



A Study on the Pattern of Plot Divisions of Courtyard Residential Blocks of Patan, Kathmandu Valley

Mohan Pant & Shuji Funo

To cite this article: Mohan Pant & Shuji Funo (2004) A Study on the Pattern of Plot Divisions of Courtyard Residential Blocks of Patan, Kathmandu Valley, Journal of Asian Architecture and Building Engineering, 3:1, 197-205, DOI: [10.3130/jaabe.3.197](https://doi.org/10.3130/jaabe.3.197)

To link to this article: <https://doi.org/10.3130/jaabe.3.197>



© 2018 Architectural Institute of Japan



Published online: 23 Oct 2018.



Submit your article to this journal [↗](#)



Article views: 1053



View related articles [↗](#)

A Study on the Pattern of Plot Divisions of Courtyard Residential Blocks of Patan, Kathmandu Valley

Mohan Pant*¹ and Shuji Funo²

¹ Research Associate, Graduate School of Architecture, Kyoto University, Japan

² Associate Professor, Graduate School of Architecture, Kyoto University, Japan

Abstract

This study analyses the ground plans and frontage widths of selected residential quadrangles of the historic core of Patan and shows that the dwelling plots were divided according to a standard method that applied to varying sizes of the courtyard settlement blocks. The size of the plots and frontages is determined by the size of the open courtyards, and their layout follows the *swastika* pattern, an ancient symbol sacred to both Buddhist and Hindu traditions, and which the paper finds as one of the rational ways of division to get the uniform distribution of the plots within a courtyard system of settlement. The study further shows the relationship of this pattern of division and plot planning to the layout of Buddhist monastery architecture, indicating that the form of the monastery could have been the model to inspire the planning idea of the larger residential courtyard settlements of Patan.

Keywords: courtyard settlement; Patan; Kathmandu Valley; Buddhist monastery; plot divisions; *swastika*

1. Introduction

In traditional towns of Kathmandu Valley, dwellings are either clustered along streets and lanes, or open courts at the interior of the quarter. The extensive use of courtyard form makes urban fabric of the Valley towns a honeycomb like structure. The dimensions of these courtyards range from few meters to more than 75 meters, with dwelling blocks belonging to families of various clans built adjoining each other. The larger types of courts are generally known as *nani* or in some instances, as *chok*.¹ It is to be noted that a greater part of the population of Patan is made up of Buddhist communities, of which communities of Sakya, Vajracharya, and Maharjans make up the largest population.² It is within the quarter of these communities that settlement quarters are organized around large quadrangular courts where utilitarian and religious facilities are built for the resident community. Among such religious establishments are Buddhist monasteries, which often constitute the central core of the settlement quarter.

In an earlier paper, the authors analyzed the spatial and community structure of a settlement quarter with Buddhist monastery court at the center, and demonstrated the primacy of the monastery court in its organization.³ This paper will further investigate the planning principle

related to the division of dwelling plots around such open courts. Four large courtyards are selected for detail analytical study, and the research shows that dwelling plots around the open courts had been planned following a principle that is specific to courtyard form related to the tradition of Buddhist monastery architecture of Kathmandu Valley.

2. Method of Analysis

Research carried out in several towns of the Valley have brought to light that the towns of Kathmandu Valley were planned. Particular instances are of Herdick (1982)⁴ on Kirtipur, Tiwari (1995)⁵ and Kurokawa (1998)⁶ on Hadigaon. These studies have focused on the location of shrines, rituals and settlement form. Another study by Pant and Funo on Thimi (2003), a town located five km northeast of Patan, shows the application of planning module in making plot divisions and settlement blocks that conform to an ancient measuring system described by Kautilya (4th c. BC).⁷ Besides this study on Thimi, no research works have been carried out to explore concepts in planning of residential plots in the settlement

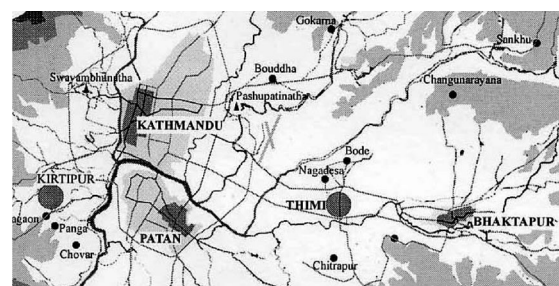


Fig.1. Kathmandu Valley.

*Contact Author: Mohan Pant, Graduate school of Architecture, Kyoto University, Yoshidahonmachi, Sakyo-ku, Kyoto, 606-8501, Japan

Tel: +81-75-753-5776 Fax: +81-75-753-5776

email: at.pant@archi.kyoto-u.ac.jp

(Received November 11, 2003 ; accepted February 27, 2004)

quarters of the traditional cities of Kathmandu Valley. Historical records to indicate such planning works are also so far not available.

During our recent field works on Patan, the planning of dwelling frontages was suggested to authors by the residents of one of the quarters of the city (Fig. 2: no. 1).⁸ This information was subsequently verified, and similar instances were sought in other courtyards. A preliminary observation on the arrangement of dwelling frontages in a number of courtyards in other settlement quarters was then conducted, which led to select three more such courtyards for further studies (Fig. 2: no. 2, 3, 4). The three were selected because one of the courts (no. 2) showed apparent similarity to the first court, while the next two formed parts of the same settlement cluster. The first two courts (no. 1 and 2) were then surveyed to make detail ground plan measurements of dwellings around four sides of the courtyard while the later two are limited to the frontage measurements.⁹ The survey works were facilitated by cadastral survey maps made by Department of Land Survey in 1979 and drawn on the scale of 1:500 that show property boundaries, built and, open areas, and community artifacts. Particular care was given towards existence of a party wall between dwellings that have bearing in identification of partition and merger of dwelling plots. The analysis primarily focuses on frontage of dwellings towards the open court and the depth of plots. Therefore, the existing frontage width of every dwelling is noted with an accuracy to the degree of a centimeter. It is to be noted that a traditional system of measure called *hasta* (cubit), its multiple *danda* (4 *hasta*) and *rajju* (10 *danda*), was in use in Kathmandu Valley where one *hasta* is approximately 48 cm.¹⁰ However, for convenience, all measurements and analysis in this paper are in metric system. This paper also makes use of measured drawings of Buddhist monasteries made by Nippon Institute of Technology,¹¹ for a comparative analysis between various forms of courtyard structures.

The analytical method is first developed from a more detail study of the first court mentioned above, which is then applied and further extended to the second one, and then to other two courts at its neighborhood that form one of the largest courtyard settlement clusters in Patan (no. 2, 3 and 4). The paper, at the end, compares existing division pattern with a particular model court and shows this as a standard adapted for residential court planning.

3. Planning of courtyard dwelling plots

3-1. The court of Nabahal nani

Nabahal quarter located at western end of the city (Fig. 2: no.1, Fig. 3) belongs to Na-*tole* neighborhood, and is known to be a branch of Bubahal, one of the 16 main monasteries of Patan.¹² The residents of Nabahal *nani* are Sakyas while those of Bubahal are Vajracharyas. It is believed that the ancestors of present resident Sakyas of Nabahal came from Lagan *tole* neighborhood of Kathmandu to build Taleju bell (1737) of Patan Palace

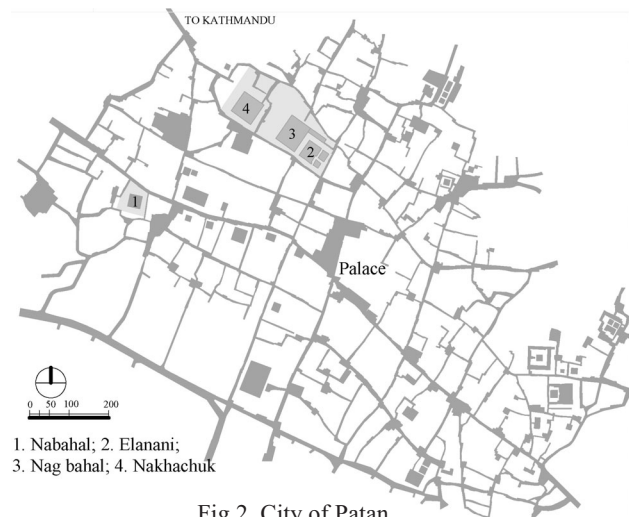


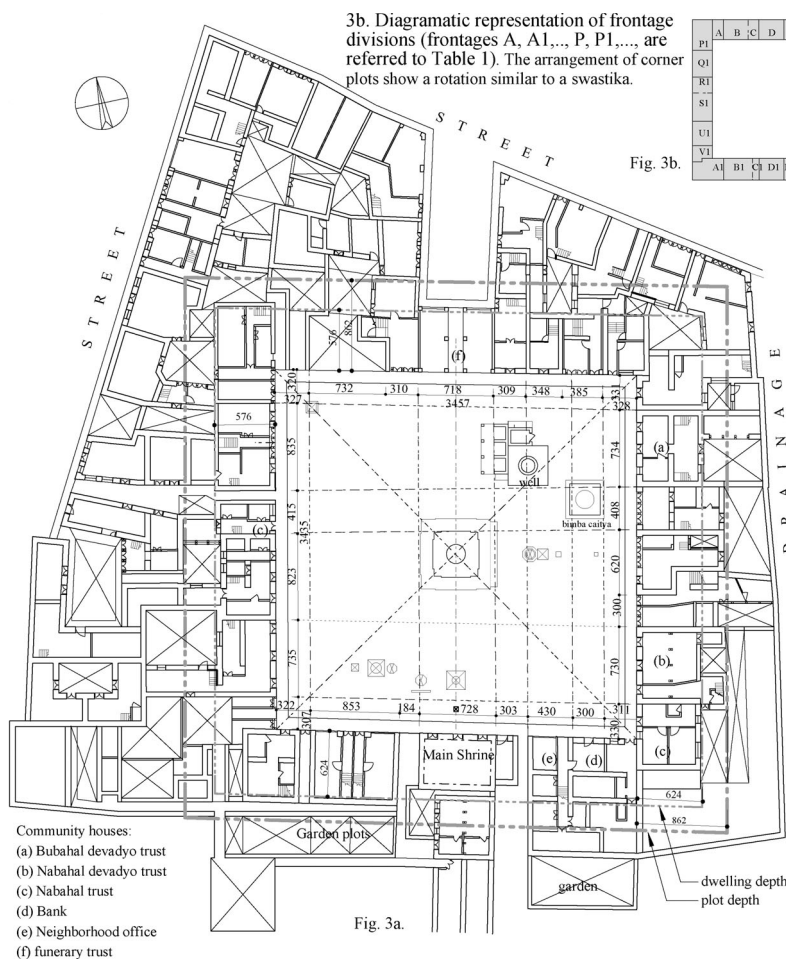
Fig.2. City of Patan.

Square, and, consequently were given this place belonging to Bubahal for their settlement.¹³ Another resident group of Nabahal *nani*, who are also Sakyas, trace their lineage to Sribahal, another main bahal located across the Main Street north of courtyard. The ancestral ties of Nabahal residents with the two main bahals mentioned above continue to exist in a number of religious rituals.¹⁴

Nabahal *nani* has a square open court with its four sides measuring close to each other (~18 *danda* = 34.56 m). Oriented approximately towards north, the court is entered from the main east west street of the city. The entrance lane is exactly at the center of the square court. The location of a *caitya* at the center, and the Main Shrine of *bahal* at south, exactly opposite to the entrance, shows strictly a symmetrical and axial disposition of the courtyard. The earliest record of Nabahal *nani* dated 1453 is from one of the inscriptions installed within this shrine that describes the renovation of shrine building. The dates for central *caitya* and *bimba caitya*¹⁵ at east are yet unknown.

Planning features of Nabahal nani

In addition to the existence of central axis in the layout of courtyard elements, Nabahal has several other planning features, which are indicated by physical dimensions and layout manner of dwelling blocks. One of the peculiar features in the layout of dwelling blocks of Nabahal court is that the corner blocks, which are altogether eight with two in each direction, have the same width. It is to be noted that this width of the corner dwelling is a general feature for all the other three courts large and small to be analyzed in later sections. This width approximately ranges from 310-330 cm with an average width of 320 cm. The corner blocks are narrow when compared to widths that are usual at central sections. In many instances, the dwelling blocks of the wing recess by about 10 cm alternately, and, the recess beginning with the corner block, the arrangement displays striking parallel with the façade of a Buddhist monastery, known as *bahal*. But the recesses and



3b. Diagrammatic representation of frontage divisions (frontages A, A1,..., P, P1,..., are referred to Table 1). The arrangement of corner plots show a rotation similar to a swastika.

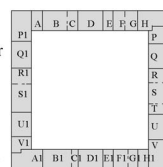


Fig. 3b.

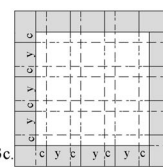


Fig. 3c.



Fig. 3d.

3c. The Pattern of sequence in the division of plots. The theoretical values for c and y are 320 cm and 726 cm respectively.
3d. Swastika--symbol and patterns.

Table 1. Dwelling Frontages (cm) of Nabahal nani court.

North	South	East	West
A 327	A1 322	P 331	P1 320
B 732	B1 853	Q 734	Q1 835 (731)
C 310	C1 184	R 408	R1 415 (519)
B+C 1042	B1+C1 1037		
D 718	D1 728	S 622	S1 823
E 309	E1 303	T 304	
F 348	F1 430	R+S+T 1334	R1+S1 1342
G 385	G1 300		
F+G 733	F1+G1 730	U 737	U1 735
H 328	H1 311	V 334	V1 307
Total 3457	3431	3470	3435

Note: The dimensions in paranthesis of Q1 and R1 are original frontages that were later adjusted, and is apparent in facades.

frontages at northeast and southeast corner of the courtyard are such an instance that were the result of partition of 7.30 m into half giving the same clear width for two dwellings. Thus, it can be seen that the two basic frontages could generate a series of dwelling frontages between 3 to 10 meters,

which may suggest randomness if the above relationships are not known. It is only through the merger of these varying dimensions, and the scrutiny of party wall that one is able to see certain patterns in the layout. It is fortunate that the case of Nabahal *nani* still preserves original frontages in a greater number of its plots, making the feature well known to residents themselves.

Following the usual division pattern of courtyard wings where the central segment is a longer one, and considering the tradition of symmetry, odd numbers of divisions are to be expected. Probably the numbers of divisions were also adjusted according to the practical requirement and limitation due to different lengths of the open court. However, the fixed corner frontage (c) of 3.20 m is one significant feature in this division pattern, the meaning of which will be discussed in the sections to follow.

It is significant to note that when the form of the corner plots are considered, the division pattern gives equal plot sizes when the depth is equal to frontage y. When depth is smaller than y, the corner plot will be smaller than the plots at central segment, and vice versa. It is to be noted that the courtyard is an important feature of the settlement; and the need and desirability of frontage to each plot is apparent. To a certain extent, area of the corner plot could be larger, to compensate its narrow frontage towards the courtyard. This consideration in

protrusion are gradually disappearing with repeated reconstructions.

The frontage dimensions of all dwelling blocks facing courtyard are arranged in Table 1 (cf. Fig. 3b). The Table compares frontages of respective dwellings of opposite wings facing each other. The relationship is also to be seen from Fig. 3a. The evident features that can be outlined in this layout manner are: 1) that the dwelling blocks facing each other have equal frontages; 2) that there are two frontage types the value of which are close to 3.20 m and 7.30 m, and are laid alternatively; 3) some of the plots are formed by merger of the above two frontages.

The relative clarity of sequence followed in the layout of Nabahal *nani* plots (Ref. Fig. 3c) allows us to derive an equation governing the division pattern of the quadrangle. This equation is $n(y + c) + c = w$, where w is the width of open courtyard, c is the corner frontage (320 cm) and y is the width of plot with longer frontage towards the courtyard. By this equation, given the width of open court (= 34.57 m), the value of y comes to be 7.26 m. The frontages of the plots consequently are 3.20 m and 7.26 m, in addition to one of 10.46 m, when a merger of adjoining blocks is considered. Further, various frontage widths that are related to the party wall, which could belong to one of the house owners, result following the partitions from parent plots. The different

division pattern that requires access frontage to the corner plots creates a plan of *swastika* form, which is probably one of the most rational ways to divide plots surrounding a courtyard. This manner of planning of courtyard plots finds exact parallel in the layout pattern of courtyard wings of Buddhist monasteries (cf. Fig. 8b). That the plots of Nabahal were planned in *swastika* pattern is shown by corner blocks where the exterior walls from the corner end of the courtyard continue inward in a manner of rotation of *swastika* arms (Ref. Fig. 3b, 3c, 3d).¹⁶

The alternating of plot frontages of 320 cm and 726 cm in the layout forms a sequence that can be represented by the simple expression c-y-c-y-...-c. There are other frontage widths deviating from the regular pattern, but as it is seen from the table that these larger frontages are also the sum, such as y + c or c + y + c, a combination of adjacent plots of the above two denominators.

It is of significance to note that community buildings of importance, such as Main Shrine and the three buildings that serve for various functions of the community, are close to 7.26 m wide. Among these structures, the Main Shrine, the known renovation date of which is the earliest in the quarter (1453), therefore, enables the dating of the existence of the planned court earlier than 15th century.

3-2. The court of Elanani, Nakhachuk and Nagbahal

The Court of Elanani

The quarter of Elanani is a part of Nagbahal neighbourhood located at the northwest sector of the city.

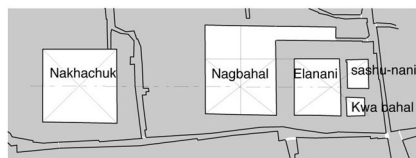


Fig. 4. Spatial relationship of Elanani, Nagbahal and Nakhachuk.

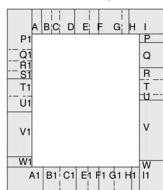


Fig. 5b.

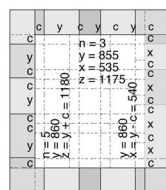


Fig. 5c.

5b. Diagrammatic representation of frontage division. (frontages A, B, ..., A1, B1, ..., are referred to Table 2)
5c. Pattern of sequence in the division of plots.

Table 2. Dwelling frontages (cm) of Elanani court.

North	South	East	West
A 325	A1 326	P 320	P1 564
B 334	B1 590	Q 882	Q1 379
C 289	C1 570	R 400	R1 350
D 523			S1 278
B+C+D 1146	B1+C1 1160	P+Q+R 1602	P1+Q1+R1+S1 1571
E 514	E1 413	T 518	T1 594
F 333	F1 380		
E+F 847	E1+F1 793	U 205	U1 559
		V 2090	V1 1566
G 808	G1 534	U+V 2295	U1+V1 2125
H 249	H1 618		
G+H 1057	G1+H1 1152		
I 341	I1 317	W 326	W1 328
Total 3716	3748	4741	4618

Kwabahal, one of the major monasteries of Patan, also known as the Golden Temple is at its southeast corner. The spatial and socio-religious organization of Elanani is within larger structure of the settlement block that includes two more courtyards—Nakhachuk and Nagbahal at west, and Saraswati *nani* and Kwabahal at east (Fig. 4). Kwabahal is the main monastery of which the residents of these quarters, the Sakyas and Vajracharyas, constitute the major communities. The earliest date available for Kwabahal is 1082 while there are Liccavi period (2nd-9th C.) artifacts in Nakhachuk and Nagbahal.¹⁷

The size of the Elanani open court is close to 24 *danda* (= 46.08 m) north-south and 19.5 *danda* (= 37.44 m) east-west. Unlike Nabahal *nani* court, the main entry approaches, at south from the street and at west from Nagbahal court, are not laid in symmetry through the center. However, the layout of dwelling plots and dimensions of the dwelling frontage of Elanani show a manner of planning similar to that of Nabahal *nani*. The comparison of frontage dimensions of the four wings given in Table 2 (cf. Fig 5b) shows various plot sizes, but which, when adjacent plots are merged, show a consistent use of certain frontage widths. These frontages approximate with the values derived by the method described in the case of Nabahal *nani*. The common denominators in this case are the corner constant 3.2 m and the standard frontage of 8.6 m in east and west side (w = 4618), and 8.55 m in north and south side of the court (w = 3741). The working equation for the east and west side is $n(x + c) + c = w$, where $x + c = y$. The most

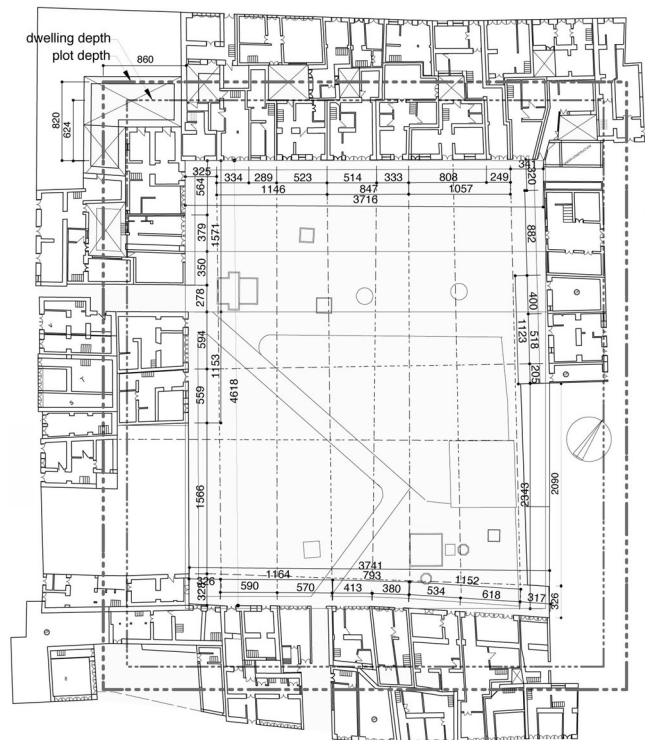


Fig. 5. Elanani Court: 5a. Dimensions of dwelling frontages (cm).

west) and 6.24 m (= 13 *hasta*, south and east). Most dwellings have partial extensions at the back with small light well or backyards. When we take into account these features and wall boundary alignments, the depth of plots at all



9

The open court of Nakhachuk is an approximate square ($31\frac{2}{3}$ *danda* = 60.80 m), while Nagbahal is a rectangular court of 72.20 m x 58.62 m. The divisions of courtyard wings giving dwelling frontages are as shown in Fig. 6 and Fig. 7. For Nakhachuk, the standard average calculated from Nabahal method gives frontage of 8.32 m. The figure clearly shows that existing dwelling frontages when merged agree with the values of *y* and *y* + *c* (11.52 m). The existing frontages can be ordered to make sequences of *c-yc-yc-y-cy-cy-c* at west, and *cy-cy-c-yc-y-cyc* at north side. Similar sequential order may be discerned in other two sides of the courtyard. The corresponding measures and sequence of order in the division of plots are also to be found in Nagbahal that lies at the east of Nakhachuk. North side of Nagbahal shows certain changes in its pattern, probably due to its extended loop at the northeast. Nonetheless, regularity in the frontages is observed and the values can be derived following the Nabahal method.

The division pattern described above through the case study on the planning of four courtyards puts forward the question on its meaning, for the most simple manner of division would be to divide the remaining central segment of the wing with a single denominator, i. e., creating plots of frontage y and its multiples at the central segment, and c or $y+c$ at four corners. But it is evident that in all of these courts, this straightforward manner



Mohan Pant 201

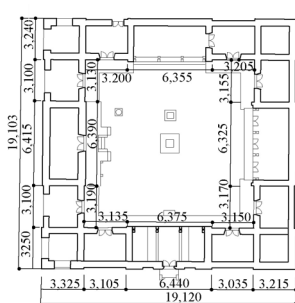


Fig.8a. Khun Bahal, Kathmandu.
(source adopted: Nippon Institute of Technology, 1986)

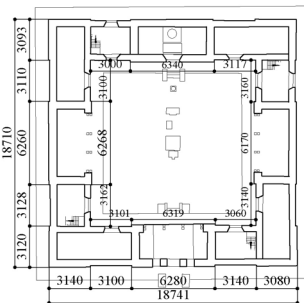


Fig.8b. Chusaya Bahal, Kathmandu.
Dimensions measured from drawing, scale: 1:100. (source adopted: Korn, W., 1978).

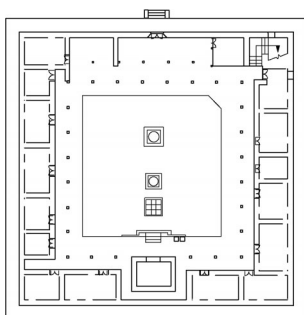


Fig.9a. Cha bahil, Kathmandu.

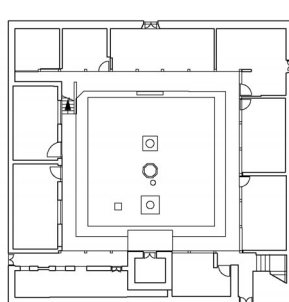


Fig.9b. Jya baha bahi, Patan.

(source adopted: Watanabe, K., cd., 1998)

in plot divisions has not been applied. Further, there must also be special reason on employment of a fixed frontage for the eight corner blocks of the courtyard. The arrangement of plots around the court that forms *Swastika* pattern is also an important feature of this system of planning. At the present state of knowledge, it is not known whether any ritual or metaphysical concepts of the prevailing age influenced the layout and division patterns of courtyard dwelling plots. However, reasons of certain functional and preexisting traditions can be cited leading to this system of courtyard planning.

First, the width of corner block is related to the ancient standard of measure mentioned in the preceding section.¹⁸ This width is exactly one sixth of a *rajju* (19.2 m). The employment of this dimension for the width of the bay of a monastery, and as one division in the wing facades is shown by Khun bahal and Chhusya bahal of Kathmandu built in 1591 and 1649 respectively (Fig. 8a, 8b).¹⁹ The proportion of the width of sections of interior facades at the open court of Khun baha are 1:2:1, i.e., c:y:c, while this is 1:1:2:1:1 or c:c:y:c:c at external facades. We consider that these divisions and dimensions are of special significance, because the proportions are wholesome, and dimensions of these two monastery courtyard blocks are close to the square of 1 *rajju* (1r = 19.2 m), a standard modular grid of planning of the settlement blocks.²⁰ While width of the bay might have functional reason, the width appearing as division in the façade—internal and external, bears to the symmetric treatment of façade and the rhythm created by alternating sequence of recessed and protruding walls. This kind of façade treatment and bay width is a common feature of

bahal architecture not found in bahils that are considered to be the earlier Buddhist establishments in Kathmandu Valley. This leads to the proposition that this form of planning with the standard corner block developed after 7th century when *Vajrayana* began to take place of *Mahayana* Buddhism in Nepal and of which bahals are thought to be its representative institutional form.²¹ Thus it also appears that the generation of sequence in the plot division, and, dwelling frontages is a parallelism between bahal courtyard architecture and the residential court dwellings.

The logic of development of such a sequence can be explained from the requirement of symmetry, and the requirement of a corner block as access to the plot located at the corner. Fig. 10c illustrates the process of development of the sequence proceeding from uniform plot divisions of the courtyard wings to a pattern creating *swastika* arm with symmetrical divisions. The side that may give uniform divisions of width (a) is divided into components of c, the corner width, and y, the standard frontage, showing the corner width as a key operator to the generation of symmetry. This first order of symmetry is further elaborated dividing y into components c and x. The first sequence that is without symmetry thus leads to a symmetrical sequence c-y-c-y-...-c and then to c-x-c-c-x-c-...-x-c. The formation of second order of symmetry might have been the result of the need to guide the inevitable division of original plots: that is, when a plot of width y was to be built, divided or partitioned to sell, the corner width was again employed as one of the component to bring the whole division into a harmony. The employment of this constant thus acts like an operator to generate symmetric sequences. When the neighboring plots are merged in a variety of combinations, and then partitioned into equal divisions, the above sequences give numerous dwelling frontages. In instances of courtyard analyzed, the ratio of such a division, however does not necessarily lead to the proportion of 1:2:1, but varies according to the width of the courtyard.

In Nabahal *nani* and Elanani it is to be seen that the corner plots (not the frontage) alternate in a sequence of standard plot size and minimum size. That is, between the two adjacent plots at the corner, one is of standard size while the other is of 3.2 m. What particular function was allocated to the small corner plot? One of the plausible explanation to this question is that the four plots at four corners served the purpose of access towards the interior of settlement block, which were also arranged either in similar manner of courtyard planning, or were small family courtyards. Such corner access links are to be seen at southwest and northwest corner of Nabahal *nani* court and northeast and southeast corner of Elanani. Other access links from plots at the central segments of the courtyard are also found, but the corner links, in addition to the main central entrance, could be a planned feature, while other links might have formed in due course of time in a more organic pattern. The possibility

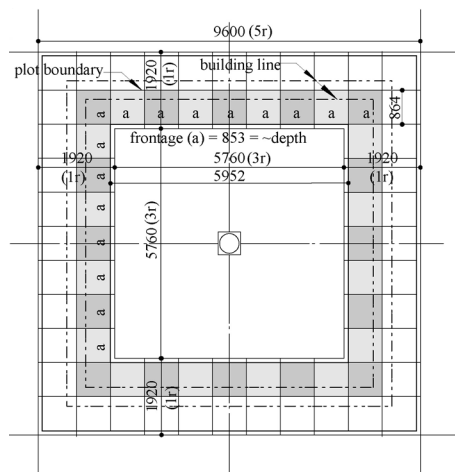


Fig.10a. Schematic diagram of a model: *Nivartana* court. The court whose sides are 57.6 m (3 *rajju*) gives 32 units when the interior ring is divided into square plots. The outer ring may belong to adjacent quadrangles when courts are built continuity. (dimensions are in cm)

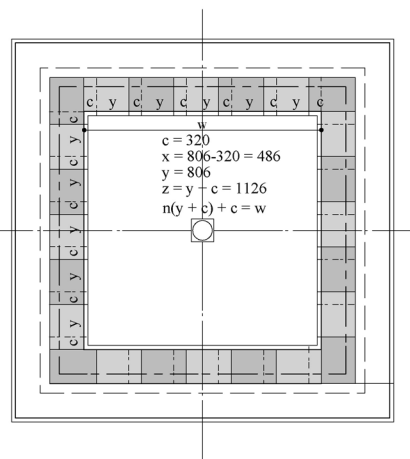


Fig.10b. The division pattern in practice as exemplified by the four courts. This division gives 24 units, which are arranged in a *swastika* pattern.

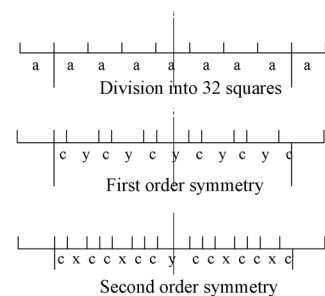


Fig.10c. This diagram shows the procedure to make symmetrical layout divisions of the plots, and, to regulate further divisions by the employment of a constant frontage *c*.

of such access ways is again suggested by Buddhist monastery courts (Fig. 9a, 9b). Chabahi, considered to be one of the earliest monasteries of Nepal, shows reminiscence of such passage way arranged in *Swastika* pattern. Likewise, Jya baha-bahi, also thought to be a Liccavi structure (2nd-9th C.) has doors at exterior walls exactly in positions that is directly reached from the four corners of the court, and which are laid to make the *swastika* pattern. The room arrangement of Chusya baha (Fig. 8b) with its opening at exterior walls at south and west presents an ideal instance of such a layout. This organization pattern is also to be seen in other monasteries. Changes due to particular location aspect and reconstructions through centuries have changed the standard pattern to a certain extent, but the general preference to have such access links from corners of the court can still be discerned.

5. Plot divisions: The existence of a model residential court

Following the preceding analysis of four courts, a theoretical planning dimensions will be worked out by illustrating an example of a 'model courtyard block' to understand how the above planning division may relate to a settlement grid, the measures of which follow the modules of ancient standard measure. In this system of measure, besides *hasta*, *danda* and *rajju*, there is a unit known as *nivartana*, a measure of 3 *rajju*. In Patan, the measurement of 7 largest open courts shows the employment of 3 *rajju* (19.2 x 3 = 57.6 m), i. e., a *nivartana* measure to be most common.²² In the instances of case studies presented in this paper, Nakhachuk represents such a standard courtyard, while Nagbahal has one of its sides of one *nivartana*, and Elanani court when added with Sasunani at its east is also of one *nivartana* wide (cf. Fig. 4). This measure of open court excludes plinth, which is a private property. Fig 10, thus, illustrates such a model settlement block in a grid of

standard module, and the process of plot division in a manner as described in the cases of above four courts.

The uniform division of surrounding plots of the courtyard, without the concept of the kind of corner plot discussed above, will give 8 plots of size 8.53 m wide and 8.64 m deep in one wing making 32 divisions altogether (Fig. 10a). Whether this number of division is related to Mandala construct of the residential block is not known at the present stage of research. However, this basic division of 32 squares is subsequently transformed to a pattern of divisions creating sequences in the manner described above. The new division of plots laid in *swastika* pattern gives a standard frontage of 8.06 m with the corner block 3.2 m wide (Fig. 10b)²³ and 8.64 m deep. Thus, when the plots are divided into uniform size, there will be five standard plots of 8.06 + 3.2 = 11.26 m frontage towards the courtyard, while the corner plot will be slightly larger (11.84 x 8.64). If the dwelling width is taken as 6.24 m (= 13 *hasta*), the width of the back yard (that includes backyard of dwelling at the opposite back) will be 4.8 m (= 2.5 *danda*).

One of the remarkable features of this method in division pattern is that the dimensioning of plot frontages does not follow the principle that gives multiples of *hasta* and *danda*, while depth of the dwelling and the plot confirm to standard multiples. However, it can be observed that in Nakhachuk and Nagbahal, the most common frontage is close to 6 *danda* or 24 *hasta* (= 11.52 m). As can be seen from Fig. 6 and 7, the total dimensions of the two courts fit so closely in this scheme of plot division (Nakhachuk: 5 x 11.52 + 3.2 = 60.80 m; Nagbahal: 6 x 11.52 + 3.2 = 72.32 m) that it may be concluded that the size of the two open courts were first determined by the plot planning than the other way round, where the plot divisions were determined by the given size of a courtyard. Elanani is also close to this approach of division. It is probable that, in such instances, standard

multiples for plot width were preferred making slight adjustments in size of the open courts given by multiples of *danda* or *rajju*. However, when the sizes of open courts are multiples of standard modules of *danda* or *rajju*, the plot divisions are consequently not the multiple of *danda*. As can be seen, for a standard *Nivartana* court itself, the corresponding frontage is 11.26 m (~23.5 *hasta* = 11.28 m). Further divisions of this measure similarly lead to fractions of *hasta*. The divisions of Nabahal *nani* are such instances. Such a division that has to take into account of *angula* (1 *hasta* = 27 *angula*) divisions is certainly strenuous to maintain accuracy in the surveyor's work than in the case where dimensions of plots are first considered. However, given a fixed size for a court, this manner of division produces plots of equal size, which therefore suggests that uniformity in the distribution of plot size was given an essential priority. The instances of the above two cases, thus, show that there existed two methods in the planning of plot divisions of courtyard wings: one determined by the larger grid and the other preferably determined by the convenient frontage of the plots, which resulted in a slight adjustment in the size of the open court.

Thus, the close concordance of the existing dimensions such as frontages, and depth of plots of the four courts with those of the model court, which may be referred as a *Nivartana* court, suggests the existence of such a model, in addition to the Buddhist monastery courts, to guide the planning of these residential courtyards.

6. Conclusion

This analysis of Buddhist monastery residential quarters demonstrates that the dwelling plots of large residential courts were planned, and the planning principle has its roots in Buddhist monastery traditions. The manner of this planning in plot divisions may be summarized as follows:

1. The courtyard plots are planned in a manner giving uniform plot size and frontage to dwellings around the courtyard. The narrowness of the corner plot is a result of predetermined plan; it is a functional requirement and is a planning feature related to the structure of courtyard system of settlement block. The fixed corner width is related to an ancient standard of measure. The *swastika* pattern of layout division proves to be a rational layout in this manner of courtyard settlement planning.

2. Apparently there existed two traditions in making divisions of courtyard plots: the first one used convenient multiples of *hasta* and *danda* for the plot width, while the other maintained the width of open courts to confirm to multiples of the above measure.

3. The planning suggests the existence of a model—a *Nivartana* court, of 3 *rajju* wide. The 32 divisions of *Nivartana* court suggest a possibility in the Mandala construct in the planning of such residential courts. Further research works are needed to examine any ritual and metaphysical underpinnings on this system of

planning.

4. The evident correspondence of courtyard plan with the Buddhist monastery court of Bahal suggests that such planning principle evolved following the introduction of *Vajrayana* in the history of Buddhism, which is thought to have been during 7th or 8th centuries. The case studies of this paper suggest that such planning existed at least by 12th century.

Acknowledgements:

1. This research has been possible with the grant of Post Doctoral Research Award by Japan Society for the Promotion of Sciences, and the authors wish to express their sincere gratitude.
2. The authors are grateful for the support by Prof. Sudarshan Tiwari, Mr. Ghanaraj Lohani, the student group of Institute of Engineering participating in the survey, and the residents of Nabahal, Elanani, Nakhachuk and Nagbahal courts.

Endnotes

- ¹ *Nani* has social and spatial connotation as a settlement cluster of one or several clans. *Choks* are best translated as courtyard or square, and is more a spatial feature than a social form. Many localities of the towns of Kathmandu Valley are known by certain particular attribute with *nani* as suffix. For more detail study of *nani*, see Pant, M and Funo, S., 2000, 'Analysis of Settlement Clusters and The Development of The Town of Thimi', Journal of Archit. Plann. Environ. Eng., AIJ, vol. 543, pp. 177-185.
- ² For a general knowledge on the social and population structure of such communities of the Valley settlements see Rosser, C., 1966. "Social Mobility in Newar Caste System" in Caste and Kin in Nepal, India and Ceylon, Furer-Heimendorf, C. Von, ed., London.
- ³ The study makes a morphological analysis of dwelling clusters, the distribution pattern of clan communities and the formation of large residential open court of Bubahal, one of the Buddhist monastery quarter of Patan. For detail see Pant and Funo, 1998.
- ⁴ Herdick, R., 1982. "Urban Residential Quarters of the Newar in Nepal—a symbolic and spatial-social unit", in Vijayanagara—city and empire, J. Fritz, ed.
- ⁵ Tiwari, S. 1995. Patterns of Settlements in Kathmandu Valley in Ancient Period. PhD dissertation submitted to Tribhuvan University. See also The Brick and The Bull, Himal Books, 2002.
- ⁶ Kurokawa, K., and et. al., 1998. "Space Formation of Hadigaon, Kathmandu, Nepal—Distribution of Holy Places and Ceremonies", J. Archit. Plann. and Environ. Eng. AIJ. No. 514, Nov, pp. 155-162, (Japanese)
- ⁷ The planning of the settlement blocks of Thimi in addition to a field adjacent to it thought to have been settled in ancient times have been studied in Pant and Funo, 2003. It demonstrates, for the first time, that settlements and lands in Kathmandu Valley were planned according to an ancient measure that confirms to a standard described by Kautilya, the prime minister of Chandragupta Maurya of 4th century BC. For the measurement values see note 10.
- ⁸ The field survey was conducted from June 10 to July 9, 2003.
- ⁹ The survey measurement was conducted between the period June 20 and July 5, 2003. The survey team included Mohan Pant, Ghana Raj Lohani and student group of Institute of Engineering, Tribhuvan University.
- ¹⁰ Previous studies have shown the equivalent metric measures of the ancient measuring system employed in Kathmandu Valley. The ancient system employs *hasta* (cubit) measure as one basic unit. The dimensions of *hasta*, according to purpose of use and authorities are different, but among them, the measure that corresponds to those found in Patan and Thimi is close to 48 cm. Other multiples besides *hasta* and *danda* in this system of measure

described by Kautilya are *paridesha* (2 *rajju*) and *nivartana* (3 *rajju*). In this system, one *hasta* is divided into 27 units called *angula*. Pant and Funo (2003) demonstrate this relationship in the study of Thimi, Kathmandu Valley.

- ¹¹ Nippon Institute of Technology, 1985, 1998.
- ¹² The Buddhist monasteries of Kathmandu Valley are classified as *bahal* and *bahil*. Among *bahals*, they are further classified into main *bahal* and branch *bahal* (of the main *bahal*). Locke, J. (1987) gives an extensive inventory of the monasteries of the Valley.
- ¹³ Padmavati Mahavihara, 1995.
- ¹⁴ Ibid.
- ¹⁵ The central *caitya* is also known as Asoka *caitya*, a name usually given to larger ones with characteristic plain hemispherical domes, which are usually white washed with lime. For the classification and detailed iconographic study of Nepalese *caitya* see Gutschow, N., and Basukala, V., The Nepalese Caitya, Axel Menges, Stuttgart/London, 1997.
- ¹⁶ The symmetry with narrow corner frontage is already apparent in rockcut monastery caves of Pitalkhora, Maharashtra of 1st C BC, while the use of *Svastika* symbol goes to remote past to Indus civilization of 3rd millennium BC. Swastika is a sacred symbol in Buddhism, often to be seen in Buddha's footprints as one of the auspicious signs. The distinct *svastika* pattern in the ground plan of a monastery in Sirpur, Madhyapradesh of India of 7th C., and of Great Stupa, Paharpur (Bangladesh) of 8th-9th C., shows that the symbolic figure was adapted to the planning of monasteries. See Huntington, 1985, p. 23, 82, 391.
- ¹⁷ See Locke, J., 1987, p. 85. For Liccavi period caityas, see Gutschow, N., and Basukala, V., 1997, op. cit., note 15.
- ¹⁸ Note 10, op. cit.
- ¹⁹ The study of Pant on Thimi (Pant, 2002. A study on the spatial formation of Kathmandu Valley towns--The case of Thimi, Phd dissertation, Kyoto University, p. 84,) through the analysis of existing dwelling forms proposes a standard street house that has its bays of 322 cm when measured from outer wall lines. For the date of the two bahals see Locke, J. op. cit.
- ²⁰ See Pant, M. and Funo, S., 2003.
- ²¹ See Bhattacharya, B., 1927, Origin and Development of *Vajrayana*, Indian Historical Quarterly, vol. 3.
- ²² The 7 largest open courts of Patan measured are Nakhachuk (58.88m x 58.90m) Nagbahal (70.28m x 57.58m), Elanani +

Kwabahal + Sasunani (44 .28m x 58.20m)Tabahal (76.80m x 51.84m), Subahal (55.86 x 55.78) Bhinche bahal (59.54 m x 51.99m), Bubahal (32.64m x 57.60m). The measurement excludes plinth width. (Survey measurements: Mohan Pant and Ghana Raj Lohani, July 1-July 4, 2003)

- ²³ The layout of the grid and divisions take into account the plinth width of 2 *hasta* (96 cm) that adds to the open court of 3 *rajju* wide. This width is assumed from a convention known as '*hayaphu niku*', i. e., two *hasta* to the end of the eave. The widths of the plinths that presently exist show certain variation from this standard but our field measures in places where the plinths across property boundaries show continuity confirm to this tradition.

References

- 1) Huntington, S., 1985. Art of Ancient India--Buddhist, Hindu, Jain. Weatherhill, Tokyo.
- 2) Korn, W., 1978. The Traditional Architecture of Kathmandu Valley. Ratna Pustak Bhandar, Kathmandu.
- 3) Locke, J., 1987. The Buddhist Monasteries of Kathmandu Valley, Sahayogi Press, Kathmandu.
- 4) Nippon Institute of Technology, 1981. The Royal Buildings in Nepal, Nippon Institute of Technology Research Mission, Saitama-ken (English and Japanese).
- 5) Nippon Institute of Technology, 1986. The Royal Buildings and Religious Remains of Nepal. Nippon Institute of Technology Research Mission, Saitama-ken.
- 6) Padmavati Mahavihara: Na-bahal ko samksipata parichaya ra pragati vivarana (A brief introduction and progress report of Padmavati Mahavihara: Nabahal), Tole sudhara samiti, Nabahal, Lalitpur, 1995.
- 7) Pant, M. and Funo, S., 1998. "Spatial Structure of a Buddhist Monastery Quarter of the city of Patan, Kathmandu Valley". J. Archit. Plann. and Environ. Eng. AIJ. No. 513, Nov, pp. 183-189.
- 8) Pant, M. and Funo, S., 2003. Considerations on The Layout Pattern of Streets and Settlement Blocks of Thimi—A Study on The Planning Modules of Kathmandu Valley Towns (Part I), Journal of Archit. Plann. Environ. Engg., AIJ, vol. 574, 2003.
- 9) Watanabe, K., Ed. 1998. Buddhist Monasteries of Nepal, Chuo Koron Bijitsu Shuppan, Tokyo.