already been discussed. Briefly, it meant that the over-all plan of the house had to be either square or rectangular without any offsets. Complex T, L, or E shaped plans were not feasible, and the same was the case with the classical catuhālā mentioned in texts. Wherever there were four blocks around a courtyard, two of them would have to be either covered with terraces or, if pitched, with roofs which were much lower in height than the others and could therefore abut against the higher walls. But this latter was not what the term seemed to imply.

The wooden weathershade was a second line of protection required only at first or second floor level. The fact that it was of wood, and not some other material, is very curious because wood does not last long in wet weather. To leave wood exposed to rain, or to try and combat rain with wood, was itself contradictory and revealed that the device was
not part of the original tradition. It was noteworthy that the manner in which it was fixed to the main structure showed a lack of integration, as if it had been added as an after-thought. The fixing details can be seen in Ill. 386. This particular method was that which was, and still is, used by the Indian shopkeeper to put up a canvas awning over the front of the shop to provide shade. The edge of the material was stitched into a bamboo pole which was then placed horizontally upon two cantilevered diagonal supports. The system was taken from tent design, and appeared to be here translated into wood. It is a matter of speculation whether this was indeed its origin, and whether it was borrowed mainly to protect against the rain or to provide shade against the sun. When it is considered that the multi-storeyed house was itself not part of the original architectural tradition, but a later development in response to urbanization, then the awkward presence of the weathershade becomes clearer.

As against this, there is sufficient evidence that the weathershade in stone, and used as part of stone architecture, is very ancient. It can be seen in all the traditional temples of Gujarat as a horizontal course (chādyā) around the base of the sikhara, and what is even more interesting is that the stone weathershade shows ribs on its upper surface in exact imitation of wood (see for example the temple of Sunak (17). Are we, then, to assume that wooden weathershades were in fact anciently known and used? This matter is difficult to decide, and we give the speculative possibilities.

Evidence has earlier been given that wooden temples did exist in Gujarat and so it would be quite logical to
assume that wooden weathershades were part of the system. And if it is further assumed that the area in which the tradition arose/had originally a dry climate then the use of wood in such exposed locations would no longer appear contradictory. We ourselves find this theoretical possibility very probable as it conforms with all the generally accepted data about Gujarati culture. Added to this would be the possibility that it was accepted as unavoidable that some parts of the structure were of a temporary nature and were meant to be renewed at intervals. The wooden weathershade would then be one such part, and it would be logical to arrange its fixing in such a way that it could be renewed. The fact that the detailing resembled that which was customary with awnings would detract nothing from this explanation.

7. THE STAIRS

Stairs were of two kinds: wooden and solid, and they will be described separately.

(a) Wooden Stairs:

It has already been mentioned that the wooden stairs evolved from the wooden ladder and hence retained a great many of its characteristics. The most prominent were: the steepness and the lack of a permanent fixture. The traditional stairs were made by carpenters as ready-made units which could be bought and installed anywhere (this custom still exists). The inclination at which they were placed depended upon the owner, and in this he was generally hampered by the lack of space within the depth of the Parsal—the usual location of stairs. But no particular inconvenience was felt because the upper floors were in any case not the main floors of the majority of houses, and the younger
members of the family found them tolerable. The steepness was such that it was not convenient for carrying any heavy loads upstairs, but then even this was not required as the storage spaces were on the ground-floor, as also the water supply.

The fact that the stairs were ready-made meant they could not be fully fitted into any part of the existing structure. The usual method was to simply lean them against a cross-joist or wall-plate and let them stand by friction against the floor. Sometimes an iron chain ran from them to a staple in the woodwork and served to prevent slippage.

The traditional design of the stairs is shown in (Ill. 494). It consisted of two diagonal stringers which held together the treads and risers made of planks. These were grooved into the stringers at the sides, and the two stringers were bolted together by two long bolts of wood (Ill. 494.673). This unique piece of wood had at one end a knob and at the other a slot into which could be hammered in a thick wedge to tighten the joint. The one bolt was placed in reverse of the other. On top of the stringers and at the meetings place of tread and riser was placed an additional bar of wood, nailed to the stringer, and its purpose was to take the weight of the foot. The function can be understood by analogy. In a ladder the weight is taken by the rungs; in the stairs it was taken in exactly the same manner by the bar. The planks of the tread were by themselves too thin to bear the full weight and were intended mainly to provide a bearing surface for the toes. The whole arrangement of planking had the further purpose of concealing the body from view (from below) during climbing. A second set of bars were placed along the
under-side of the stringers, but their purpose could not be discovered. We were told by carpenters that it was to permit the stairs to be utilized along either side; namely that if one set of bars got worn out, the stairs could be reversed and the second set used. This explanation seemed doubtful. On the upper side was, finally, a hand-rail fixed to the bars. It could be used to assist the person in pulling himself up while climbing the steep stairs. In many examples this feature was substituted by a rope hanging from the woodwork!

The riser and tread were equal, about 20 cm each, and the angle of inclination measured by keeping the tread horizontal was about 60°. Around the stair-well on each floor was a low railing of wood to guard the opening. One interesting feature found in some houses was a sliding trap-door located at the head of the stairs which could be closed and locked. In all of the examples seen by us the sliding shutter was not solid but perforated exactly like a screen (Ill. 542), and its purpose was to enable the person beneath to see who was above before opening it. As already explained, the security which the trap-door offered was to those on the ground-floor since that was the main floor of the dwelling. Similar trap-doors were seen by Louis Rousselet when he visited Baroda, and he has already been quoted.

It has already been mentioned that in many of the larger houses provision was made for future partition, and that openings were deliberately left in ceilings with temporary coverings to enable stairs to be later inserted. The ready-made stairs unit was easy to instal in such cases, and one set of stairs could even be shifted to a new location without any difficulty. This light and
shifting character of the traditional stairs was very curious in a permanent dwelling and it remained so even in the best houses. There were no variants in the design until the coming of the colonial style. With this there began to be installed the typical European dog-leg stairs, not only in the newer house, but also in the older ones. The old stairs were simply removed and within the same stair-well, after some slight modifications, the new dog-leg was introduced. The cutting of joists to accommodate the dog-leg was plainly visible in these examples. This is one reason why the presence of such late features does not necessarily indicate the late age of the building.

(b) Solid Stairs:

The entrance steps to the Otlo were often of solid brick paved with stone; but if there was insufficient space due to narrow lanes, then stone slabs were cantilevered from the plinth. In the ground-floor, in some houses, the stairs were also made solid of brick with stone paving, while in the upper floors the usual wooden stairs would continue. In some examples, instead of stone treads, the whole covering was of lime mortar but since this would not last the edges of the treads were lined with timber. The timber-lined solid stairs became standard for all major solid stairs.

Where the intention was to have a solid stairs going all the way up, it was customary to encase them within two thin walls in the manner which already existed in Moghul architecture. Walls with stairs inside them can be seen, for example, at Fatehpur Sikri in the building known as the Diwan-i-khas (18). The total width of the
stairs plus enclosing walls was very great and caused problems in planning. It would not fit into the normal house-plan and new locations for it had to be thought out. There were, in the main, two methods employed.

In one case it was inserted as a 'spine' into the central part of the plan, running parallel to the Gara or width (Ill. 549,641). In smaller houses it was single, but in the larger Maratha and Muslim mansions it was always made double, the two flights starting virtually from the same point and moving in opposite directions (Ill. 52 a ).

In the other case, it was located to one, or both, sides of the plan parallel to its depth (Ill. 52 a, 553 ). In all such cases a number of additional problems arose. The great width and short length of the unit did not fit into the long depth of the plan and the projection looked ugly. To solve this, a very peculiar solution was adopted; the unit was made tapering so that it gradually merged with the plan. The external (or internal) wall was thus not parallel to the planning system but this defect was thought the lesser one (Ill. 52 a ).

The other problem was what to do with the wasted solid portion of the stairs below the treads. The common solution was to hollow it out and use it as a storage space (Ill. 424,575 ). This neat solution can be seen in many of the plans, and the storage cabin was fitted with doors for locking. In some of the Maratha buildings, a grill of wood was let into the wall at the head of the stairs to allow the guard to inspect the visitor before opening the door to him. (This reverse process was because in Maratha houses the residential space was on the upper floors).
The construction of the solid stairs was the same as described above for the ground-floor. In upper floors the treads were supported by timber beams spanning between the encasing walls and the steps themselves were of brick plastered with lime mortar and lined with wood. A handrail was not provided because there was no danger of falling. The steepness of the solid stairs was almost equal to that of the wooden ones, but in long flights it was noticeable that the inclination was gentler. It varied between 35 and 45 degrees.

8. THE DOORS AND GATEWAYS

The entrance door of the typical Gujarati house was the feature on which he lavished the greatest possible care and expense in order to make it a symbol of his prosperity and well-being. Part of the care derived from the need for security, and as a result the design of the door was exceptionally massive and cumbersome; part of the expense on carvings derived from the ritual aspects of the matter discussed on page 146. But it is clear that what weighed the most was the desire for status, and it was the entrance door which the visitor first saw and from which he judged his host. The trend towards prestigious entrances had perhaps been set by royalty, for the gateways of the palaces were of enormous size and richly decorated, and this was imitated by the aristocratic Haveli. Already in the classical śālpa texts the portion devoted to the dimensions and design of the door was substantial, and minute rules were given for the proportions of the various parts. In the Pramāṇamānjari the first 40 verses are devoted to the door, of course much of it to the carvings, and no other topic has so many verses. The Samarāṇanaśūtradhāra
has a special section on Dvara-guna-dosha, the auspicious and inauspicious qualities of the door. Thus, the door has always been a very important part of the architecture.

In Gujarat, while the decorative design of the door might show a great wealth of variations, the structural system of its construction was very uniform and showed only a few alternative designs. Because of this remarkable consistency in the detailing it is sufficient if the typical, standard construction is described for this repeats itself unchanged throughout the state. In general it can be said that the massive door prevailed over North Gujarat and Saurashtra, and declined towards South Gujarat. The richness of treatment was maximum in North Gujarat and parts of Saurashtra, and became plainer in the remaining areas. The scarcity of timber had some influence on this in Saurashtra, because the smaller members used did not permit much intricate work. But this was made up by an increase in sheer size, as the photographs will show. The great sense of insecurity in that subdivision also seems to have made the front door plainer than what appeared inside. It is only the eastern fringe between Mahuva and Bhavnagar which has the northern wealth of decor.

In general, there were three types of doors which could be distinguished according to the system of construction employed, and these were: (a) the Single-tolla door, (b) the Double-tolla door, and (c) the Mitred door. Each type is described separately.

(a) The Double Tolla Door:

The name given has been derived from a very unusual wooden member used in it and locally called a Tolla; this
piece is so distinctive that it virtually characterizes the type.

The method of construction was determined by the fact that the structural stability was derived from a combination of woodwork and brickwork; both had to be erected simultaneously and all the details of construction were tailored to this need. The basic principle followed was to separate the structure into two parts each with its own frame, and to then lock these two frames together. The one frame was designed to support that portion of the wall which came over the opening of the door; the other frame was for the shutters to close against and be secured. The latter frame was simple and has here been called the inner frame. The former frame was very complex as it had many functions to perform. It consisted of four vertical posts joined together, but the main junction was between the two front posts and then to this was joined to the back one post each. The main junction of parts has been called the outer frame and the rear posts the rear frame. These various complicated parts are shown fully detailed in Ill. 480.

The inner frame was of four members joined together in the usual manner by mortices and tenons. The outer and rear frames were made as follows. There was at the lowest level of the structure, and partly embedded in the flooring, a horizontal frame (Ill. 480), to which were tenoned the four vertical posts. Each front and rear post of the two frames were then joined together (along the depth) at the top by the Tollia (Ill. 480). The shape of the Tollia was that of a saddle facing upwards and its ends projected much beyond the point of junction. The top member of the inner frame was tenoned to the side of the Tollia, while its lower member fitted into a space on the lower-most horizontal frame. By these complicated means the three
frames were now all linked to each other. This whole arrangement was then placed on site and the next step was to fit the wall into it. As the brick-laying progressed to either side (partly weighing down the lower-most frame) and reached lintel level, two or three extra members were now put into position across the two Tellas and parallel to the width of the door (Ill. 480). These were: one vertical piece of bonding-timber which faced the entrant and projected to either side into the wall. Behind this came a thick plank placed horizontal and flat, and in it was a hole to take the pivot of the shutter. The third piece (optional) was a filler and had the same purpose as the bonding-timber to front. Now the brick-laying over the door could be continued and be supported by the three timbers just placed. The weight of the brickwork held them down and also held the bonding-timbers, and the composite structure was now complete. The shutters were inserted just before the upper brickwork was started. At their lower ends the pivots fitted into small metal studs in the lower-most frame. This description of the door is very involved because that was how it was constructed. The drawings shown will give a better picture than the description. In them the wooden parts in the elevation have been named and these have been repeated in the details for easy identification.

The construction of the shutter (there were always two) was as follows. There were a number of thick planks which formed the body of the shutter and were bound with iron straps placed at intervals along the length. The straps were fixed by spikes which were turned on the other side and acted as rivets. On the front side of these planks were fixed additional ledges running both horizontally and vertically and secured with spiked rivets of a larger size
and often with knobs which exactly fitted into the pattern of the carvings. Very often these knobs formed the centre of the carved flowers. The shutter moved on pivots above and below which were differently designed. The upper swivel was of wood and fixed as an extra piece to the upper corner of one plank with the iron straps. It was housed in the hole left in the plank forming part of the outer frame. At the lower end there was an iron pivot (Ill. 472) nailed to the plank, and its tapering end rested upon an iron stud which had a round groove (Ill. 460) and was fixed to the lower-most frame. The method of swiveling the shutters was very efficient and caused no difficulty despite the heavy weight of the woodwork. All these details can be seen in Ill. 480.

The above construction of the typical door remained unchanged in essentials but variations could be produced by varying the individual details of the ledges and the fixings. It was the ledges which carried the main carvings and numerous variations of these occurred producing a great variety of designs. Some of these can be seen, for example, in Ill. 404, 682, 805. Further variations occurred in the treatment of the frame. A comparison will show that the Tollas in particular were much smaller in Saurashtra (Ill. 634). The completely undorned ledges were also common in this sub-division but combined with richly decorated canopies in stone (Ill. 710, 729). Some of the doors of Ahmedabad were made tall as to reach unto the wall-plate of the Otlo. Their frames were designed as columns complete with capitals which projected into the openings. The ledges were then cut out into fantastic shapes to fit into the equally intricate profiles of the capitals, and examples of such doors are shown in Ill. 483, 499.
Another example from Ahmedabad had a whole surface pattern of metal straps with painted matter in between (Ill. 252). But all this multitude of forms was superficial to the construction technique which was everywhere the same. In sharp contrast to the wealth of decor on the front was the severely plain and unadorned back of the shutters. These could not be seen when the shutters were open and were visible to the inmates only when closed—but then the decorations were not for them.

It will be seen from the above method of construction that Gujarati carpentry was extremely robust and massive, and it was designed to produce a structure which could carry heavy loads. In other words, it was a carpentry originating in building construction and not in furniture design. It used wood in great profusion and in heavy cross-sections, and the various joints, despite their extreme complexity, seemed to have preserved very archaic features. The pivot was, of course, not indigenous to Gujarat but was common elsewhere as well. It appeared in Rajasthan and in Moghul architecture, and in the latter was even used with stone shutters (19). M.S. Vats reports the pivotted door for Harappa, "Door pivots were frequently made of brick, but sometimes also of fairly large sized stones or of discoid pebbles" (20). Among those illustrated in the volume is a square one exactly similar to the ones from Gujarat. The system of using planks and ledges fixed with spikes was again common elsewhere, for example in Rajasthan (21) and Mysore (22). The only really indigenous feature was the Tolla and about this some further discussion is required.

The structural principle of the Tolla was that a saddle-shaped piece of wood was used to clasp and support a load.
If now a glance is given to the primitive, tribal fork and its development in Ill. 876, it will be seen that these already incorporate the same structural principle. The capital used by the villager of South Gujarat is precisely related to the Toll—a both are saddle-shaped, and both perform the same functions. This peculiar and distinctive member does not appear in any of the doors of India or Nepal so far illustrated in the various publications. It appears only in Gujarat, and not once but twice. The upper Toll is matched by a lower one belonging to the lower-most frame (Ill. 470). It projects and is visible in the interior of the dwelling in many examples (Ill. 473). It is because of these two distinctive Tolls that the designation was selected.

The classical śilāpa texts nowhere mention the Toll with one exception, and that is the Pramāṇamānjari. It is there called todika (23) and is joined to the uttaranga or lintel, and is to be of a greater width than the wall. This latter point is decisive and can only refer to the Toll projecting so prominently beyond the wall face.

We now come to a use of the Toll which is perhaps startling in its occurrence and is in the nature of a discovery! Upon looking through "Early Muslim Architecture" by K.A.C. Creswell there was found a sketch depicting the door construction of a building from Abyssinia of about the 11th century A.D. and reproduced in our Ill. 752. Here in ancient Abyssinia appears the Gujarati Toll! It is not an isolated phenomenon but appears in many buildings illustrated, for example in the Debra Damo (24). Along with the Toll-system there is the typical bonding-timber and the cross-pieces holding it to the wall. There is not the slightest doubt that the details from Abyssinia
are identical with those of Gujarat, and it only remains to discover which country originated the technique. The relative dates give priority to Abyssinia, but in our opinion the matter is to be decided, not only by dates, by the prevalence of the method. In Abyssinia it appears sporadically whereas in Gujarat it forms a wide-spread tradition. If the intensity of use is any guide, then the priority would go to Gujarat. When it is considered that wooden temples were once constructed in Gujarat about the same time that the technique appeared in Abyssinia, then that too favours the former. But, on the other hand, if the whole system of using bonding-timbers is considered, and if the door construction is seen as but a development of the bonding technique (which is theoretically possible), then it is West Asia which must figure as the original source. This problem needs further study for its solution. What is here significant is the fact that the Abyssinian examples clearly demonstrate that Gujarat had links, not only in trade, but also in craftsmanship with that region.

We may here remove one minor misunderstanding. The name given to the Tolla system by the local people is Bārsāk or Bārsākh, and it is taken to mean that the system is made up of twelve pieces of wood and hence the name (Bār also means 12, and Sākh is the Sanskrit sākhā meaning door frame). But this explanation is wrong. Firstly, the system has many more pieces than twelve; secondly, the Gujarati word for door is Bāranu, so that Bārasākh simply means door-frame and nothing else.

Since the Tolla-door was the traditional door of Gujarat, this is the appropriate place to describe its locking arrangements and the information given here may then be taken as being valid for the two variants
Locking Arrangements

The door had a great variety of locking arrangements and many of them were ingenious. The chief methods are given serially below.

(i) The Chain and Staple: This was the ordinary and common method in which a chain fixed to the shutter was passed over the staple fixed to the upper member of the inner frame, and this could be left as a temporary closure, or it could be locked.

(ii) The Rings: In this case two metal rings were fixed, one to each shutter (Ill. 318, 804), and a special padlock with a long arm could be inserted through them and locked.

(iii) The Latch: This was of the kind known elsewhere and was fixed to the inside of one shutter. The latch, of wood, or metal, was held by a bolt on which it swivelled and caught in a holder fixed to the other shutter. This was a temporary means of closure. In some examples the knob of the swivel was accessible from the outside, and by turning it the latch could be manipulated even though the shutter was closed. The knob resembled the other spikes of the shutter, and a person not knowing this would not know it could be opened from outside.

(iv) The Bar: A long, stout piece of square wood was housed in a hollow space within the wall to the inner side of the frame; when required it could be pulled across both of the shutters from behind and prevent them from being opened. This arrangement was the strongest of all for
without breaking down the whole door, it would not give way. The Bar was the preferred method of locking the huge doors of palaces.

(v) The Tower Bolt: This is also known in modern practice as the Barrel Bolt. It was in wood the exact counterpart of the Barrel Bolt (Ill. 374). Its movement within the holder is clear from the drawing. But there were a number of interesting features about it. It was always fixed on the inside of doors and the designer had invented two devices by means of which it could also be opened from the outside even though it was locked. In the one case, a length of rope was attached to a ring fixed to its top and passed through a hole in the shutter to the front. This was knotted to prevent its slipping back. By pulling on the rope the Bolt would lift and the shutter could be opened. But this method provided no security for anyone could manipulate the rope. The second method was that the top of the Bolt was provided with a number of cogs (Ill. 374). At some distance from the Bolt in the shutter was a small hole through which could be passed a thin strip of metal with a hooked end. The length of the strip was such that it just reached up to the cog, and by catching into it the Bolt could be lifted up and the shutter opened. This metal strip was kept hidden. By this ingenious device the door could be opened from the outside even though it was locked inside.

One of the reasons given to us for this strange locking device was that in the case of the Ordo containing the stores of the dwelling, it was very convenient to be able to lock and unlock it from the outside without using the cumbersome padlock. The usual way to lock it
was to merely pull the shutter to, and the Bolt would then automatically fall into place. It seems to us that another reason, not mentioned, was to open the door in case by mishap it chanced to get locked, say through a child who had entered and was too small to unlock it.

Besides this device, there were others of a similar nature: all designed to unlock from the outside doors which were locked from inside. In fact, the great majority of locking devices were operated from the inside.

(vi) The Aldrop: This was just like the modern ones (Ill. 46), and was fitted to the front entrance door. Its movable bolt slid through a hole in the vertical ledge of the door.

(vii) The Padlock: The indigenous padlock is shown in Ill. 78. It came in a variety of shapes and sizes, but all were characterized by great weight and massiveness. Its basic constituents were a housing made of strips of iron to the outside of which was attached a long bolt. This bolt was for inserting into the two rings mentioned earlier or into the staple of either aldop or chain. A second piece made up of a forked piece of iron and a staple could be so maneuvered that while the fork entered the housing, the staple moved over the bolt. To push in the fork it had to be compressed while passing through a narrow opening, once inside the fork opened out and could no longer be withdrawn. To now open it, a long iron key had to be inserted at the opposite end of the housing and so twisted that it squeezed the fork, upon which it could again be pulled out. Such padlocks are still in use in some parts of Gujarat.
A reference to keys very similar to those used in Gujarat comes from "Taxila" by Sir John Marshall (25); there key number 51 is almost identical with one in our illustration. The locks had apparently not been found but the keys are sufficient to identify the system, and it shows close similarity.

(b) The Single-tolla Door:

The Single-tolla door was identical with the above type, except that the lower-most frame was absent. It was replaced with a large wooden cill (Ill. 477) made of thick planks and the total depth was equal to the width of the wall. The total width of the cill was slightly more than the frames of the door so that it projected at the sides into the wall and was thus held firmly in place. The various vertical posts of the frames were tenoned into the cill, including those of the inner frame. The absence of the lower members of the frames gave to the door a cill almost flush with the floor and this was unusual. It will be recalled that the high cill was characteristic of internal doors, particularly in the Ordo. The low cill appeared in the entrance door of the house and in the door leading to the Parsal, and this was deliberately so arranged because these entrances were very frequently used and the high, protective cill would have obstructed movement. But there are indications, explained below, that the low-cill door was a late innovation borrowed from elsewhere. The low cill is visible in Ill. 369, 370.

(c) The Mitred Door:

The Mitred door (Ill. 477) was wide-spread in various parts of India. It has been illustrated in numerous journals and from these it can be seen that it
was known, for example, in Punjab, in 1886 (26); in Madras in 1890 (27); in Mysore (1904) (28). In short, it was a recognized technique in these areas and was the predominant detail. In Gujarat it occurred sporadically and generally in buildings which had greater Muslim or Maratha influence. This will become more clear when the descriptive part is seen later. Here it may be mentioned that the old Bhadra in Baroda, the Kazi family Haveli in Ahmedabad, the Padnis Vada - Baroda, the Sarkarvada - Baroda, in all of them it was the common detail. In Hindu houses it appeared simultaneously with the Tolla-door, and this dual feature was intriguing.

In the well-known Haveli of Haribhakti in Baroda, the doors of the inner apartments, for example of Ordo, Chowk, Khadki-room, all were of the Tolla-type (Ill. 544); suddenly in the first-floor the doors opening onto the front balcony were Mitred (Ill. 477). The different treatment given to doors in different areas of the same dwelling seemed to indicate the reasoning behind the phenomenon. The traditional Tolla-door appeared in the traditional, intimate and more archaic part of the dwelling; the mitred novelty appeared in the more alien upper Khadki-room. The mitre was meant to impress the visitor with the fact that the owner was keeping up with trends. A similar dual detailing can be seen in the magnificent house in Kaira which was illustrated in the "Journal of Indian Art and Industry" (29) - this house no longer exists.

The method of construction of the Mitred door was such that it did not intricately combine with the wall as was the case with the Tolla-door. There were the
usual outer and inner frames (Ill. 443-4, 477) connected to the cill below and carrying a thick lintel overhead. The wall above the opening rested upon the lintel without any further bonding between the two. And this was feasible and safe because the wall, in the normal case, was in lime mortar! Lime mortar needed no bonding—timbers, it was itself stable, the wall was held firmly together by the mortar, and the simple lintel was sufficient for the purpose. The absence of the cumbersome Tolla made it now possible to fit the members of the frame with the mitre. This looked more attractive and neat—besides it was imitating royalty.

The details of construction are shown in Ill. 443-4. The system of having double frames, one for supporting the heavy lintel and the other as abutment for the shutters, continued, and the only significant changes occurred in the manner in which the junction at the upper corner was effected. Here the junction of members was not diagonal. The ends of the members were both tenoned as well mitred, and this produced a very complicated detail. It will be noticed that this kind of detail is derived from furniture making, and was not suited to bearing very heavy loads. The lime mortar prevented that— it produced an arch—action within the upper wall and only the small portion of wall below the arch had to be borne by the lintel. We see here clearly how the Mitred door belonged to a completely different structural tradition, and it seems that this must have been Muslim.

In Ill. 557-8 is shown a very garish and ornamental mitred door from the Puranik Haveli in Baroda; it shows the degeneration of craftsmanship under electric influence.
There was a fourth type of door which was used only with partition walls and was designed exactly like that of wall cupboards. It was very light and plain, and its details can be seen in the section on cupboards.

The Gateway:

The large gateway appeared generally in aristocratic establishments and the size was dictated by the fact that elephants and carriages had to pass through it. The largest gateways were found in the fortified towns, but most of them have decayed and not been replaced. Among the surviving one's seen were those of Dabhoi (Ill. 413) and the palace gateways of Bhuj (Ill. 452) and Sardar, the original seat of the Rajkot princes (Ill. 7/5). The character was in keeping with the local tradition: massive and imposing. All of them had a small wicket-gate inserted in one shutter of the gateway, and it was meant to be used by the attendants. Being parts of fortifications, the shutters were studded with long, projecting spikes to prevent them from being battered down with elephants. An interesting feature of these royal gateways was that almost all of them had brick or stone arches thrown across the supporting piers, and this must have been in imitation of Mughal practice. There was no structural reason for them, for the shutters were fixed to timber frames which were quite independent of the arches, and were located behind.

The construction of one such typical gateway is shown in Ill. 389. It is from the carriage stables of the Desai family of Vaso. It will be seen that the principles of construction are unchanged: thick planks are bound with metal straps which are rivetted with huge spikes, and the front and back are further strengthened with ledges having a separate set of ornamental spikes. It may be noted how
the top ledge is curved to fit into the arch. The pivots are identical with those described earlier, and the locking with a bar was also the same. The Tolla is, of course, missing and was not required because these defensive walls were generally in lime mortar. The arch in any case made that unnecessary. The cill below was kept flush with the road for entry of carriages.

The design of the wicket-gate was such that its structural parts were aligned with those of the shutter, and the hinges used to hang the wicket were of the kind used in cupboards and described there. Despite the huge weight of the gates, they could be smoothly moved on their pivots.

We may now make a comparison between the doors actually built and the śāstrio prescriptions. The subject of doors being an important one, every single text has rules about them and it would be tedious to go through all of them. Instead, we have selected material from only those which have greater relevance to Gujarat, and these are mainly the Pramananmanjari (PM), the Samaranganasutra-dhāra (SS), and the Rājavallabha (RV); other texts are quoted only when these are silent or when they have something different to say.

The SS specifies (30) that the centre of the dwelling should have no door, meaning that its location should not be exactly in the centre of the wall. The same rule is in the RV (31). Our own measurements showed that in many cases the door was in the centre, and in those few cases where it was slightly to the right (as prescribed), the difference was so little as to make it uncertain whether it was due to inexact workmanship or intention.
The SS has another rule (32) prescribing that the door of the upper floor should be (exactly) over that of the lower floor. The Silpadeepak agrees (33) but adds that the upper door should be narrower. This rule was strictly followed in all the houses seen and its proof can be seen from Ill. 544 where the collapse of the ceiling disclosed the exact alignment of doors over each other. The Silpadeepak has a further rule that there must be no door at the back of the house (34), and this would mean that the southern house was not in accordance with textual rules.

The RV (35) and the Silpadeepak (36) both have an interesting rule that if the shutter opens or closes by itself (swayamapickapatodghatanam), then it is very inauspicious. Certainly this was the case in all the doors seen: their weight was such that without a deliberate effort no shutter would move of its own accord. But the rule also meant that the shutter should be so accurately aligned along the vertical that no imbalance should arise.

Coming now to the topic regarding which the rules were most prolific, namely the dimensions, the PM prescribed three types of doors: Jyestha, Madhya and Kanyasa and these were permitted a range of dimensions which matched the range of sizes prescribed for the rooms (37). But when a comparison is made with actual doors, then no co-relation with prescriptions can be discovered. This can be seen from the following chart:
<table>
<thead>
<tr>
<th>House</th>
<th>Door width</th>
<th>Door height</th>
<th>Outer Inner frame</th>
<th>Ratio of Lintel frame dim. to height</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Divetia</td>
<td>136</td>
<td>293</td>
<td>17</td>
<td>1/17</td>
</tr>
<tr>
<td>2. Vaidya</td>
<td>114</td>
<td>237</td>
<td>13.5</td>
<td>1/18</td>
</tr>
<tr>
<td>3. Parekh</td>
<td>98</td>
<td>193.5</td>
<td>12</td>
<td>1/16</td>
</tr>
<tr>
<td>4. Desai</td>
<td>155</td>
<td>217</td>
<td>18</td>
<td>1/12</td>
</tr>
<tr>
<td>5. Amod</td>
<td>117</td>
<td>217</td>
<td>18</td>
<td>1/12</td>
</tr>
<tr>
<td>7. Dhamdhere</td>
<td>98</td>
<td>178</td>
<td>14</td>
<td>1/13</td>
</tr>
<tr>
<td>8. Vyasa</td>
<td>98</td>
<td>161</td>
<td>12</td>
<td>1/14</td>
</tr>
<tr>
<td>Vyasar</td>
<td>120</td>
<td>189</td>
<td>12</td>
<td>1/16</td>
</tr>
</tbody>
</table>

The general rule in the PM is that the height of the door should be twice the width in **Jyestha**, 1/12 less in **Madhya**, and 1/6 less in **Kaniyasa** (37.a). It will be found by calculations that taken as a whole, the rule is not followed. Another rule (37.b) states that the height should be 1/24th of the house-width plus 70 or 60 or 50 Angulas, but this again does not tally because houses of completely different widths have doors which have the same heights. On the other hand, when an internal comparison is made then certain clear ratios do in fact emerge.

It will be seen that in almost every case the outer frame is greater than the inner or equal. Further, that when a ratio of width of frame to door height is taken, then the ratio varies between 1/12th and 1/18th. And the greater the height, the smaller is the ratio. The dimensions of the lintels show no regularity. In general it seems that only a rough rule-of-thumb was followed and no precise system existed. This is all the more surprising when it is considered that the sizes of the timbers used in doors were...
small enough to be precisely cut and hence there was no practical difficulties as in the case of large beams. The absence of dimensional regularity is striking and is a proof that textural prescriptions were not being followed, even though the texts are so voluble on the subject of doors.

9. THE WINDOWS AND VENTILATORS

The general structural details of windows closely followed those of the doors and little fresh material has to be added. The need for securely supporting the wall above the opening made the upper sill essential, but this was not repeated below. Instead, the solid sill made of thick planks was substituted. The shutter of the window (there were always two) being much lighter than that of the door, there was no need for the metal pivot below and instead this was of wood and lodged in a hole in the lower sill. The full details of a typical window can be seen in Ill. 490.

The part of the window which differed from the door was in the various kinds of grills which were inserted into the opening to serve a variety of functions. These were either of wood or of metal, and the two are described separately.

(a) Wooden Grilles:

The wooden grill did not offer the necessary security against a determined attempt to break in, and so it appeared only in the inner ground-floor windows of the dwelling, or in the upper floors. The typical method of construction was by means of wooden battens placed in two layers over each other and with each batten rebated to the other at junctions (Ill. 495, 538). The end of each
batten was morticed into a groove in the surrounding inner frame of the window, and once this frame was firmly joined together the individual battens could not be moved. Here again the grill and frame had to be put together at one time and the whole arrangement installed simultaneously. Once in place, no further changes or repairs could be made to the battens.

The design of the grill was mainly of two kinds. In the one case, the battens were of substantial cross-section, about 3 x 3 cm, and they were carved out into very ornate 3-dimensional patterns in the round (Ill.330,341) As an additional ornament, but structurally not required, small wooden flowers were nailed to each junction and the iron nails went right through both the battens. In an alternative design, the main battens were covered with a second layer of woodwork carved out into a geometrical pattern with flowers. It will be seen from the photographs that in these heavy grills the quantum of woodwork is so great as to leave almost nothing of the opening itself. In other words, they would just suffice for ventilation but not for viewing out. Their resemblance to screens of a Muslim zenana comes to mind, and it is possible that this kind of heavy grill was derived from that. The grills seen by us were in both Hindu and Muslim homes (Ill.330,341 ) so that, apart from mere decoration, their real function could not be clearly ascertained. Since these wooden grills are very attractive, a great majority of them have been dismantled and sold to antique-dealers, and the original situation is difficult to reconstruct.

One point in this connection may be mentioned. In general, it was our finding that the use of iron was extremely cautious and rare in Gujarati woodwork, and
wherever possible wood was used in preference. This would mean that wherever a simple barred inner window was required, wooden battens would be used. Such would be the case, for example, in ventilators to kitchens or store-rooms where the bars were meant to keep out birds and rodents from entering. This simple design could have then developed into the ornate and decorative version, and begun to be installed merely on this account.

The second kind of design, already mentioned earlier, cut the individual battens into an undulating form and the two sets of battens produced oval openings resembling a cows-eye pattern (Ill. 4, 538, 648). And it is our opinion that when the classical texts speak of the Gavākṣha, it is this kind of screened window which was meant. Such grills were used, for example, in the sliding trap-doors of stairs (Ill. 542), and also in windows to the smaller rooms adjoining the Chowk (Ill. 538). Some very extensive examples of such grills appeared in the Maratha houses (Ill. 430-1), and here it was obvious that they were meant to afford an opportunity to the women to look out without being seen.

(b) Metal Grills:

It has already been mentioned that the metal grilles seen in Gujarat had a striking resemblance to similar grills found at a much earlier date in West Asia, and that if the earlier occurrence can be taken as conclusive proof, then West Asia would be the source of origin. The West Asian examples are, among others, the tomb of Sultan Qayt Bay (1472-74)(38) and the Caravansarai of
Qansuh al-Ghuri (1504-05) (39) both at Cairo. These may be compared with those of Gujarat (Ill.329,485,190). It will be at once seen that the general proportions, the size of bars and openings, the manner of forming the junctions, are identical in both and the affinity is conclusive. It will be shown later when we analyze Gujarati carpentry that the use of metal was deliberately avoided, and if this evidence is added to the affinity, then it seems reasonable to assume that the custom in Gujarat was borrowed from West Asia. Another interesting and supporting point is that during field survey it could be observed that the metal grill became the dominant type in Saurashtra and appeared there in numerous variants not found in North Gujarat. Saurashtra, being closer to West Asia, and climatically more akin, was probably the route by which this type of metal grill entered Gujarat (Ill.9

The utility of the metal grill derived from the greater security which it provided, and it became the preferred detail in all of the ground-floor windows (Ill. 187). It very rarely appeared in the windows of the upper floors. The grill was used in all those small ventilators which were high up at the back of the Ordo and were thus in an exposed location. A major use of the metal grill was to close off the upper levels of the Chowk, and here the large iron grill was placed sometimes only above the ground-floor or alternatively on the top-most floor as well (Ill.225,796). These photographs will show how strongly made it was.

Regarding the method of its construction, there were two main techniques employed. In the one case, the round iron bars used were very thick and these were simply placed
horizontally and vertically within the inner frame to produce a square pattern (Ill. 488, 490). The ends of the bars were inserted in grooves in the inner frame, and at the junctions the vertical bar was passed through an eye in the horizontal bar. The details of construction can be seen in Ill. 490. In the other case, more common in Saurashtra, the round bar used was thinner and it could thus be inter-twined like wire to produce more complex patterns (Ill. 9). A third, very crude and late detailing, was that seen in Surat. Here the cross-section of the bar was square and only one set of vertical bars was placed within the inner frame. The general appearance was extremely ugly and the pattern seems to have appeared only after the fire of 1837 - it probably originated in Bombay (Ill. 658, up).

One interesting feature of window design can be seen in Ill. 485, 486. Here the building was being demolished and these grilled windows had been dismantled and kept aside waiting transport. They were placed erect upon the ground and stayed upright because of the system of framing. This placement revealed the fact that it was precisely in this manner that the window must have been once placed within the wall during construction - and that the brick-laying went on to either side to encase it. In other words, the frame had to be self-supporting for part of the time during which it was being installed. The doors must have had a similar structural system.

Regarding the placement of windows, this has already been mentioned in planning in chapter four, and here it may be only briefly re-capitulated. The ground-floor windows always had fairly high cills, upto a metre above floor-level; those of the upper floors had high cills if
they were in the interiors, but the windows fronting the road generally reached down to floor-level in order to enable people sitting behind them to look down and observe events. This kind of long window can be seen in Ill. 40. The small guard-rail was often made decorative by projecting it and making the rails of ironwork. The Ordo ventilator was always high up in the room to permit smoke to escape, and in many examples the lower soffit was sloped down to facilitate this. In the ventilators of the under-ground chambers a similar slope was introduced to facilitate the entry of fresh air (Ill. 786).

An important development which occurred in window design was the following. The upper floor viewing-window (facing the road) gradually evolved into a small, cantilevered balcony for better viewing (Ill. 773). And this now offered an opportunity to the craftsman to transform it into a rich design (Ill. 69,75). A great many variations on the same theme were produced, as the illustrations show, and the decorative balcony soon became a prominent and prestigious part of the elevation. Its next stage of development was into a long balcony running the full width of the house, but since this totally changed the original concept we have described it below in a separate section. The structural details of the window-balcony were by means of the usual struts fixed to the wall by small lengths of wall-plate and cantilevering outwards. As no new structural principles were involved this has not been detailed and the illustrations clearly show the necessary parts (Ill. 344).

A last item concerns the textual references to the window. Here it is significant that compared to doors,
and other woodwork, the window receives very scant treatment. Probably its ritual importance was negligible. The PM has a few references to Gavaksha (40) and states that the height should be 1/4th of the door and the width 1/2, or alternatively the height may be 2/3rd. Since it is not clearly mentioned where the dimensions are to be measured, i.e. whether including frames or not, accurate comparisons could not be made. But of the windows measured by us these rules did not appear to apply. This can be seen from the chart at the end of the text. It is interesting to find that another word for window is also used in a single verse, vātāyana, and this dual terminology must mean that the gavaksha was different. If our assumption is correct, then gavāksha was the screened or grilled window and the vātāyana the ventilator. The text says that the latter should be square, and certainly some square ventilators were found (41) (Ill. 479).

10. THE BALCONIES

The full balcony, as opposed to the small window-balcony, was a feature which few houses could afford. But there is evidence that at one stage of development it had begun to become very popular particularly as it enabled so much display towards the entrance. In another development, emanating from the Vohra houses of Kapadwanj and then becoming common in that town, was the balcony at the rear of the house facing the road. Similar in design to the balcony was the regular upper floor verandah which often surrounded the Chowk. In all of these examples the general principles of construction were the same. The parts were as follows.

The more exposed situation of the balcony required an additional roof over-head and this must have originally
been made of tiles but in all the examples surviving it had been replaced by corrugated iron in recent times. In a few specimens the roofing was of wood and its details have already been shown. The supporting system was in every case round columns with a taper in its middle portion; the upper and lower parts were square since they had to take structural members (Ill. 217). These columns were embedded in the solid flooring which was carried by the usual wooden joists, while the upper ends were connected by a beam which was linked by cross-beams to the main wall of the house. All of these details were as before. What was new was the balustrade of the balcony, and it was of solid wood (Ill. 27, 344, 366). The use of wood in this exposed location was surprising and may be considered wrong, for in a great majority of the cases it had become strongly weathered and many had collapsed. This was doubly regrettable because these balconies were generally the most richly decorated parts of the building.

The structural details of the one such typical wooden balustrade can be seen in Ill. 364 and the views in Ill. 344. The wooden balustrade was of two long, very thick pieces of wood which were tenoned at the sides into short posts which were spiked to the supporting columns. Since the balustrade itself was given a slope (as shown) towards the outside, the posts also had to follow suit, and this produced a gap between post and supporting column which was closed with a filler. This detail was very cumbersome and inefficient but it was persisted with in all the examples seen. The body of the balustrade was plain towards the inside and curvilinear facing outside, and this profile made it look very attractive on the elevation. This kind of detail consumed
a great deal of wood and hence it appeared only in the richest houses; in many other areas it was substituted by a more flat design resembling panelling (Ill. 324, 327).

Below the balustrade came the fascia board which covered the solid portion of the floor, and then the floor joists. It has already been mentioned that to the head of each joist was affixed a short piece which was carved into an elephant's head while the gaps in between were closed with wedged fillers having birds on them. (Ill. 541, a). The joists rested upon a beam which was supported in two ways. If the detail was part of a veranda, then it was supported by the system of columns, bracket-capitals and struts described earlier. If the balcony was cantilevered, then the same kind of struts and bracket-capitals were now fixed to wall-plates embedded within the wall (Ill. 220). It will be recalled that the same method was used to support the flying purlin of the extended eaves.

One very unusual detail was the use of iron straps to hold together the various parts which came together at the junction of the balustrade with the column (Ill. 216). This strap took the spike which rivetted the other parts. The strap was, strictly speaking, not required because the tenoning and spike was sufficient for the purpose, and the fact that it was nevertheless employed indicates that there was some other reason for it. If one looks closely at one of the photographs (Ill. 216) it will be clearly noticed how the strap at the lower left edge of the balcony has been placed over the carvings in a very clumsy manner. This is proof that the strap was added later; and it must have been added because the junction was coming
apart due to weathering. When we say later we do not mean recently; it could well have been a hundred years ago (whereas the corrugated iron sheets were recent, meaning within a generation). The weathering had led to a weakening of the tenons and hence the need for additional measures. This occurrence once again emphasizes the incapacity of the indigenous craftsman to deal with damage caused by moisture, and it makes it seem logical to assume that he had learnt his carpentry in a much drier climate.

The balcony as described above received an addition only in the Ahmedabad area in the form of an all-wood panelled front which was placed above the balustrade and completely closed off the elevation. To provide support to the paneling, the posts of the balustrade were now continued upwards as vertical parts of the frame and tied up with the main beams of the front. The fact that two different traditions met here can be seen clearly if the elevation is closely examined (Ill. 192, 215). It will be seen that the balustrade continued the traditional curvilinear profile, and suddenly above there appeared a linear and flat pattern borrowed from textile design. In many examples the lower balustrade still had human figures carved upon it, while the geometrical/floral motif made up the remainder of the front. The difference between the two parts of the design is so obvious that there can be no doubt that two different sources were here operating. One was structural carpentry and Hindu mythology, the other block-making and surface pattern. It is also revealing that the two differing methods did not lead to a synthesis; each retained its own technique and province and the close proximity of the two was not felt as contradictory. Further, the
need for the inclined balustrade had lapsed once the panelled front was added to it, and yet it was retained. It is as if each part had become a stereotype, and all of them together had become part of what was considered as essential 'elements' of the better class house. The suppression or modification of any one element would have implied a loss in the general schema of things and hence was never contemplated. The attitude which it reveals is one of accretion and eclecticism of parts lacking in overall organization.

The most spectacular development of the balcony occurred in those few royal Darbangadhs of the Nawabs, of which those of Palanpur and Radhanpur are illustrated (Ill. 4, 6, 15, 16). The method of construction was that a series of cantilevered beams and struts placed over each other and progressively projecting further away from the wall ultimately produced a very daring top layer which was the balcony (Ill. 4). In the other example (Ill. 16) the horizontal bonding-timbers can be clearly seen at the bottom. Since all of these structures were intact, it was not possible to discover whether any additional timbers hidden inside secured the whole arrangement to walls further inwards. The bonding-timbers alone would hardly have held such large cantilevers. It should be added that such cantilevered balconies (called *jharokhās*) were well known in Rajasthan and there made in a similar technique in stone. One well known example is in the Bhadra in Baroda (in stone) and the whole custom of having these royal *jharokhās* comes from northern practice. It was typically translated into wood in Gujarat - and this is itself revealing.
In this section are taken together a number of minor details which do not merit individual treatment under sectional heads. They are merely separated below as individual topics.

(a) Wall Niches, Shelves and Cupboards:

The wall niche existed already in the mud wall and was simply a scooped out hole in it meant for keeping things. In the brick house, it became more regular in shape and needed support for the portion of wall over the opening. In those examples which were following Muslim practice, the upper part was designed as an arch and no wood was required (Ill. 262). In the others, wooden lintels were needed, and in due course wooden shelves were added to the niche. The details of one such typical arrangement are shown in Ill. 541 and the originals can be seen in Ill. 542.

The addition of doors to the shelf and niche converted it into a regular cupboard, and its structural details are given in Ill. 546,547. The fixing of the shutter was by means of iron hinges which were nailed to the wooden parts. Hinges such as these have been found at Taxila (42) and they are thus of ancient design. The fact that such hinges were used in the cupboard, rather than pivots, was because of the light weight of the shutter; but an additional reason was that it enabled the shutter to be installed after the remaining woodwork was already fitted in. This was very convenient in the case of such small features. A similar reason operated in the case of doors which were fitted into partition walls and...
there too similar hinges were used (Ill. 407, centre). The design of these shutters was also light and this precluded some of the heavy ledges which appeared in the larger Tolla-door and permitted so much carving.

A different kind of decorative shutter was found in some Muslim houses (Ill. 27) both in windows and cupboards, and this soon became popular and was repeated in numerous later Hindu houses (Ill. — ). The design clearly shows its alien character.

Another type of shelf which appeared mainly in the Parsal, was located at the level of the door lintel and ran continuously all round the room (Ill. 516). It had wooden planks which were nailed to brackets projecting from the wall. In some cases the brackets were in turn fixed to bonding-timbers (Ill. 548), and the latter was held to the wall by wooden hold-fasts. One curious point was that in many, many houses we found brackets meant to carry shelves but without the shelves (Ill. 416). This indicated that the brackets had been installed at the time of construction to avoid breaking into the wall at a later date, and the shelf could then be added at leisure.

(b) Pegs and Lamp Holders:

Wooden pegs meant to hang up various objects were generally of two kinds. The simpler type was a piece of wood turned on a lathe along its projecting end, and inserted into a wall at its other, rougher end (Ill. 541). Such pegs were commonly used to hang up clothes, particularly the turbans and caps which were worn in the past. Maratha houses had many of this kind. The use of lathe-turned wood was rare in Gujarati domestic carpentry and it is a matter for further study whether it was at all indigenous.
So far as the architecture is concerned, it can be said that it hardly existed. Lathe-turned pieces were used in window balustrades (Ill. 410) but these are obviously late.

The more ornate peg was that already discussed, namely of the prancing horse variety. In this case the dimensions of the wood were much greater, approximately 10 x 10 cm, and much heavier loads could be borne—assuming that they were ever used for this purpose. This variety of peg is specifically mentioned in the PM and the passages have already been quoted (Page 218), here something about the placement has to be mentioned. In one verse it is stated that the width of the room (sālā) should be divided into 24 parts, of these 10 in the centre should be left free (for the door), and of the 5 parts in each corner the horse-peg should be placed after the last two. This rule would bring one horse-peg roughly to each side of the door, and in a 2-Orño Haveli it would give a total of four horse-peggs. But as the photographs will show (Ill. 58, 284), there were more peggs than this in the centre. Here again, it seems that the craftsmen were not following written texts but oral traditions which were far less precise. There is a resemblance between text and practice but it is sufficiently inaccurate to reveal the real situation.

A variant wooden peg, hollowed out into a cup-shape, was used to carry oil lamps, and these were placed at a much lower level to make them easier to reach (Ill. 187, 204). The fact that wood was used even for this hazardous job, rather than metal, proves that metal-work was not common. It will be seen from various drawings (Ill. 297, 230) that the placement of shelf-brackets, wall pegs, horse pegs, and lamp holders, were generally vertically aligned
to each other, and that frequently they were simultaneously aligned with a cross-piece of the bonding-timber. It shows that all of the smaller wooden pieces were thought of as functioning as cross-pieces and this whole concept derives from the technique of timber-bonding. From these scattered occurrences, it becomes possible to draw the conclusion that timber-binding was the primary system in North Gujarat.

(c) Lamp Niches:

Lamp Niches were installed in addition to Lamp Holders, and it has already been mentioned that according to one verbal communication, the holder was used when it was wind-still and the niche when it was windy. The design and placement of these small lamp niches was, however, complex. The placement followed the rules of Vedha (see page 210) and hence niches were placed at far more locations than would be warranted by the function. Virtually every wall had a niche. In addition, it was customary to place two symmetrically located niches to either side of doors and these can be clearly seen in the numerous doors of the palaces at Halvad (Ill. 709a). In other illustrations (Ill. 615) it will be seen that lamp niches occurred also on the elevation to either side of upper floor doors, and these were obviously for Diwali lamps.

The design of lamp niches was unusual. In the simpler case, a pointed arch was made and this was logical for the wick and flame needed greater height in the middle of the opening. But in the more complicated design, the upper part of the niche was formed of corbelled layers in exact imitation of the profile of the mandapa of a temple (Ill. 492). This small but peculiar feature was
intriguing. Why the shape of the mandapa, and why the corbelled form? The only possible explanation seemed to be that the lamp had religious overtones, and the corbelled outline had become associated with a religious structure. But then why were not all the niches made in this way? It could be that not every lamp carried this connotation; some must have been lit in order to specifically ward off some unseen danger from various parts of the house, perhaps during illness or lying-in or religious ceremonies, and hence only these niches were modelled in this way. We could not gather any definitive information on this point from the inmates, and the texts make no mention of the corbelled form. The PM merely says that lamp niches should be in walls having doors and be located at the third part from the corners (of the 24 parts of the division). This would bring them in relationship to the doors, and this is actually the case.

(d) Secret Chambers:

These are known as Sanch in Gujarati, and there were a great variety of them showing much ingenuity in design. The commonest type was the under-ground chamber covered with a stone and made even with the mud floor. Its location was almost always in the Ordo, usually beneath one of the platforms meant for the storage jars. In one unusual instance it was beneath the stairs which were also in the Ordo (Ill. 753), and the size seen here may be taken as typical for most of them. The usual dimensions were 60 x 80 and 60 cm deep (Ill. 463, centre). The location of this chamber in the ground-floor Ordo proved that it was this floor which was considered the main area of the dwelling and where any defense would be planned.
The next most common type was a hole concealed under the lowest plank of wall cupboards (Ill. 546) and to close it either the whole plank could be slid over the opening, or a small, round wooden cover was provided which fit into a space within the plank in such a way that it could not be made out. There was a notch at one point for prising it open. These holes were generally small, of about 12 cm diameter, and obviously only small articles, like jewellery or coins, were kept in them. In some cases, the hole was located to the lateral sides of the cupboard. In the same Ghogha house with the unusual Ordo stairs, another hole was located within the stone wall on the first-floor, covered with a stone, and plastered over. In the Tolla-door, the sides between the vertical posts were also used for these chambers.

A very skillful design was again in the Ghogha house, namely that one of the wedge-shaped fillers between two joists over a beam was fitted with hinges and could be swivelled open. In the tiny cavity behind there was just enough space for keeping the most precious objects—probably precious stones (Ill. 755). This Ghogha house has been mentioned a number of times for its unusual features, and it is interesting to here sum up its various secret chambers merely in order to see how many there were in this single house. The ground-floor had the underground chamber, the cupboard adjoining to it had three chambers, and in the same room was the cavity between joists, as also the wooden panelling on the walls mentioned earlier. All of these measures would indicate that in this one room must have been hidden a great deal of wealth. On the first-floor was the wall cavity.

A different class of secret chambers must now be mentioned, which were much larger in size and could
possibly conceal persons as well. The most notable example was that found in the Desai Haveli in Broach (Ill. 626). Here, through a removable rear panel in a cupboard, was an opening leading to steps which went down to an underground room about 150 x 180 cm in size and 172 cm deep. A similar room, accessible through a cupboard, was in two houses in Dholka (Ill. 311, 312), while in one example in Patan the opening to the small room was hidden by a large wooden trunk (patārā) placed before it. In many of Patan houses, a peculiar feature observed during the drawing out of the plans was that one corner of the house was as if pushed in by the neighbouring house, but when the neighbouring house was examined, no such protrusion could be seen. It seems that there was here a hidden chamber secreted between two houses which had been in the past blocked up and was now inaccessible.

(e) The Brickwork:

The details of bricks and walls are given in the detailed chart at the end of the text; here are given some abstracts of typical sizes:

(all sizes are in cm.)

<table>
<thead>
<tr>
<th>Town</th>
<th>Brick sizes</th>
<th>Wall thicknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patan</td>
<td>20 x 11 x 5</td>
<td>36, 37, 47, 60</td>
</tr>
<tr>
<td></td>
<td>23 x 14 x 5</td>
<td>40, 35</td>
</tr>
<tr>
<td>Siddhapura</td>
<td>20 x 12 x 3</td>
<td>36</td>
</tr>
<tr>
<td>Ahmedabad</td>
<td>22 x 11 x 4</td>
<td>35, 37, 47</td>
</tr>
<tr>
<td></td>
<td>21 x 11 x 3</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>15 x 11 x 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21 x 11 x 5</td>
<td>17, 36, 65</td>
</tr>
<tr>
<td>Kapadwanj</td>
<td>22 x 14 x 6</td>
<td>13, 35, 40, 63</td>
</tr>
<tr>
<td></td>
<td>22 x 12 x 4</td>
<td></td>
</tr>
<tr>
<td>Town</td>
<td>Brick sizes</td>
<td>Wall thicknesses</td>
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<tr>
<td>----------</td>
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</tr>
<tr>
<td>Umreth</td>
<td>23 x 15 x 4</td>
<td>38, 40, 57</td>
</tr>
<tr>
<td>Baroda</td>
<td>22 x 15 x 4</td>
<td>36, 58, 50, 40, 30</td>
</tr>
<tr>
<td></td>
<td>20 x 14 x 3.5</td>
<td>72, 77, 12, 14, 15,</td>
</tr>
<tr>
<td>Dabhoi</td>
<td></td>
<td>17, 36, 34, 58</td>
</tr>
<tr>
<td>Gambay</td>
<td>20 x 9 x 5</td>
<td>35, 36, 43, 62</td>
</tr>
<tr>
<td>Nadiad</td>
<td>19 x 13 x 4.5</td>
<td>34, 35</td>
</tr>
<tr>
<td>Dharjaj</td>
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<td>38, 41</td>
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<tr>
<td>Dholka</td>
<td>21 x 13.5 x 4.5</td>
<td>35, 36</td>
</tr>
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<td></td>
<td>20 x 14 x 5</td>
<td></td>
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<td>Broach</td>
<td>20 x 12 x 6</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>38, 47, 50, 17</td>
</tr>
<tr>
<td>Surat</td>
<td>26 x 15.5 x 5</td>
<td>32, 36, 43, 38, 60, 12.5</td>
</tr>
</tbody>
</table>

The above figures will show that, barring Surat, the rest of Gujarat had a remarkably uniform size of brick and this regularity spread over such a wide area meant that the brick-makers were following a general tradition. Most probably they were all of one caste, potters, who also made the roofing tiles and the storage jars. The proportions of the individual brick were such that it resembled a 'biscuit', and as already mentioned, the quality was poor. The edges and surfaces were poorly finished, and the material irregularly burnt.

The regularity of the brick resulted in a uniformity in wall thicknesses, and the figure of 34 to 38 recurs with the greatest regularity throughout the dimensions. This can be taken as the standard wall thickness of the normal wall.
The larger dimension of 58 to 65 was in walls which were to the rear and had to provide greater protection. Partitions were between 12 and 17 cm. (In all cases the walls were measured along with plaster).

The manner of laying the bricks was without any visible system of bonding (Ill. 143, 580 ). The bricks were simply laid in thick beds of mortar in a very untidy manner, with most bricks being stretchers. No special precautions were taken at corners. The usual mortar was mud, but in some richer houses lime had begun to be used. The plastering was always in lime, about 2 cm thick. It could be observed during the demolition of some buildings that even where lime mortar had been used, this had become like dust and the brickwork could be prised apart with the greatest of ease. There was simply no binding power left in the lime mortar. Whether this was due to some error during construction or due to poor mortar could not be ascertained. It seemed to be the case that the brickwork had not been kept sufficiently moist during laying, so that it had sucked out the moisture from the mortar, making the latter lose its plasticity.

Another very interesting observation which could be made during demolition was that wherever lime mortar had come in contact with wood, i.e. in frames and joists, it had charred the surface of the timber making it look as if singed by fire. Lime is known to have astringent properties that is why it is added to chewing pan. And it struck us that this could have been one reason why lime mortar was so rarely used in Indian brickwork. One or two of the contractors questioned (who were engaged in demolition of old buildings as a regular business) confirmed that this was common to all old woodwork in contact with lime. Of course, it reflected upon the fact that the lime had not been properly slaked before use at
site. It would require further comparisons to fully establish this tentative conclusion.

In Ahmedabad we were informed by some house owners that they had noticed, during repairs, that even though the usual mortar was mud, at intervals a few courses of brick would be placed in lime. Fortunately, one such example could be discovered intact and exposed to view and is shown in Ill. 163. This manner of using lime mortar intermittently clearly reveals the following: that the strength of lime was well known; but it was used sparingly either due to prohibitive cost or due to the danger of charring the woodwork.

The foundations of old buildings could not be seen because even during demolitions these were generally left in situ until a new building was planned, and the only example seen by us (in Baroda) had lime mortar throughout, so that it is not possible to give further details.

In those buildings which belonged to the richer families who wanted to have paintings done on their interior wall surfaces, the plaster used was of a richer quality. For this, instead of using the lime gained from lime-stone or kankar, it was the lime from sea-shells which was used, and by polishing it the surface could be given a glossy shine. Many observers in the past have remarked upon the superior quality of Indian plaster, and some of these may be quoted.

The following is from "The Remonstrantie of Francisco Pelsaert (1620-27), "... but the white plaster of the walls is very noteworthy, and far superior to anything in our country. They use unslaked lime (compare this observation with ours above), which is mixed with milk, gum, and sugar into a thin paste. When the walls have been plastered with
lime, they apply this paste, rubbing it with well-designed
trowels until it is smooth; then they polish it for a
whole day, until it is dry and hard, and shines like
alabaster, or can even be used as a looking-glass." (44).

The Mirāt-i-Ahmadi (1571) gave further details, "The
quarries of pathalī stone, which is found in the hilly
country of I'dar, are not met with elsewhere. On account
of its whiteness it is used for the walls and roofs of
buildings, ..., The lime which is burnt from it, when it is
plastered and polished, is like a looking-glass, and
reflects images." (45)

The primitive method by which lime was burnt ( and also
bricks) was noticed by Stavorinus and has already been quoted
(Page 93 ).

Along with the subject of brickwork, something may be
said regarding the construction of the under-ground cisterns.
These were always made with arches and vaults supported by
walls and piers, and finished with the superior plaster to
ensure that it remained water-proof. A similar design
appeared in the great under-ground Bhoirus of Surat and the
one belonging to the Nagarseth's family is detailed in
Ill. 786 . A number of cisterns were measured to
discover their depths, and the average depth found was
between 500 and 700 cm below finished floor level.

The wells which were installed in private houses also
used brickwork in the lower reaches, and only the projecting
head was of stone (Ill.320,491 ). The diameter of such a
private well was about 65 cm and that of the head about 45.
Steps were cut into the shaft at the sides so that a person
could climb down for inspection.
12. CARPENTRY AND CARVING

In this section it is intended to examine the details of the general state of the workmanship in wood, in so far as it could be observed in surviving specimens, and also to discuss the carvings and other decorative features. In short, it is the state of carpentry which is the theme.

In general, it can be said that the carpenter was thoroughly familiar in the use of very large timbers of great cross-section and weight, and he needed these because of the unusually great loads which had to be supported. Despite these great loads, it could be observed in all better class work that the beams had remained perfectly straight and horizontal, i.e. there had been no deflections after 100 to 200 years of use. This meant that the wood must have been very well seasoned before use, and in the case of teak its treatment by girdling has already been described (page 44). The fact that good timber had to be brought from a great distance automatically resulted in a time lag between the cutting of the tree and the installation of the timber and that itself enabled a natural seasoning to occur.

The reason for the preference of teak can be judged from the following:

"Teak owes its value chiefly to its great durability, ascribed to the fact that it contains a large quantity of fluid resinous matter, which fills up the pores and resists the action of water. The oil in the wood prevents its getting water-logged, and seems also to safeguard it against weevil and other timber-boring insects. It is specially valued because it does not rust the iron with which worked up." (46). And again, "It is moderately hard,
exceedingly durable and strong, does not split, crack, warp, shrink or alter its shape when once seasoned." (47).

Apart from teak, many local timbers were also used in the subsidiary members depending upon circumstances. Among the common timbers listed in the Census volume on Wood Carving are: Haldarvo (Adina cordifolia); Nim (Azadirachta indica); Rayan (Manilkana hexandra); Dudhi (Lagenaria Vulgaris); Sajad (Terminalia tomentosa); Mahuda (Madhuka indica). Some of these were specifically used in particular locations because of their structural qualities; thus Rayan was used in thresholds, Mahuva and Sajad for beams, etc. Most of these timbers are also specified in the Rājavallabha (49) and it adds a warning that certain combinations of timbers should not come together in the same house; best was if only one timber was used throughout. But as already explained, there was generally such a scarcity of timber in many cases that even wood from old houses was indiscriminately re-employed, and such fine distinctions would have hardly been possible.

Because of the large size of timbers used, the hauling up and installation of members would have been difficult and there was always the danger of damage to parts. This practical consideration was the reason that the main structural members were mostly without carvings. Beams, joists, attached columns, wall-plates, were all generally plain; the only exception was the free-standing column. This member was so prominent that it had to be carved and there was no alternative to it. But the accompanying strut was added later.

The methods used to form junctions of timbers were in the main: lapping, tenon-and-mortice, tongue-and-groove, plus the use of those peculiar Tallas. All of these
Carpentry joints are primary joints of great simplicity and they were already known and practised by the village carpenter using the simplest of tools. The fact that they continued in even the most sophisticated work was surprising and reflected both the persistance of the tradition as well as the lack of technical innovation. The securing of joints was done with pins and spikes, and occasionally with metal straps. But in the main, the security was dependent upon the weights which pressed down upon the members and forced them upon each other, creating strong frictional forces which prevented slipping and dislocation. As already mentioned a number of times, this kind of system was derived purely from building construction and owed nothing to the kind of carpentry which was associated with the more delicate requirements of furniture design. Furniture was generally conspicuous by its absence in the Indian home, and hence no carpentry of this kind could arise. Whatever carpentry existed was derived from robust village practice and persisted in the architecture. And it was this archaic structural carpentry which drew the following comment from experts, namely from Burgess, Cousens and Havell, in their "Indian Art - Technical Art Series" when they wrote on Gujarati woodwork, in 1886, "Both the new and the old work are generally put together in a very rough and unbusiness-like way. The carver's work appears to have ended with the carving, and the village carpenter, taking it in hand as so much timber, knocked it together with great iron spikes and nails, and rough clumsy clamps. Joinery was always, and still is, a very weak point in native work. Wood carving of this class is very frequently disfigured by the presence of ugly iron chains, nail-heads, bolts, and clamps, attached with utter disregard to the design, and often in the middle of some of the best work". (49).
The interesting point about the above expert comment is that it was felt that those who made the beautiful carvings were different people from those who subsequently 'knocked it together'! The care and quality of work exhibited in the carvings was so much superior to that found in the structural carpentry, that it seemed to them impossible that the two could be by the same hands. Now, this qualitative difference is genuine; but it is our opinion that the dichotomy was inherent in the Indian technical tradition. A lack of technical innovation in fundamentals was compensated by an enormous concentration on improving of details. The same thing can be observed in other spheres. The technical details of temple construction, for example, were equally primitive and far inferior to the excellence of the stone carvings. The poverty in the manufacture of bricks was opposite to the fineness of its covering plaster. In every case the weakness is one of technology, and not of fine arts. The real reason for this was that the whole technical tradition was derived from, and never went much beyond, the village. The refinements which urbanization called forth were prompted by a desire for 'show' - and this was met by an elaborate treatment of the surface rather than what was hidden beneath. It will be recalled that within the dwelling itself, the treatment of the domestic Ordo was in sharp contrast to the Parsāl; the former was left bare while the latter was covered with decor. The intention here was not to improve the whole domestic milieu, but to only present a wealthy facade to the visitor. The highly ornamented door had its rear left plain if not ugly, with nails turned in and exposed. Again and again one can find in the Gujarati architectural environment this dichotomy between elegant surface treatment and primitive technology, and there is thus no reason to assume that the two
Coupled with the primitiveness of the carpentry was the dominant position of the wooden tradition. It will be recalled that all of those parts of the door which one would have expected to be made in iron, for example the locking arrangements, were in wood. The safety of the house depended on wooden tower bolts and latches, the palace gateway was secured with a wooden bar. Iron bolts and chains, which would have been far stronger, were not used as permanent features. Iron appeared only when absolutely unavoidable. The reasons for this situation are not known. The black-smith was a much part of village society as the carpenter, but why the latter should have so dominated the scene remains a mystery. Of course, in ancient classical literature the Takshaka was already named as one of the leading figures in architecture, but it would be too speculative to say that this was the reason operating in medieval Gujarat.

Of the caste of carpenters, there are two interesting references of the period. The Bombay Gazetteer of 1901, describing the population of Gujarat, wrote about the carpenters as follows, "Suthárs or carpenters ... They belong to six division A‘hir, Gujar, Meváda, Pancholi, Márvádi, and Vaish. Of these the Pancholis and Vaish are found only in Gujarat proper, the Gujars and Mar vadis in Gujarat, Káthiávád and Kachh, and the A‘hirs only in Kachh."(50). Later it gives the valuable information that there was no Muslim carpenter caste. An additional point comes from George Watt in "Indian Art at Delhi 1903" on woodwork in general, "... and the circumstance that the wood and stone-carvers belong to one and the same caste, may be..."
accepted as an additional evidence in favour of the gradual production of the one from the other and that at no very ancient date." (51). These two references indicate that the caste or group which was engaged in stone-work was earlier working in wood, so that the whole business of construction was in the hands of the same group from very early times. It was the exclusive occupation with architecture which gave to these craftsmen their dominant role and this may explain why they never permitted others, such as the black-smith, to compete.

The dominance of the carpenter in architectural work would also serve to explain why, when confronted with the problem of unstable walls, the solution adopted was one derived from woodwork - the bonding-timber. What is not yet clear is how such a strong wooden tradition could survive in an area deficient in wood. But the answer to this is already hinted at. The wooden tradition, at least in religious architecture, gave way to an architecture in stone and the carpenter turned stone-mason could continue to occupy his leading position as builder and constructor. The wooden tradition was simply transferred into stone, and all of the structural knowledge and details were transferred along with it. This would then perfectly explain why the construction in stone was so closely modelled on that in wood. In this connection some expert opinions are worth quoting with reference to Gujarat and adjoining areas. (It is important here to exclude other parts of India for reasons which will become clear later.)

Burgess described the famous gateway of Dabhoi of the 13th century A.D. "It is a framework mortised and tenoned together, exerting bending and tensile strains, for which stone is but ill adapted. In wood work this would be
perfectly legitimate, ... and it is evident that the construction of these gateways was actually copied in stone from similar structures in wood then existing."(52).

In "The Architectural Antiquities of Western India," Henry Cousens spoke of this as follows, "A close examination of these rock-temples shows that they follow wooden prototypes, and this may be seen in the Nasik caves, where not only are the beams and joists faithfully copied, but the wooden pins in the ends are not even omitted."(53) And elsewhere, "Many of the earliest temples, following those of wooden construction, were of brick - firstly, brick with wooden door-frames, pillars, and beams, and then brick with stone door-frames, pillars, and beams."(54). In other words, stone gradually replaced wood, and thus retained not only its features but also enabled the carpenter to retain his hold.

The above evidence would show that the older wooden tradition had branched off into two directions, the one leading to stone architecture, the other continuing that in wood. And since the wooden tradition was the original one, it would mean that the forms which had survived in medieval Gujarat in the wooden architecture were in fact descendants of ancient forms which had continued to be reproduced over the centuries by families belonging to carpenters' castes. What these relatively late domestic buildings were revealing were techniques and details deriving from an ancient past; but more than this, they were also revealing the stone derivatives in temples and forts of these wooden prototypes. In other words, it was the wooden, medieval house which contained within itself the only surviving evidence of a common past! The religious architecture of Gujarat could, therefore, be fully understood only by comparing it with the domestic architecture in wood - at least so far as building construction was concerned.
This finding may be taken as one of the most valuable of this study.

Given in the following are some examples of such wooden construction which have influenced work in stone. The most clear example is from Champaner, the medieval town founded by Mahmud Begarha in the 15th century A.D. In Ill. 601, 602 are shown the attached columns used in the eastern gateway of the citadel. It will be seen that these attached columns, including the striking corner column, are duplicates of those in wood, and even the capitals are faithfully copied. Ill. 601 shows a part of the surviving wall-plate. The imitation bonding-timber appears in the elevation of the Jami mosque (Ill. 603) while in its upper floors can be seen a copy of the wooden weathershade and the wooden balustrade. It is only the columns here which are not wooden in their form. Reference has already been made to the sloping balustrade of the domestic house which finds a similar detail in many temples and mosques, but in these cases the profile is not curvilinear. The use of stone struts, as for example at Mt. Abu, are too well known to need to be illustrated — these are again borrowed from wooden construction. These few instances should suffice to prove conclusively that those who made these medieval structures were still following wooden practice, and this would have been possible only if they themselves had once been carpenters.

Turning now to further details of carpentry, we must describe the manner in which woodwork was generally finished. Most of the woodwork in the interiors was usually stained with oil and additives to give it a dark colour, but in some more exposed parts it was painted. The use of colours in exteriors was common, and very often the coat of
paint was renewed at ceremonies and festivals. This frequently resulted in almost obliterating the finer lines of the carvings. Here is a description of the paint-work from the technical report of 1886 quoted earlier, "This newer work is, moreover, almost invariably ruined by paint. Brilliant reds, greens, and yellow, picked out in very haphazard manner, quite drown the wood carver's work ... very little of the old work has been so treated ... and the uniform sepia-tinted carving shows to advantage alongside the meretricious work of the present day."(55).

In Ahmedabad, however, a different treatment seems to have prevailed from the beginning, namely to coat the wood even on exteriors with an oil called Beltel which made it look almost black in colour. H.Evan M. James, writing in "The Journal of Indian Art and Industry"(1916), commented, "The outside is usually oiled, which not only gives it the handsome colour of ebony, but serves as protection against the fierce rain..."(56).

The Carving

The numerous illustrations will have shown that the art of wood-carving in Gujarat was magnificent. It is, of course, not our purpose to deal with this subject in any detail because it belongs to the sphere of fine arts and is a separate discipline. Here it is only intended to give a general picture in so far as it formed part of the architecture, and to mention something about the technique as related to carpentry.

The theme of Gujarati wood-carving has been touched upon by many authorities, and quotations from some of them will provide a good background.

H.E.M. James in the "Journal of Indian Art and Industry", "Wood-carving in Gujarat has been practised by
the Hindus from time immemorial ... Carving in that part of the country seems a born instinct, even with the lowest carpenter, and in the remotest villages. Wherever the local money-lender rebuilds his house, even on the cheapest specifications, charming little bits of carved pillars and capitals in the verandah of the lower story and balconies and jalousies above, are inserted by the village artisans as a matter of course" (57).

In a subsequent issue he then wrote, "It may be noted that although the carved wooden facades and balconies are often so solidly built into the brick and stone walls as to form an integral part of the fabric, still in many cases they have evidently been added subsequently to the construction of the main building solely in order to beautify it" (58).

Regarding the unique character of Gujarati work, the best authority is George Watt in "Indian Art at Delhi 1903", "The Jaina and Saracenic wood-carving of Ahmedabad and Gujarat ... are collectively as distinct from the Chalukyan (meaning Deccani) and Saracenic arts of Khandesh, the Deccan and the Mahratta country, as it is possible to imagine" (60). Watt was not quite accurate about the Mahratta work, for much of the wood-carving was done by Gujaratis (61).

When the carvings are seen in their architectural context, then what is significant is their location. Naturally carvings appeared in all those parts which were exposed to visitors, i.e. in all front elevations, court-yards, Parsals and Divankhanus. The members which carried the most decorative treatment were: struts, balconies, bracket-capitals, columns, doors, windows, wooden panelled
fronts, and wooden ceilings. The plainest members were: beams, joists, wall-plates, bonding-timbers, and attached columns in the interior. It is obvious that the plainness was due to the fact that these heavy load-bearing members had to be erected at a time when the building was in its initial stage and since work was still going on, there was every chance of damage to delicate carvings had such been applied. Nevertheless, the desire to decorate even these members was so strong that recourse was taken to carved beads which were subsequently fixed as long strips over structural members, and particularly to cover joints. In the case of joists, the carved elephant heads were additional pieces joined on to the front once the main building had been completed. Even the wooden balcony could be installed later by spiking it to the columns. In all of these cases, practical considerations determined the technique.

The actual method of carving, in the great majority of cases, was to first prepared a flat, plain surface. This was then carved out according to the pattern required by going into the depth. The depth of carving was generally not much, so that most of the work retained a flat relief. This is characteristic of work done by carpenters as opposed to sculptors. The more rounded work, with undercutting, was done only in struts. Figures carved more in the round were done separately and fixed on to the existing woodwork. In the case of balconies, the whole arrangement was fixed later to the structure, and this permitted much of it to be made in the round.

Wherever timber projected in cross-section, it was given a very elegant profile, as can be seen in the capitals and bracket-capitals. One such very typical profile is
shown in Ill. 495. This particular profile was so common in Gujarat that it can virtually be taken as diagnostic of the style. The details of the typical column (Ill. 5c9,5) are also distinctive, and are quite different to columns used elsewhere.

One decorative feature hitherto not mentioned in detail was the carved arch of wood which was inserted in between two columns or even the two frames of doors and windows to make an added show. This is perhaps the only piece of carved wood which was purely non-functional. Whereas all the other carvings and decorations were applied to woodwork which was structurally necessary, or were in some way related to the structure, the arch in this case was structurally useless. The tendency to over-decorate the building with an excess of carvings was in every case a late phenomenon, and all the earlier examples had both less woodwork and less of carvings.

Comparative Woodwork:

In this last portion, we may now make some comparisons between the woodwork of Gujarat and that of some other important wood-using regions of the subcontinent. It should, however, be emphasized that what is being compared is the structure and not the carvings; in other words, it is an architectural comparison, and not one of fine arts.

During the previous part of the discussion, we have identified some of those structural features which were characteristic of Gujarat, and these may be summed up as: the attached column (including the corner column); the bracket-capital; the bonding-timber; the Toll; the wall-plate; the flying purlin with strut; the system of embedding column in massive floors; the curvilinear
balcony; the general use of straight timber; the pitched roof. Unfortunately, on most of these structural points few studies have been published, and one is forced to go by some of the minor details illustrated. The main wood-using centres appear to have been: Punjab, the Himalayan foot-hills, Kashmir, Nepal, Bijapur in particular and the Deccan as a whole, Kerala.

The most significant distinguishing feature of Gujarati woodwork was the Tolla-door, and it appears nowhere in any of the centres mentioned above - but re-appears most unusually in far away Abyssinia. The whole system of fixing the frame of the door to the brickwork is so unique and so different from all Indian practice, that on this ground alone Gujarat must be put in a separate category. In a work on the restoration of the famous Pujahari Math in Bhaktapur (Nepal), Dr. Niels Gutschow illustrated the structural details of a typical window (62), and although the junctions made of tenon-and-mortice were certainly similar (as they also are all over the world) the manner in which the whole frame was fixed to the brickwork was completely different. Each frame had a projecting 'wing' to either side which was inserted into the adjoining brickwork like a lateral hold-fast, and that was all. These wings or brackets have been extensively illustrated by Dr. S.B. Deo in his monograph "Glimpses of Nepal Woodwork" (63), and he writes, "Other windows, contained within the compartments formed by the pillars, rest on the brick walls ... and are not fastened to the timber framework in any manner."(64). The Gujarati frame was either held to the brickwork by the Tolla or joined to the main columns by means of the bonding-timbers. Here, then, is an essential difference.
A second important difference in Nepali work was the absence of the bracket-capital. Capitals were there, but were tapered in manner wholly uncharacteristic of the more robust Gujarati carpentry. At junctions of columns to beams, there were capitals in only two directions parallel to the direction of the beam; in Gujarat there were four bracket-capitals forming a cross-arm which took the load very securely. It was quite clear that in Gujarat the design of the junction was meant to meet a much greater danger of dislocation of parts than in Nepal. This could also be seen in the relative rarity of bonding-timbers. A wall-plate always appeared in the Nepali flooring to support the joists, and here there was a similarity, but the elaborate system of bonding-timbers with cross-pieces going through the wall was absent. The many photographs of Nepali brickwork (65) show a very much stronger wall with well-made bricks of a large size, and this was possibly the reason why the woodwork did not have to compensate for the stability.

In the plans of Nepali houses published by Fran Hosken in "Kathmandu Valley Towns" (66), there are neither attached columns nor corner columns - and this was very different to Gujarati practice where the attached column appeared even in stone buildings.

The strut and flying-purlin are extremely highly developed in Nepal and form a prominent aspect of elevations; their general details were similar to Gujarat(67).

The above comparison of woodwork will show that the problems which faced the Gujarati carpenter were fundamentally different from that in Nepal, and although there are many similarities in details, for example in joists,
flooring, wall-plates, wooden grill-work, yet it must be said that the structural systems were different. Wooden half-timbering no doubt appeared, with filler walls, as Dr. Deo observes (70), but it was not common and is generally absent in the elevations of the ground-floor. As against this, the whole frontage of the upper floors was with prominent half-timbering.

Apart from Nepal, there was a great amount of woodwork in the Himalayan foot-hills, but of these only that of Chamba and Simla has been published, and this certainly had a resemblance of Gujarati work. This was noticed by M.F.O. Dwyer (1890), "... (on Simla)... square pillars, chamfered or fluted into octagonal or circular shapes, - the elements of a form highly elaborated in wood in Gujarat ... but it is scarcely ever seen in the Punjab plains ..." (71). The similarity between this Himalayan work and that of Gujarat was due to the migrations of Gujarati craftsmen, and this has been taken by Dr. Goetz to expound on the subject in an article entitled "The Role of Gujarāt in Indian Art History" in which he wrote, "But at the same time the emigration of Gujarati artists continued even so far to the North as Kumaon..." (72), and further, "But Gujarati wood sculpture was to win another sphere of influence: Mahrāashtra.... But the indigenous Marātha house, with its stone platforms and brick or rubble walls within a wooden frame work, held its ground. Thus the Gujarati wood style proved easily adaptable for the embellishment of the Maratha palaces..." (73).

The influence of Gujarati woodwork on the Deccan has been amply demonstrated by M.S. Mate, quoted earlier, and a few observations will now support the view of Dr. Goetz. He quotes from the Gazetteer for Nasik (1883),
"A chief point of interest in the Nasik houses is the considerable number ... which have richly carved wooden fronts. These carved fronts belong to two styles, the Hindu, locally known as Gujarati work and the Musīman, locally known as Delhi work." (74), and further on, while speaking of columns, "Somewhat similar but much less intricate pillars are to be found at Mandurbar, Pimpalner and a few at Shrigonda. The close resemblance between all these on the one hand and the pillars occurring in the Gujarat region is too evident to be enlarged upon." (75). The illustrations in the volume fully prove this.

All the above evidence would lead to the following general conclusions. Gujarati woodwork is found to have influenced areas as far apart as Deccan in the south and Kumaon in the north; it did not extend to Nepal. Not enough is known about other areas of South India to draw conclusions, but the mitred door certainly indicates that a second wooden tradition existed there. This must have been Bijapur, but the woodwork shown there is not generally similar to Gujarat except in details. These have already been noted earlier. In so far as the structural system is concerned, while bonding-timbers were known elsewhere (Nepal, Himachal), they were nowhere made into such a comprehensive system in association with the attached column. It is this combination of the two techniques which is original in Gujarat.

And the above evidence will also now permit a comparison to be made with Buddhist woodwork as seen in situ at some places, but much more from the imitations of woodwork in stone. The fact that Buddhist architecture was everywhere imitating in stone. The fact
that Buddhist architecture was everywhere imitating in stone the wooden prototypes has been noted by so many scholars that there is no need to review and quote their opinions. The facts may be taken as fully proved. It only remains to discover whether this woodwork had any similarity to that of Gujarat.

The most important feature of Buddhist architecture was the use of curved wood. This was used to make the peculiar whale-back roof seen in so many carved fronts. The curved roof, together with curved wooden rafters, was a regular feature of the caitya hall; and it gave to the front the well-known caitya window of horse-shoe shape. It has already been frequently shown in our study that curved wood was rare and uncharacteristic of Gujarati woodwork - so that here we have one major point of difference.

The second was in the shape of the columns and their use. In all Buddhist examples the form, particularly of base and capital, was quite different. In the Nasik caves, the pot-shaped base and the corbelled capital are unlike Gujarati work; apart from this, all of those southern cushion-shaped capitals again belong to a different tradition. The supports appearing in the Sanchi gateways are different in concept and detail. In them also, the curvilinear bar appears. In none of the caves do any attached columns appear, although they can be seen in later Hindu temples. This, then, is a second difference.

The balustrades appearing both at Sanchi and as a decorative frieze on so many reliefs were made of upright posts which carried horizontal bars of oval cross-section. The Gujarati balustrade was quite different. In domestic
work it has a curvilinear profile, while in the stone temples it was serrated. This was a third difference.

Many doors are shown in both caves as well as in reliefs, but their frames are without any supporting Tolla. This was a fourth difference.

It is not necessary to seek any further. In all of these major points the wooden tradition apparent in Buddhist work was sufficiently different from the Gujarati as to make them quite unrelated to each other. There are some scholars who assume that the origin of the former was bamboo which could be bent into a curvilinear shape; this may be. It is our opinion that this curvilinear architecture belongs to eastern India from where it travelled elsewhere along with Buddhism. The western, or Gujarati architecture, was based upon the use of structural timber which was straight. A similar straight timber appears in many southern stone structures (in imitation), so that there is more relationship of the southern to the western. This southern and western timber was teak. Of course, sal is also straight, and was found in eastern India (sal was used in the wooden fortifications of ancient Pataliputra), but why a roof more suited to bamboo was evolved is not clear. Our main conclusions would then be that there were in ancient India two, if not three, different wooden traditions, so that when it is said that ancient Indian architecture was in wood, that is an oversimplification which leads to misunderstanding. And if there were these differing wooden traditions, then we may assume that they produced differing developments when they were imitated in stone. A further comparative study of the original wooden prototypes may then reveal the reason for these differences in stone. By this means our understanding of ancient Indian architecture would become more fruitful.