CHAPTER 6

6 OBSERVATION OF P-N-P METHOD IN FORM
GENERATION OF PEETHAS AND SIKHARAS

6.1 Path and profile approach in plinths

After observing various components of the temple and their form genesis with reference to path and profile, it can be said that a definite pattern of form finding existed in all the components. A variety of plinths “pitha” of the temples is selected to verify the path and profile parametric design approach in variety of pith or plinths of Kalyani Chalukya temples. Care is taken that the typical examples are orthographic (square based where all lines of polygon are perpendicular or parallel to each other), stellate and few hybrid plan typologies are included to check the versatility of the path and profile theory in their form generation.

6.2 Case example 1 – Plinth of Siddeshwara temple, Haveri.
Using the various 3D technologies a comprehensive 3D data accurate to 1mm in 50 m is recorded.

The above example is of a segment of the *vedi* of Siddeshwara temple located at Haveri. Classified as one of the matured phase of the Kalyani Chalukya period, in terms of plan typology, it stands out as the typical orthogonal offsets. The adecular composition of the Siddeshwara vimana is kuta-double staggered *sala* with panjara aedicule in the middle (sspss)-*kuta* per side repeated in four *talas* (vertical levels) ref (Figure 6-2).

Figure 6-2 Photograph of vimana of Siddeswara temple of Haveri (11 century CE)
A detailed dense mesh with an accuracy of 1mm has been scanned using hybrid techniques as explained in the previous chapters Figure 6-3.

Figure 6-3 Generation of orthographic drawings screen shot of the 3D 1 wire mesh mode

Figure 6-4 Course wise information is mapped for investigation as indicated. screen shot of textured 3d model.
Figure 6-5 Segregation of vertical profiles and course wise information to examine the variations from each level.

The course by course information is sliced to analyse the variations both in terms of vertical and horizontal sections. Figure 6-5 isometric views of the course-wise data.

Figure 6-6 From a dense mesh the model is reduced to a relative simplified planar level.

The model has been rendered from the wire-mesh to planar level geometrical details. ref Figure 6-6
OBSERVATION OF P-N-P METHOD IN FORM GENERATION OF PEETHAS AND SIKHARAS

Course 1

Course 2

Course 3
OBSERVATION OF P-N-P METHOD IN FORM GENERATION OF PEETHAS AND SIKHARAS

Course 4

Course 5

Course 6
Figure 6-7 – profiles at each level of the course has been obtained by slicing the course by course and converting to vector level data. Considerable variation of dimensions has been observed from course to course.

Figure 6-8 Vertical profile is obtained by slicing the model.

The vertical sections, show that the profile remained constant throughout, as shown Figure 6-8 above. While slicing care is taken that the vertical plane of intersection is perpendicular to horizontal plane at which the section is taken (orthogonal sections). Any decorative details beyond the basic primitives (like figurines, motifs) are omitted.

Figure 6-9 Image showing variations from course to course. Shades of grey shown are the changes that occur from course to course.
Three plinth forms were derived using the path and profile approach with the same vertical section and using horizontal paths varying at three different levels. (a) form generated by moving the profile intersecting path at lower course (upana), (b) profile intersecting path at middle course (kumuda) and (c) profile and path intersect at top most course of vedi. It is found that the form generated using the top of vedi as a path is identical to the actual plinth form. It is also observed that the gap between kuta and sala is the narrowest in comparison with other courses. And in this narrow slit is varying in width at every course and gets eliminated in lowest course i.e., in upana level.

Figure 6-11 A 3D image generated from interaction between the path at upper level and profile as shown in different colours.
The above form has been generated using the *vedi* as the horizontal profile with the sectional profile as path and profile approach.

Figure 6-12 Alternatively the form of each stone course can be generated by interaction between it's profile and its own path.

It may be that all the profiles of individual courses (*upana, jagati, kumuda, kapota, vyalamala, vedi*) are derived by extruding the sectional profile along the path of the *jagati*. In other words, each courses’ profile is an offset generated by a base course *vedi*.

Figure 6-13 Image showing superimposition of generated 3D model over 3D mesh.
To check the degree of similarity simulated model and 3D scan model are superimposed as shown in the image Figure 6-13 above in CAD environment. The results shows remarkably identical geometry. The genesis of some of the micro gaps of varying dimensions between the members of kuta and sala can be understood as logical derivations of the computational process.
Thus the entire geometrical derivation of the plinth can be summed up in these two profiles as form generating parameters. ref Figure 6-17. Having understood that, the entire form of plinth can be parameterised into two basic graphical representations of path and profile. Further the majority of the drawings found at these temple sites show similar to these profiles as shown in Figure 6-17 to Figure 6-18 of Ashapuri site.

Figure 6-16 Line drawings/ representation of profiles found at temples of Ashapur.

Figure 6-17 Line drawings/ representation of profiles found at temples of Ashapuri.
To examine whether this course wise information is generated where each course generates the subsequent courses path, we have generated plinth forms – one form taking the bottom most course as a path and the subsequent courses moving upwards and the second one taking the course as the beginning, the lower course follow the process.

6.3 Case example 2 – The plinth of Kasiviswesvara temple of Lakkundi,

Kasiviswesvara temple located at Lakkundi is one of the most ornate examples of the region and has shown a very exotic detail of twisted kuta-stambha in 45degrees in otherwise simple orthogonal configuration. This experimentation shows remarkable change in form generation and subsequent geometry which is–different from the others. The plinth of Kasiviswesvara is taken as an example to verify whether this parametric design is applicable to unconventional form.

The experiment has been repeated with lowest course as a starting point and keeping the sectional profile same, the above geometry has been simulated.
Figure 6-19 3D mesh of Kasiviswesvara temple of Lakkundi

The plinth of Kasiviswesvara temple has been scanned using high precision 3D scans and overall surface details are generated using computational techniques. The mesh has been converted into a planar geometry as shown in the image above.

Figure 6-20 Course wise geometry derivation by slicing the mesh.

The course wise geometry is generated by slicing each course and the data has been computed for further analysis.
Figure 6-21 The course wise slicing of the plinth.

Figure 6-22 Course wise geometry as seen from top in an orthographic vectors.
The plinth is cut at various locations to examine the consistency of vertical profile and the observation shows the result of very high level consistency.

Using path (the course geometry of *vedi*) and section as profile the form is generated using the path profile method as explained earlier.
Figure 6-25 Generated form and path profile of Kasivisvesvara plinth.

Figure 6-26 Geometrical form is super imposed with 3-D mesh.

The generated geometrical form is super imposed with scanned 3-D mesh ref Figure 6-26 in CAD environment to verify the similarity. It is observed the geometrical configuration matches with each other with precise correlation of each course and vertical subdivisions.
OBSERVATION OF P-N-P METHOD IN FORM GENERATION OF PEETHAS AND SIKHARAS

----------------------------------------scanned 3D model 3D model by p-n-p method-------->

Figure 6-27 screenshot of orthographic representation of part 3D scanned mesh and part generated mesh through p-n-p method for comparison.

6.4 Case example 3 – Galageswara temple of Galaganatha

Galageswara temple of Galaganatha of Haveri district is one of the very unique examples of buttress shaped plinth. Probably an intervention done either during the construction of the temple or just after the construction to protect the super structure from probable sinkage or tilting. The temple is located on the banks of Tungabadra river.

Figure 6-28 Image showing derivation of course wise geometry (a) process of acquiring paths and profiles from scanned 3D data (b) and (c) , and form generation simulation results with path and profile parameters.
As explained in the previous case examples the standard procedure of 3D data acquisition from scanning, deduction of the data to course wise information, deduction of two distinct parameters of path and profile and the most appropriate intersection is done. From the path and profile, the plinth 3D geometry has been simulated by moving the profile to follow the path at first tala level. The information is computed in the fig ref Figure 6-29

Figure 6-29 Plinth and first tala of Galageswar of Galaganatha. A 3D mesh over generated form using path and profile.

The 3D mesh data and the simulated 3D model is arranged next to each other as shown in Figure 6-30.
Figure 6-30 Orthographic elevation with part mesh and part generated form of the Galageswar temple.

Figure 6-31 Orthographic plan with part mesh and part generated form of the Galageswar temple.

The orthographic drawings generated to show the consistencies of similarities both in plan and elevation. This highly unconventional form of plinth which does not have any typological or textual reference in cononic texts or a reference in previous examples poses as ‘the example’ to ratify the theory.
One of the significant member of Dravida temple typology is the topmost component of vimana - the shikara. A careful observation of the shikara reveals that though in principle they all look similar, each of its geometry has a strong connection and governed by the footprint of the temple. The variations ranges from a simple square base plan at lower level to multi staggered square offsets to stellate geometry corresponding to geometry of temple's footprint. To examine this variation in form with respect to different sides of the base profile (at vedi level) path and profile approach, is applied to different case examples.

6.5 Inferences

From the comparison of all the above examples of sikharas and plinths of various Kalyani Chalukya temples it is evident that the path and profile as form generative applicability. The visual comparison shows that the path profile gives a very high geometrical derivatives of every course of the plinth consistently.

6.6 Case example 1- Miniature shrine found in Lakshmeshwar.

One of the significant component of the top most element of the vimana in Dravida temples is the shikara. To check the applicability of p-n-p method for the form generation of the sikharas were attempted for the study. However the precise scan data of these elements could not be procured as these element is inaccessible. For the purpose of this the miniature wall shrines embedded in the walls of Siddeswar temple of Lakshmeswar of Haveri district were attempted assuming that they are similar to the large scale replicas. Though these miniatures resemble completed scaled models of large scale temples the data procured is subject to some assumptions as it is treated as more of a sculptural entity. One of such miniature shrine which has stellate configuration with 16 sides and multi stepped curvilinear profile of sikhara. The shrine is scanned using short range infrared scan and photogrammetry and the dense mesh is created of the surface. sections are extracted from the dense mesh as shown in fig below.
OBSERVATION OF P-N-P METHOD IN FORM GENERATION OF PEETHAS AND SIKHARAS

Figure 6-32 A photograph, 3D scanned mesh and extraction of path and profile of a stellar miniature from Siddeswar temple of Laksmeswar, haveri dist.

Figure 6-33 The 3D scanned mesh sliced at various levels to get the path and profile and final path and profile derived.

To understand the behaviour of profile when it moves at inward and outward junctions of the path, the series of images showing the extrusion logic is herewith shown below.

6-34 Images showing sequential surface development of stellate sikhara through path profile
As we can see in above example the path follows the profile's pattern which could understood as the offsets explained in path profile the final generated model is compared with acquired 3d mesh both orthographically and also by superimposing with each other as shown below.

Figure 6-35 scanned 3D model of sikhara and generated 3D model through path and profile parametric approach

Figure 6-36 part scanned 3D model and part generated model for comparison
6.7 Inferences

The overall shape and geometry of the scanned miniature sikharas of adecular and p-n-p generated models show similarity of form and shape in general for stellate example taken for verification. As already explained the acquisition of data of these elements capped at the highest level of the temple could not be completely acquired the different case examples could not be completely verified. It is observed that in the certain aspects of these sikhras are treated as sculptural entity, however the overall shape and form could be predictable using the p-n-p method by using the outer line of griva as path and vertical section of sikhara as profile.