International Journal of Architecture and Infrastructure Planning
Vol. 1: Issue 1
www.journalspub.com

# Parametric Design Principles Found in Ancient Indian Temple Architecture - Case Examples of Columns of Kalyani Chalukya Period of Karnataka

***Kailash Rao M.*[1] and Dr. B.S. Bhooshan[2]***
[1]Faculty of Architecture, Manipal University, Manipal (Karnataka), India
[2]Principal Architect, BSB architects, Mysore, (Karnataka), India

***Abstract***

*Traditional Indian temple architecture often has a very high degree of complex geometry embedded in its construction. The predominantly stone constructions during the period of Kalyani Chalukya period exhibit a highly sophisticated form generative logic in its visibly complex geometry. This is not only of the form at the micro level elements but also at the macro level elements and even in the overall form generation of its sikharas. This research investigates the possibilities of these parametric form generative principles embedded in the temple designs. It is done by comparing the 3D scanned models of the temples acquired from Laser scans, photogrammetric and infrared scanners with that of models generated using computational methods in CAD environment using only a few parameters. The virtual #D model is tested for similarity or anomalies in both geometries through geometrical investigations of few selected examples of columns, sikharas, plinths and vimanas of temples. This paper reports only the method and the testing of its robustness in columns only.*

***Keywords****: Kalyanichalukya temples, parametric design development in temple architecture, 3D scanning of heritage buildings, path and profile theory*

**Author for Correspondance:* *Email ID:kailashrao69@gmail.com*

## INTRODUCTION

Though the traditional texts dealing with Indian temple architecture like Manasara, and Samaranganasutradhara, give very elaborate descriptions, they cannot be used to arrive at a precise constructional instruction. It may be due to losses in translation and/or misinterpretations over time. One of the missing details is a possible unambiguous translation into certain graphical vocabulary for actual constructible instructions. Mattiasalivi's recent translation and interpretation of Samaranganasutradhara, says "A large part of the temple description are extremely schematic and would allow for remarkable variations in terms of how one may fill that scheme. No precise picture of decorative elements comes through and several cases we find the repetition of the verysame scheme, with minor permutations applied to different scheme. If these chapters were indeed intended to have a linking with actual building, it is likely that a good deal of oral explanation would have been necessary attached to the text"[1].

Thus looking for a precise constructional level instruction from the text is quite difficult proposition. Prof. Adam Hardy aptly describes; “There are no universally correct terms for Indian temple forms, only terms that is more or less correct, more or less accepted, and more or less useful. Present-day scholarship has a choice

between labelling types by numbers, describing them in, say, English, or using relatively correct, reasonably well-accepted Sanskrit terms that are useful for explaining what the architecture itself shows"[2].

In this context, some have tried to understand and explain the geometries of Indian temple, but the conclusions are far from the explanations at conceptual level. This paper is an attempt to study the geometry from a different perspective i.e., parametric form generation. This is done only with respect to Kalyani Chalukya Temples and the details are presented in this paper only of the form generation of columns.

## INTRODUCTION ABOUT KALYANI CHALUKYA TEMPES

Kalyani Chalukya dynasty often known by its other names as western Chalukyas or later Chalukyas were major rulers during the period of 9th to 12th century ACE (Foekema, G. 2003).. During this period a vast number of temples (according to Gerard Foekema approximately 240 temples) were built in northern parts of Karnataka and parts of present Maharashtra states; majority of them were in the present Haveri and Gadag districts and are dedicated to Shaiva, vaishnava, jaina faiths. Many distinctly different typologies (classified as karnatakadravida typology by current scholars) exhibiting a great deal of vesara features that is mixed combination of Nagara and Dravidafeatures[3].

A huge amount of work has been gone into the identification of these typologies into categories like phamsana, vallabhi, latinabhumija, dravida, shekhari, vesara, misraka etc...etc but according to Dr Hardy (Hardy, Indian Temple Typologies, 2011) the nomenclature of these typologies is a tricky affair as these are not precise styles. The terms often are interchangeable[2].

## GEOMETRY OF YANTRAS OR MANDALAS AND TEMPLE FORMS

Michael W Meister (Meister, 1979) Based on the investigation of the vasthupurusa mandala as indicative/ derivative plan for temples of early Nagara temples of 7th 9th CE concludes that the use of grid of this mandala has a limited applicability for a few early 7th century temples of present Madhya Pradesh and Rajasthan only[4]. That too only if one looks at the plan drawn at "khara" (a particular course of molding towards the base of temple plinth) level.

Usage of this Mandala as a source diagram to derive temple frome is doubtful at later complex temple plans. Stella Kramrischfeels the use of the grid of vasthu remained as a tonic value rather than a viable ground plan[5].

## THE PROBLEMS OF PERCEPTION AND DATA INTERPRETATION

Majority of earlier scholarship viewed the temple architecture through inaccurate 2D drawings which restricts the conceptual ideas that shaped these highly complex 3D entities. To precisely draw a plan at specific course as plan also poses a problem especially each course varies in terms of shape and dimension. The profile of temple also varies from one tala to other.

Thus, to perceive the intricate geometry through the plans, elevations and sections, which are the communicative tools of present architectural practices has limitations. Absence of drawings as instructions in the traditional texts or absence of typical orthographic drawings such as plans and elevations in the canonical texts lead to the suspicion whether the mode of design and communication was through codified instructions.

*© JournalsPub 2015. All Rights Reserved* 

Prof. Adam Hardy's analytical approach of configuration of a Dravida temple through K-S -P (kuta, shaala, panjara, etc.) gives sufficient representational/codifiable insight in describing temple geometry (Hardy, Indian temple Architecture), However it may not give a precise constructible instructions like working drawings[6].

With this background this research paper investigates few typical examples of Kalyani Chalukya temples for a possible parametric approach to understand the geometry. This paper describes only the design and development of columns only, though the method had been successfully demonstrated in other parts and the oval temple form as well.

## METHOD OF PATH AND PROFILE

A few selected temples were scanned using state of art technology of laser scanners and converted into 3D models in virtual environment. These models were tested for dimensional accuracy by verifying the site dimensions with that of virtual model and found that the accuracy is within 5 to 6 cm in a span of 25m (Kailas Rao & Dr B S Bhooshan, 2015)[3].

The 3d scan data is deduced to two lines called as path (a horizontal section at a specific location of the temple) and profile (a vertical section line of a typical tala)[7].

Using these two parameters the entire geometry of elements like columns, sikharas, plinths and the entire temple geometry is generated by making the profile to move in horizontal direction following a path (The terms path and profile are not traditional terms used in texts, but are used in popular CAD softwares to generate/or simulate 3dimensional forms by extrusions) as explained in the following graphics.

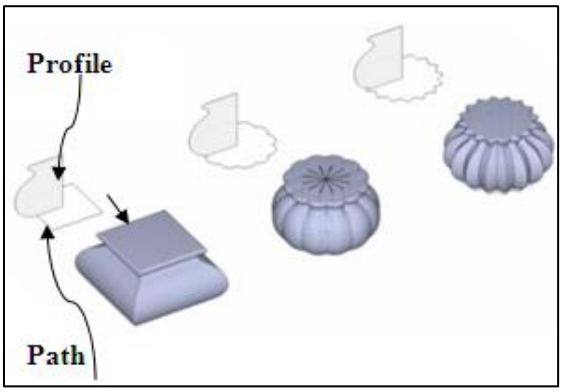


***Fig. 1:*** *Creation of Various Three Dimensional Forms using the Movement of the Same Profile (Vertical Parameter) with a Movement along Different Paths in a Designated Direction of Movement (Horizontal Parameter).*

The above image demonstrates the different shapes can be achieved using a same profile moving in different paths. The parametric design development is restricted to the overall geometry only and not applicable to the various sculptural, figurative, surface treatments. Many of such surface details or the sculptural embellishments are finished in-situ and during the assembly of the stone blocks that are left as blobs and fine finishing done at a later stage. For instance, it is noticed that the details of vyalis in vyala mala, termination of capping details of kuta roof/ saala roof/ panjara are left as rough rectangular blocks in many semi-finished temples.

## PATH AND PROFILE APPROACH IN COLUMNS

To test the parametric design detailing few columns of circular (popularly co called lathe turned columns), square based, Stellate and few hybrid configuration were taken for investigation. A detailed 3 dimensional meshes were extracted from 3d scanned point cloud data using 3D scanners. The data was verified for dimensional accuracy by testing random dimensions that were recorded manually

and found that the data is accurate within the acceptable range. See Figure 2.

The profiles (vertical sections) and paths (horizontal sections) were deciphered from these 3D mesh models. The column was recreated virtually by moving the profile along the path. The geometry of original virtual mesh model and the generated Path- profile model is then compared especially the sections as shown inFigure 5. The exercise was repeated to several cases as in Figures6–9.

***Fig. 2:*** *Actual Photogrraph And A Screen Shot of 3D Scan Model of a Circular Column of Galgaganatha, A 11th century Temple of Haveri District.*

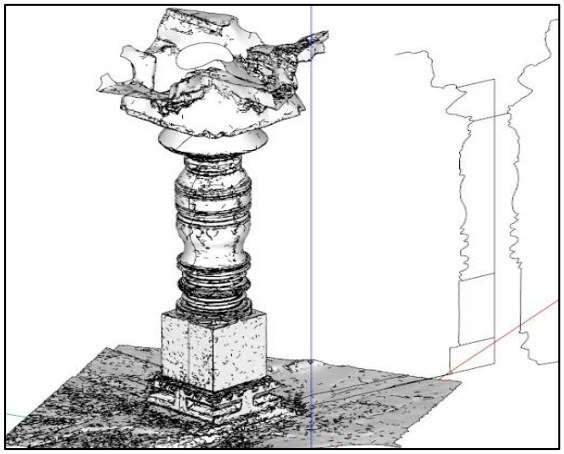

***Fig. 3:*** *Screenshot Image of 3D Mesh Sliced Horizontally and Vertically to Extract Path and Profile of The Model.*

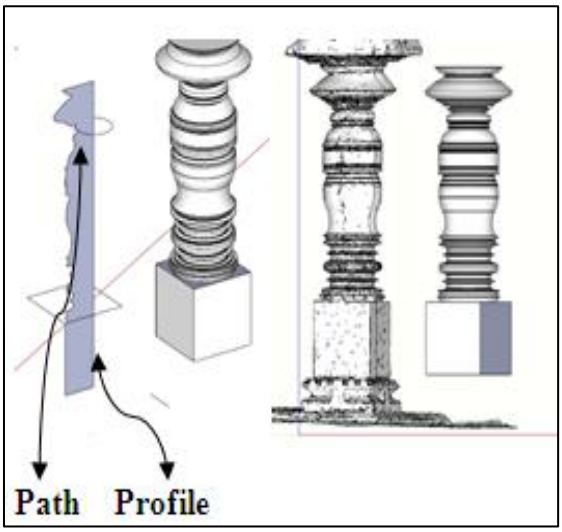


***Fig. 4:*** *A Screen Shot of 3DModels for Comparison between Generated Modelwith Scanned 3DModel in Isometric View and Orthographic Drawings.*

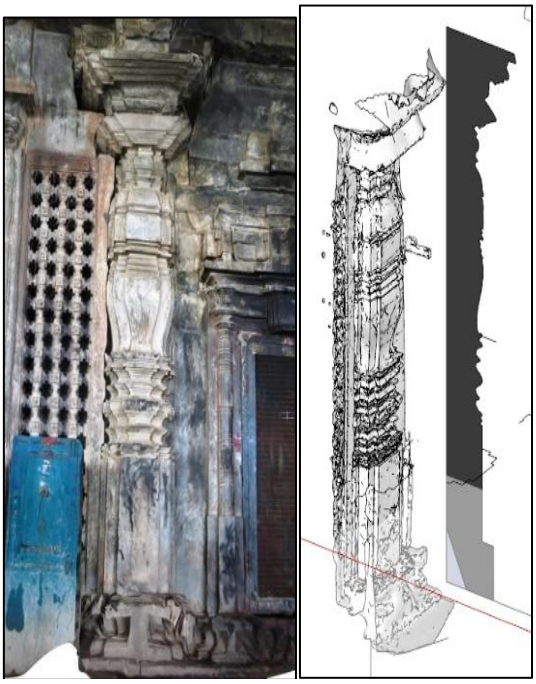

***Fig. 5:*** *4 Photograph and Screenshot Image of 3DScan of an Orthogeometric Column with its Path and Profile of GalgaganathaTemple of Haveri District.*

*© JournalsPub 2015. All Rights Reserved* 

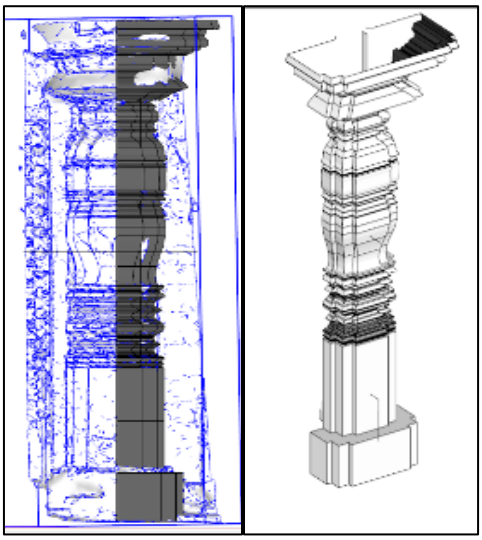

***Fig. 6:*** *Visual Comparison of Acquired 3D with Parametric Generated Model by Superimposing Part Mesh, Part Model in Orthographic Mode Screenshot.*

From the above examples it's very clear that the two distinctly different columns were created through subtle change in paths. The geometry of acquired 3D Mesh and generated path and profile models completely match. Note that by following path and profile method simulation of many other geometrical configurations were achieved as shown in the examples of temple of Lakkundi. The sections generated match with the originals.

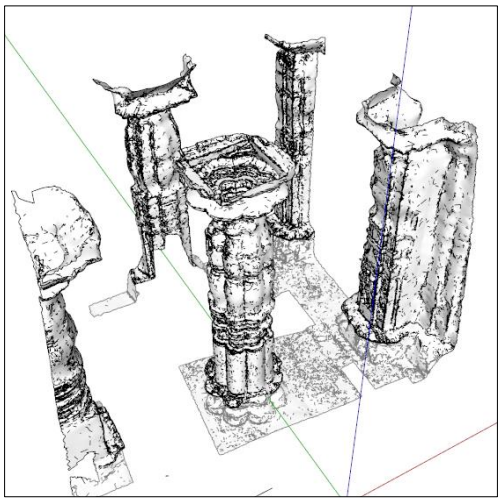

***Fig. 7:*** *Screenshot of 3D Models of Different Temple Columns of KasiVisveswara Temple of Lakkundi.*

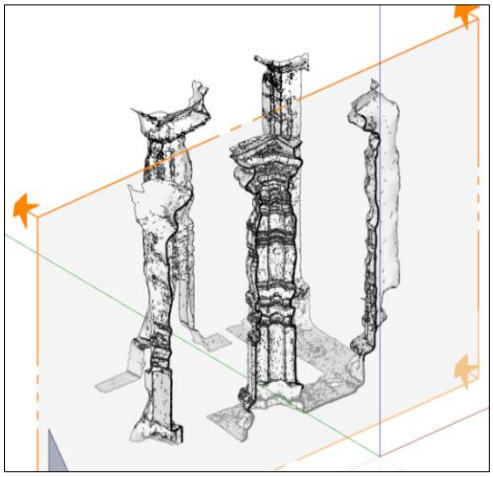

***Fig. 8:*** *Derivation of Profiles through Vertical Slicing of 3D Models.*

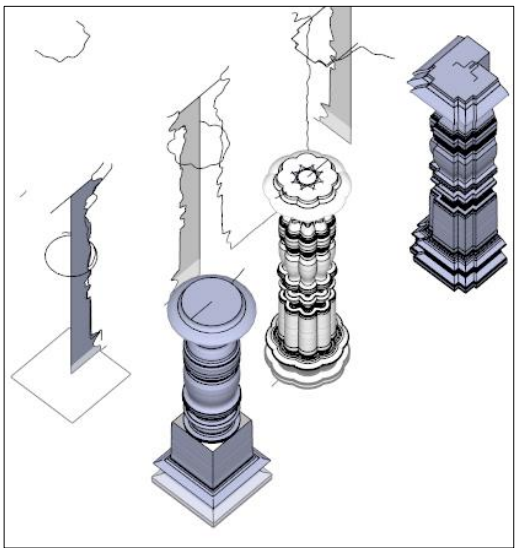

***Fig. 9:*** *Screen Shot of 3D Models of Columns of Lakkundi Kasi Visveswara Temple Through Derived Geometry of the Path Profile Parametric Method.*

## CONCLUSIONS

The exercise of path and profile simulation models and matching it with the original mesh models of different columns of Kalyani Chalukya temples show a marked similarity. It could be repeated for other elements and for the whole temples in its basic form devoid of embellishments and sculptural surfaces. This has been already verified and will form another paper. It is not claimed that the approach of path and

© JournalsPub 2015. All Rights Reserved 

profile, though it explains how a simple method of form generation was exactly the method used, in the actual execution or of design by the sthapathis and artisans in 9th or 12th century. This is the computational facility followed by us certainly were not available then. Yet the precise similarities and simplicity of parameters of two simple shapes of path and profile that are easily identifiable indicate a possible usage of a similar parametric method by the ancient temple builders of Kalyani Chalukyas.

It should also be noted during research that the artisans marked exact part profiles on stones in sale 1:1 and they were the only signs of representation used in place of present day drawings. Further, it is reasonable to think that parametric form generation with only two parameters can be imagined by gifted sthapathis even without a computer. Only during execution, they might have resorted to scale models and perhaps detailed oral codes to deal with specific problems and resolve them in ingenious ways.

## AUTHORS

M. Kailash Rao, Faculty of Architecture, M. I. T, Maniapl University, Manipal.
Dr B. S. Bhooshan, Professor and Research Advisor, Department of Architecture, B M S College of Engineering Bangalore, Principal Architect, BSB Architects, Mysore.

## REFERENCES

1. Salvini M. *The Samarāṅganasūtradhāra: Themes and Context for the Science of Vāstu.Journal of the Royal.* 2012.Kramrisch S. *The Hindu Temple. 2 Volumes.* Calcutta: MotilalBanarasdas. 1946.
2. Hardy A. Indian Temple Typologies. *Glimpses of Indian History and Art. Reflections on the Past, Perspectives for the Future.* Rome: Università di Rom. 2011; 101–25p.
3. Foekema G. *Chalukya Architecture. Volume 1–3.*MunshiramManoharlal Publishers. New Delhi. 2003.
4. Meister M.W. Mandala and Practice in Nagara Architecture in North India. *Journal of the American Oriental Society.* 1979; 99: 204–21p.
5. Stella K. *The Hindu Temple*. 1981;2. Delhi: Motilalbanarasidass.
6. Hardy A. *Indian Temple Architecture: Form and Transformation-The Karnataka Dravida Tradition 7th to 13 Centuries.* New Delhi: I G N C A. 1995.
7. *Kailas Rao M., Bhooshan B.S.*Digital Documentation Techniques as Tools for Conservation of a Buddhist Stupa *through Virtual* Reconstruction. *International Journal of Architecture and Infrastructure Planning.* 2015; 1(1).

*© JournalsPub 2015. All Rights Reserved* 