CHAPTER 7

7 P-N-P IN SUPERSTRUCTURE OF TEMPLES WITH ORTHOGONAL BASE

In this chapter we will look into the applicability of p-n-p method in generating of the form of super structure of temples with orthogonal base such as near rectangle or square with adecular and offsets projections developed as extended boundaries by . Many of these temples are of similar configuration based on rectangle. But when extended boundaries increase the base form extends to a multi sided polygon but the orthogonal geometry is maintained as two adjoining sides of plan meet at right angles always. When they do not at right angles always and has a radial configuration from the centre it is termed 'Stellate' and the combination of both orthogonal and stellate as hybrid or part stellate. Dr Hardy has elaborated on various configuration as shown in ref Figure 2-1

Here we take two cases

1. Siddeshwara temple at Haveri

2. Galaganatha temple at Galagageswar of Haveri district.

7.1 Case example 1 – Siddeshwara temple of Haveri

This example of Siddeshwara temple at Haveri, is chosen primarily for a typical representative of Kalyani Chalukya period as an orthogonal plan typology. This small and exquisite temple is one of the better known Kalyani Chalukya monuments and is often dated as mid-11th century. Its inscriptions go back to 1067 AD (Foekema). Haveri is a small town on NH 4 main road, about 70km south-east of Hubli. This is a small and very ornate ekakuta with open hall mandapa. Its decorations are sophisticated. The main temple faces the west, the opposite direction to the norm. The vimana measures 4.65/5.15m. There are four talas. In the first tala a chadya is added and this addition divided the vimana into a wall and a superstructure. The centre of each tala is emphasized very much by an additional second panjara-roof and by the heavy framing of each panjara-roof. The frames are decorated with scrolls, as are the sides of the tala ends. (Foekema)
The adecular composition of this vimana is a common one, only the numbers of 5 projections and 4 talas are large for its modest size. The shapes and decorations of many architectural components are elegant and elaborate in a way that suggests a date well after 1100 AD. All the kapotas are flat. Apart from their shapes, the architectural components of the Siddesvara temple have a special character because of their sharp chiselling. The upper parts of the framing pilasters, and their elegant bells, high lasunas, square ghatas and high phalakas, all these parts indented, are cut so sharply that they acquire a metallic look. Also the wall-pillars of the pillar-aedicules are very sharp and smooth. (Foekema)

To get complete information of a large complex like that of the Siddeshwara temple, hybrid technologies like long range laser scans for overall geometry to close range photogrammetry for accurate 3-D modelling were used. Multiple scanned data with a precision of 1mm in 5 meters was acquired using infrared scanners.

Figure 7-1 Screen shots of part scans of the Siddeswara of Haveri using infrared scanning technology.
Figure 7-2 Data registration and point cloud compilation.

Figure 7-3 Image of dimension retrieval from 3 dimensional meshes for cross checking with actual site dimensions.
Using data processing software. These multiple scans were integrated to prepare comprehensive error free three dimensional data of the entire temple. Dimensions taken from the data acquired from meshes were cross checked with random manual measurements at site.

To acquire textural information, 270 images were taken as per the standard procedures of close range photogrammetry. These images were processed to obtain a close knit textural blanket onto the dense mesh created by point clouds. This textural mapping provides us with micro level relief information which normally is less than 2mm.
A number of images with sufficient overlap are taken with a calibrated camera using photogrammetric software; this data is projected onto the mesh.

Figure 7-7 Point cloud data with photogrammetric information
Course wise geometry is retrieved from this scanned data by slicing the virtual model into number of horizontal layers. The variation in dimensions, shapes and configurations were carefully examined to establish relevant levels that significantly affect form generation. Features like figurative sculptures and ornamental treatment were not considered for evaluation of geometric configuration.

Data has been divided into plinth, superstructure, parapet of ground level and different talas. Features like kuta stambha, corner pilasters and miniature wall shrines were analysed separately. The primary focus of the analysis is restricted to the vimana alone as the details of columns and other features are discussed in other earlier chapters. Series of orthographic drawings and sections were extracted for proportion analysis.
Figure 7-9 Generation of meshes to orthographic true elevations with photogrammetric data superimposed for accurate analysis.
Figure 7-10 Selection of course wise geometry from 3D mesh data

Figure 7-11 Slicing of the mesh at course level and *tala* level to derive precise geometry at each of these levels
Figure 7-12 Orthographic plan above the vedi level

Figure 7-13 Vertical slicing of the mesh to get a precise profile data

From the data analysis two distinct parameters of path and profile were identified. Path that defines the overall form of the building is identified from the outer line of the vedi
platform. A section which passes through the centre of the *shikara* along the cardinal directions, excluding the ornamental details and the additional features, is taken as the profile.

Using this path and profile, the plinth, the superstructure and parapet of the lower base level is generated. Above the superstructure, the first parapet’s offset is used as Path and the sectional profile of the *tala* at the same level is taken as Profile. Using this path and profile, the three dimensional form of the first *tala* is generated. The exercise is repeated by using subsequent path and profile of the other *talas* to generate their forms.

Using the top most line of the third *tala* as path and section of *shikara* as profile, the three dimensional form of the shikara is generated. The geometries of pilasters, kuta stambha, panjara and *salas* were generated separately and added to the overall form. While creating the *haras* and *vyalamalas*, a generic rectangular outer block profile is used for generic representation of *vyalas*.

![Figure 7-14 Path and profile of tala to tala of Siddeswar temple of Haveri.](image)
A point to note is that entire profile (top of sikhara to vedi) is not used to make a p-n-p model as it generates an inaccurate object. Profiles are cut into different tala levels and then the p-n-p models of each tala are generated up to sikhara. The overall form is made by placing the individual tala models over each other. The process is similar to stacking or layering process of construction of these temples.

It is found that the horizontal parameter (the path) is at topmost course of each 'tala'. and vertical parameter is profile through cardinal direction. As the progression of tala's from lower level to upper level in ascending order each of these upper talas are identified as scaled down version of lower tala excluding the plinth and part of superstructure. These upper talas can be expressed in terms of percentage reduction or number of bhaga's - parts for mathematical expression. For example second tala is 8:10 to first tala and so on (though it could also be expressed as 4:5 but it is easier to divide in multiples of 2 in the process of stone marking from the practical point of view).

As the objective of this research is not to establish the proportion system practiced but to understand the derivative logic, and thesis is not focusing on the changing proportion system of various temples of the era. However it is to be noted that by making subtle changes to these proportions each temple explore and create variety of form configurations.
Figure 7-15 Geometrical form generated from path and profile parameters of Siddeswara temple of Haveri.
Figure 7-16 Orthographic images of the basic geometry of temple of Siddeswara temple of Haveri.
Figure 7-17 Completed p-n-p generated form with surface details like pilasters, *kuta*, *sala* and *panjaras* added.

### 7.2 Comparison with 3D mesh data

The 3D scan mesh is compared with the parametric form generated model by keeping them next to each other in CAD environment for comparison of the results as shown in Figure 7-18. The consistency of dimensions of varying courses and their shapes were cross checked for similarity and dimensional accuracy.
Figure 7-18 Orthographic elevation image showing part 3D scan model and part 3D (P-N-P) generated model for comparison
Figure 7-19 Ortho images of superimposed meshes with parametric generated form.

Figure 7-20 Images of comparison between scanned model with generated p-n-p model
7.3 Inferences

Form generation using path and profile method shows a conclusive evidence of validity of this p-n-p approach for orthogonal configurations in the similar temple of orthogonal base like Bhankapur, Chowdadanapura, Tarakeshwara of Hanagal, Ittagi Mahadeva, Kubbattur Kaitabeswara, Koteshwar, Lakkundi Brahmagajinalata.

7.4 Case example 2 – The Galageswara temple of Galaganatha

This example of Galageswara temple of Galaganatha is taken primarily for the reason of investigation of a very unusual plinth which is not found elsewhere. This buttress looking plinth and its geometry responds in a manner which reinforces the idea p-n-p method.

Galaganath (Galagnatha, Galaganatha, Galaganath) is a tiny village on the left bank of the Tungabhadra, about 10kms north of Guttal. The river here flows from south to north, thus the temple faces the east as well as the river. It does so in a very commanding way, because the bank is fairly high and the dimensions of the temple are large. From its open hall the view over the river is majestic.

The vimana is complete and consists of four talas and of a closing vedika-cum-kuta-roof. The superstructure consists entirely of undecorated architectural components, with a giant crowning kuta roof received foliage and decorated nasis. All kapotas are of the same type, flat with shallow flexures.

The pedestal here is formed by the pyramid, which is topped by a vedika and which has a pedestal of its own. This pedestal is without kumuda, between plinth and topping kapota it has a wide recess with diamond shaped flowers. At the back corners of the hall only the corners themselves have a framed aedicule, all other projections are pillar-aedicules. The hara continues seamless above the open part of the hall. The parapet wall of the open part is striking due to its simple execution. All in all this hall is fairly common except for its size. In particular it is higher than any other open hall. The Dravida towers on two pilasters are detailed and sharp and consist of two talas and a crowning. The interiors of the temple is exciting. The open hall is very spacious and offers a view over the river. Besides that, exceptionally fine images are found in four niches (Foekema).
To get the complete information of this temple, use of hybrid technologies like long range laser scans for overall geometry to close range photogrammetry for accurate 3-D modelling has been done. Multiple scanned data with a precision of 1mm in 5 meters is acquired using infrared scanners.

Figure 7-21 Screenshot of the scanned model in wire mesh mode of Galaganatha temple.

Figure 7-22 Dense solid mesh mode
Using data processing software these multiple scans were integrated to prepare comprehensive error free three dimensional data of the entire temple. Dimensions were cross checked with data acquired from meshes to random manual dimensional correlation.

To acquire textural information of 196 images taken as per the standard procedures of close range photogrammetry and were processed to attain a close knit textural mapping onto the dense mesh created by point clouds. This textural mapping gives the micro level relief information which normally is less than 2mm.

![3D Model with Texture Overlays](image1.png)

Figure 7-23 Screen shots of the 3d model with texture overlays.

Course wise geometry is retrieved from this scanned data by slicing the virtual model as explained in the case example 1 into number of horizontal layers. The variations in
dimensions, shapes and the configurations were carefully examined to establish relevant levels that significantly change the form generation. Features like figurative sculptures ornamental treatment features were not considered for evaluation of geometrical configuration. Data has been divided into plinth superstructure parapet of ground level and different talas separately. Features like kuta stambha, corner pilasters, miniature wall shrines were analysed separately. The primary focus of the analysis is restricted to the shikara alone as the details of columns and other features are discussed in other chapters. Series of orthographic drawings and sections were extracted for proportion analysis.

Figure 7-24 Deduction of data to critical parameters of path and profiles including sikhars.(of a quadrant)

From the data analysis two distinct parameters of path and profile have been identified. Path that defines the overall form of the building is identified as the profile of the top of the first tala and a section which passes through the centre of the cardinal direction of the shikara excluding the ornamental details and the additional features is taken as the profile.

Using these path and profile, the plinth and the superstructure and parapet of the lower base level is generated. Using the offset distance after the first parapet as a path and the sectional profile of the first tala as the profile, the tala #1 is generated. The exercise is repeated by using subsequent path and profile of the other talas generating their forms.
Using top most line of the third tala as a path and section of shikara as profile the form of a shikara is generated. The geometries of pilasters and kuta stambha and panjara and saalas were generated separately and added to the overall form. While creating the haras and vyalamalas generic rectangular outer block profile is used rather than sub detailing of vyalas.

7.5 Comparison of the Results

The similar procedure as explained in the earlier case example 1 the model generated by p-n-p method is generated and compared with the scanned mesh model as shown in fig Figure 7-25 to Figure 7-27

Figure 7-25 Orthographic image showing the similarity between the scan model and the generated model of the temple Galaganatha in elevation
Figure 7-26 Orthographic image from top showing the similarity between the scan model and the generated model of the temple Galaganatha in plan.

Figure 7-27 Comparison between scan model with generated model of Galaganatha temple.
7.6 Summary and conclusions

It is a conclusive evidence of the validity of the p-n-p form generation method even for a completely uncommon feature like the buttressed base of the temple. Though it looks like a later addition, the principle of form generation has led to a conclusive termination of this additional feature in a predictable manner that has been generated using p-n-p. The method is adequate the universal applicability for the form generation of exterior.

From both the examples deciphered above, we can see the similarity between the actual built temple's basic geometry and the models generated by p-n-p method. In the case of temples built over a long periods possibly without complete drawings and with no examples for reference, the possibility of geometry of scheme of p-n-p into different talas make sense and each tala is a simple enough to be integrated at the same time to be continued in a similar way later time by later builders without affecting the grammar of the composition.