clay

wood

stone

metal

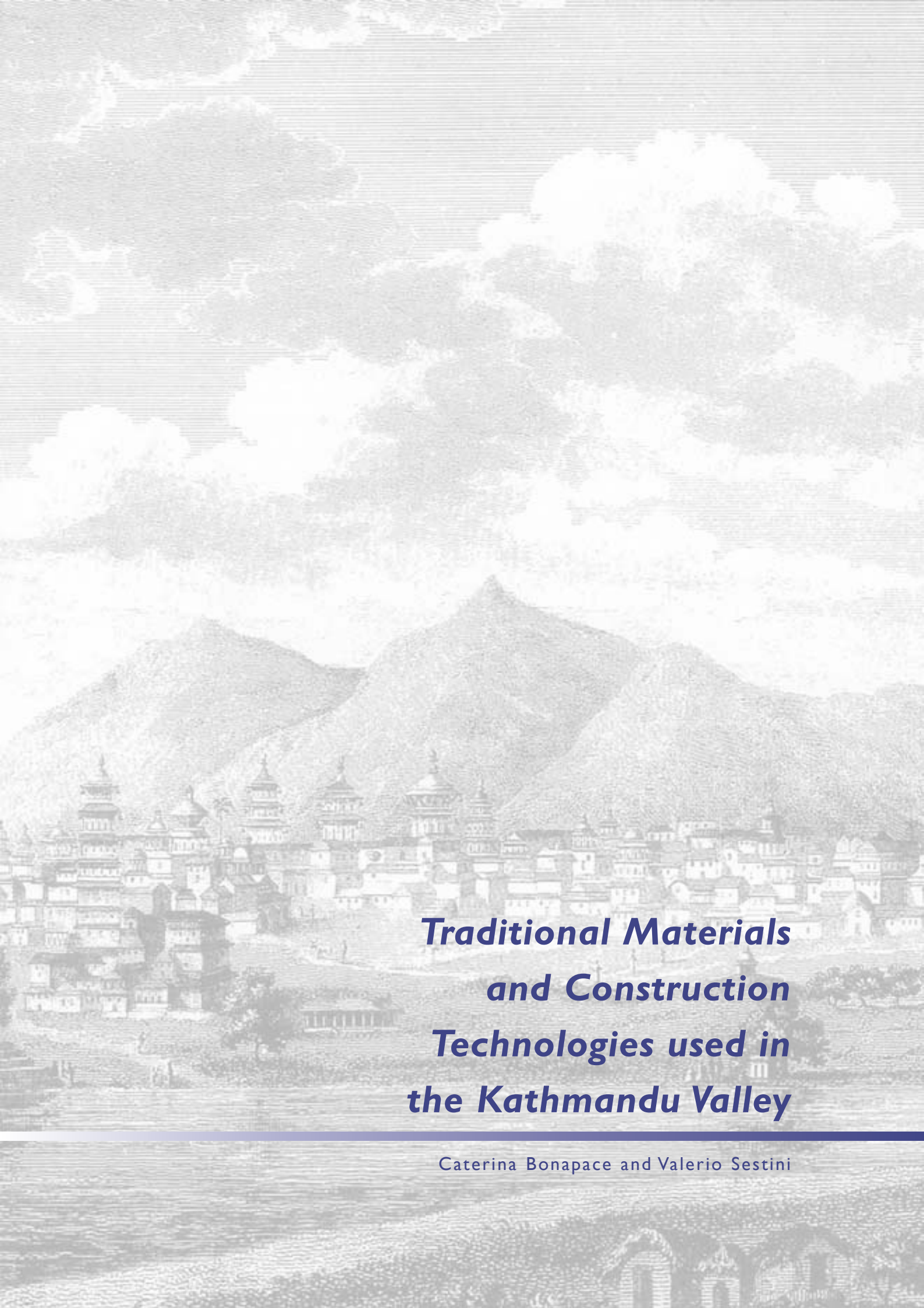
adobe

plaster

Traditional Materials and Construction Technologies used in the Kathmandu Valley

Caterina Bonapace and Valerio Sestini

United Nations Educational, Scientific and Cultural Organization



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View of Kathmandu
From W. Kirkpatrick, 1811

Foreword

This book is the result of a close collaboration between an architect and an anthropologist. Such an interdisciplinary team was essential since the Nepalese culture, environment and religion are so unique and intricate, that it is necessary to tackle the subject matter from different angles, in order to provide the additional information and elements needed to grasp the essence of the subject.

This book deals with architectural features which focus on construction materials and techniques, and promotes their appropriate use in the rehabilitation, refurbishment and restoration of the historic buildings of the Kathmandu Valley. Not only in Nepal, but also globally, the preservation of our cultural heritage, and the reuse of the built-up environment, play a major role in the improvement of our physical environment, which includes schools and educational facilities.

The authors, Professor Valerio Sestini and Dr. Caterina Bonapace, are dedicated professionals with specialised knowledge of this part of the world. Professor Sestini teaches at the University of Florence and started working in Nepal as early as 1971. Dr. Bonapace wrote her doctoral thesis on 'The Bagmati River in the Kathmandu Valley', and joined Professor Sestini in 1997. They have carried out research together for many years with great enthusiasm and commitment.

Their present research is based not only on several years of study and visits to remote parts of Nepal and India, but also on ad hoc missions related to specific aspects of the architecture, history and social and economic background of the country. For the preparation of this book, which began in late 1999, a number of special missions were carried out in Nepal and India, and to specialised libraries in Paris. The authors are of the opinion that architecture should be considered not only as the result of time and knowledge, but also as the reflection of a certain epoch. This is why attention was paid equally to monumental and traditional architecture, which share similar construction materials and techniques, although the levels of refinement are different.

To reaffirm this, visits were paid to construction sites, where rehabilitation or restoration work was under way, to quarries and forests where raw materials were still to be found, and kilns or laboratories where these materials were transformed into the primary products used for construction. During these visits interviews were conducted to record information and data, particularly with regard to the modifications introduced in the 'production' processes. The results of the investigations and interviews confirmed that the same technical skills of the *Newar* artisans of the past are still available today, and there is continuity in the provision of such highly specialised work. Also investigated were the rigid division of work based on the caste system still in place, and the extent to which the continuity of specialised work still remained within the same family, as was the case in the past. In-depth studies on the effects of earthquakes on traditional constructions were completed, and preliminary studies made.

The book is structured in such a way that each chapter focuses on a specific construction material and techniques, and covers such matters as where the raw materials were found, the way in which they were transformed into construction elements, and finally on the assembling techniques used. Numerous explanatory photographs and drawings are included in order to enrich the text.

This book covers all of the above-mentioned issues. It is not just a collection of information concerning the Nepalese architectural heritage, but is also a means of transmitting important skills and knowledge from the past to the present. It will serve as a useful and handy reference manual for architects and other experts. But it will also be an intellectually stimulating book for students, and all those interested in Nepalese culture, architecture and society.

Alfeo Tonellotto

Acknowledgements

We, the authors express our profound gratitude to UNESCO, the Italian Ministry of Foreign Affairs, the University of Florence and the Department of Technologies applied to Architecture and Design "Pierluigi Spadolini" for the valuable financial support contributed for this research. We also wish to record contributions and technical cooperation rendered by many individuals, without whose help this publication could not have come out at this quality level: First and foremost, we would like to express our sincere thanks to Mr Alfeo Tonellotto, Chief, Architecture for Education Section, UNESCO HQs, for his continued professional support and total involvement at all stages in the preparation of this publication.

For the fieldwork, we are very thankful to our interpreter and guide, Mr. Sange Lama, for his efficient services during our visits to several places, workshops and laboratories. Also many thanks go to all those Nepalese craftsmen and workers for their hospitality in opening to us their workshops and for generously providing us with valuable information on their skills and knowledge in craftsmanship

Special thanks is extended to our colleague architects Mr Vincenzo Gabriele, Mr Paolo Sestini, and Riccardo Somigli for their ingenious contributions in preparing many drawings contained in this book in electronic format, and last but not least, Ms Barbara Brink for the graphic design and final text editing.

We would also like to note that the surveys of historic buildings, monuments, and artefacts were carried out by Mr Vincenzo Gabriele, Mr Paolo Sestini, Mr Valerio Sestini, Mr Enzo Somigli, Mr Riccardo Somigli, Ms Claudia Sacchi and Ms Cristina Albertini. All photos contained in this book come from original photos taken by the authors.

CONTENTS

PLATES AND TABLES

CHAPTER 1

introduction

Nepal Mandala

From W. Kirkpatrick, 1811

A living history

Environment, materials and crafts activities have all had an important role in the development and recognition of so called 'Nepali' architecture, otherwise known as the '*Newar*' style. This style is very different from those found in neighbouring Asian countries with similar cultures, traditions and religions. A distinguishing factor of the style as a whole is the way in which the two principal materials, wood and brick, are used. They are used to make up building elements using technological processes that have evolved over many centuries to create a distinctive style of architecture.

The material that unifies this architecture with its environment is the clay soil of the Valley. The soil that is excavated from a now dry lake whose waters previously opened out into a gorge in the south, as the Manjusree legend goes (1), is still used for the fabrication of bricks. Until the beginning of the last century, most of hills and mountains around the Valley were covered in forests.

Stone, a clay metamorphic limestone, is also found in the Kathmandu Valley. It is used for the construction of many architectonic and sculptural works. Some monuments, in particular the *shikhara* temples, built according to the Indian models, are typically made from stone.

Indian researcher, N.R. Banerjee, noted that there is a strong link between the soil and structural elements of buildings: "*The structural complex necessarily involved the use of wood and a pliant mortar, such as clay, that made for elasticity of the edifice which was so essential to the region where the soil was prone to seismic movement as a result of a periodical landslides or earthquake, in the interest of the mere solidarity of structures*" (2).

W. Korn, pioneer of all western research on *Newar* architecture, prepared extensive graphic documentation on many aspects including the most important *dega* temples, Buddhist monasteries (*bahal*), Hindu priest houses (*math*), and simple houses. His research and records focus on analysing buildings, urban spaces and their organisation. He summarised his research in a few words "*The appearance of the towns and the villages has not altered appreciably over the centuries, as the design concepts and building materials have remained almost unchanged*" (3).

After Korn, other authors continued to explore the subject (4). Among them Gutshow (5) who together with his collaborators drew up a unique illustrated dictionary, from *Newar* into English, where all building systems and material technologies used by *Newar* craftsmen were described and explained sector by sector.

The origins

Many authors have described the architectonic works of Nepal by making a typological classification of the principal monuments. It was only in 1905 that Lévi clearly identified all the works that constitute the cultural patrimony of the country. However, nobody has so far prepared a complete chronical of the arts and more specifically of the architecture. The works analysed by Lévi are linked to a system of religious worship, a cult, and are described according to it. These works have their origins in Indian culture and are directly linked with the two main religions that come from India, Buddhism and Hinduism. Lévi identified Nepal as *"l'image autentique d'un Inde disparue"* (6).

Penetration of these religions in Nepal was made by the dynasties, all of whom had originally come from India where they had been predominant for centuries. They contributed to the making of an autonomous civilisation. Under the guidance of these reigns the Nepalese artistic schools developed. The Nepalese in turn contributed towards Tibetan and Chinese artistic development. Nepalese artists, disciples of the Indian teachers, became teachers themselves. One of them, the famous artist Ar-ni-ko, went to the Chinese Emperor Kublai Khan in 1274 A.D., to help in the renovation of artistic Chinese metal structures. Most of the artistic movements towards Tibet, however, happened at the time of migrations. Buddhist teachers often had to move because of invasions by Muslims in the north of India.

In its expression, all Nepalese art including painting, sculpture and architecture was influenced by the two main religions. The most important architectonic works that we admire in Nepal, have origins that lie in the Indian culture, often keeping their original names. As they have developed, however, they have assumed new morphologies and a style that differs from the typical Indian style.

Various famous authors have expressed the same opinion concerning art and religion of the Himalayan region, in particular Nepal. Singh observed that *"L'arte himalayana è in primo luogo arte religiosa, arte sacra, che nel corso dei secoli ha espresso la fede e gli ideali di monaci, dei loro protettori (ricchi mercanti, re, piccoli sovrani e le loro corti) e della gente del luogo"* (7).

Brown noted that *"the art of the* Newars *is essentially a religious art, ordained and consecrated to the service of the country's creed"*. (8). Slusser further underlined that *"Traditional valley architecture encompasses temples and shrines, monasteries and* stupas*, the residences of kings and theirs subjects, community buildings, fountains, votive pillars, and a number of other minor features. None can be rigorously categorized as sacred or secular, for all serve both gods and men"* (9).

Almost broader are Tucci's thoughts: *"Come accade generalmente in oriente, quest'arte che i Newari coltivano è un'arte religiosa. Per la qualcosa, se ne vogliamo intendere il significato, non dobbiamo giudicarla secondo il nostro modo: l'artista nepalese, come il maestro indiano o il suo scolaro tibetano, non si propongono di dar corso nell'opera alla libera fantasia. Essi traducono invece nel simbolo di certe forme, le proprie esperienze e visioni, o rappresentano per imagini e figure le intricate vie che l'iniziato deve percorrere per trascendere il piano temporale e trasumanarsi in piani divini e atemporali."* (10).

These quotations seem to be directed more towards painting and sculptural art, but are also relevant to architecture with the construction of temples, the choice of the site location, the orientation and proportions, as well as the realisation of simple sacred objects. These are applied to the decorative features of the buildings, expressed in frames and friezes using symbols that have their tradition rooted in the two religions.

While tracing a short historical and artistic profile of Nepalese art Goetz, a known researcher in eastern civilisations, discovered many reasons why so many works from the more ancient period of Nepal, defined by Goetz as 'archaic', have not survived. (11).

The principal factors for why most ancient works have been destroyed over time are invasions and wars, general deterioration of materials due to natural causes and changes made by people attempting to restore works according to Asian tradition. From this most ancient period, only the four Patan *stupa* (3rd century B.C.), associated with the name of the emperor Ashoka, and Carumati in Chabahil still remain. Even here, probably only the general setting and layout of the first works remain. Parts were added to these structures more recently in conjunction with the doctrinal developments of Buddhism as can be seen by comparing the existing structures with those recorded in documentation from the 19th century. Another *stupa*, Swayambhunath *stupa*, was reconstructed and modified many times and, according to some authors, very little remains of the original one.

A significant development in Nepalese art took place at the beginning of the 5th century, and in the following centuries, during the Licchavi reign (400-750 A.D.). They came from Vaisali in north India and reigned in Nepal during the same period that the Gupta affirmed their empire in India.

Plate 1.1 - Stone sculpture of Vaikhunthanatha (Vishnu), Changu Narayan complex

Plate 1.2 - Stone sculpture of Brahma, Changu Narayan complex

Many sculptures come from this period, clearly showing the influence of Gupta art, while in the domain architecture the sacred places of Pashupatinath and Changu Narayan were founded (Plates 1.1 and 1.2). Later, between the end of 6th and the beginning of 7th centuries, there was the foundation of the sacred complex of Boudhanilkantha, far north of Kathmandu, where a well known Vishnu sculpture is found, sleeping on serpents (Plate 1.3). It was at this time that the large Bodhnath *stupa* was constructed.

It was during the period dominated by the Licchavi that Nepalese craft techniques like the bronze working process, gold gilding, silver and copper work and stone carving developed. Unfortunately many of these works have since disappeared. At the end of this flourishing period, many sculptural objects of great artistic value and importance were made. Among them the river deity statue, Yamuna in Pashupatinath.

Plate 1.3 - Vishnu sleeping on Ananda snake, Boudhanilkantha

With the end of the Licchavi reign at the end of 8th century, a period described as 'medieval' by Goetz began. The first dynasty of this period was Thakhuri and later the first Malla, lasting until the beginning of 14th century.

Not so much is known about this obscure 'medieval' period, when Nepalese art started to establish its own style under the influence of the late Gupta style, blended with styles of Bengal and Bihar, where Pala and Sena dynasties dominated. A further development of Nepalese art took place with the migrations of Buddhist populations, among them artists and monks, after the invasion by Muslims in northern India. The main cities of the Valley were founded during this period, from Kirtipur (8th and 9th centuries) to Kathmandu (9th century) to Bhaktapur (12th and 13th centuries).

Unfortunately, most of the architectonic works built in this period in the cities and in other places around the Valley were lost because of events that took place during the 14th century, in particular the invasion of Ilyas sultan in 1345-46.

Malla centuries

It is only with the coming into power of Jayasthiti Malla in 1382 that a period of stability started. It lasted until around the middle of the 18th century, when Kathmandu, Bhaktapur and Patan cities developed as three independent reigns. Inside the cities the well known royal palaces were built and near them many temples of different styles and forms still exist. During these centuries construction technologies developed and the architecture in both cities and villages acquired their own distinctive character defined by many as the '*Newar* style'. In particular, the *dega* temple, incorrectly defined as a 'pagoda', developed its own aesthetic quality and construction system from a central cell with a walkway delimited by walls around it, to a cell with an external peristyle (Plates 1.4 and 1.5).

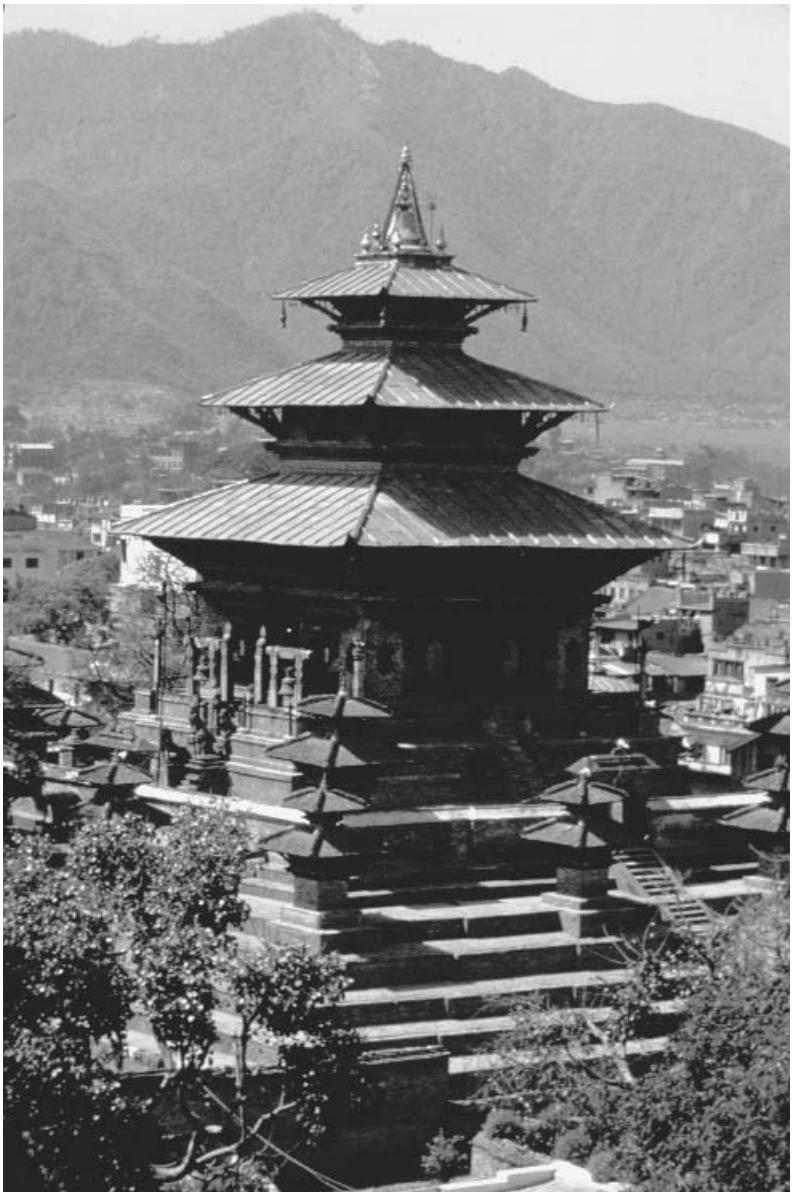


Plate 1.4 - Teleju Temple, Darbar Square, Kathmandu

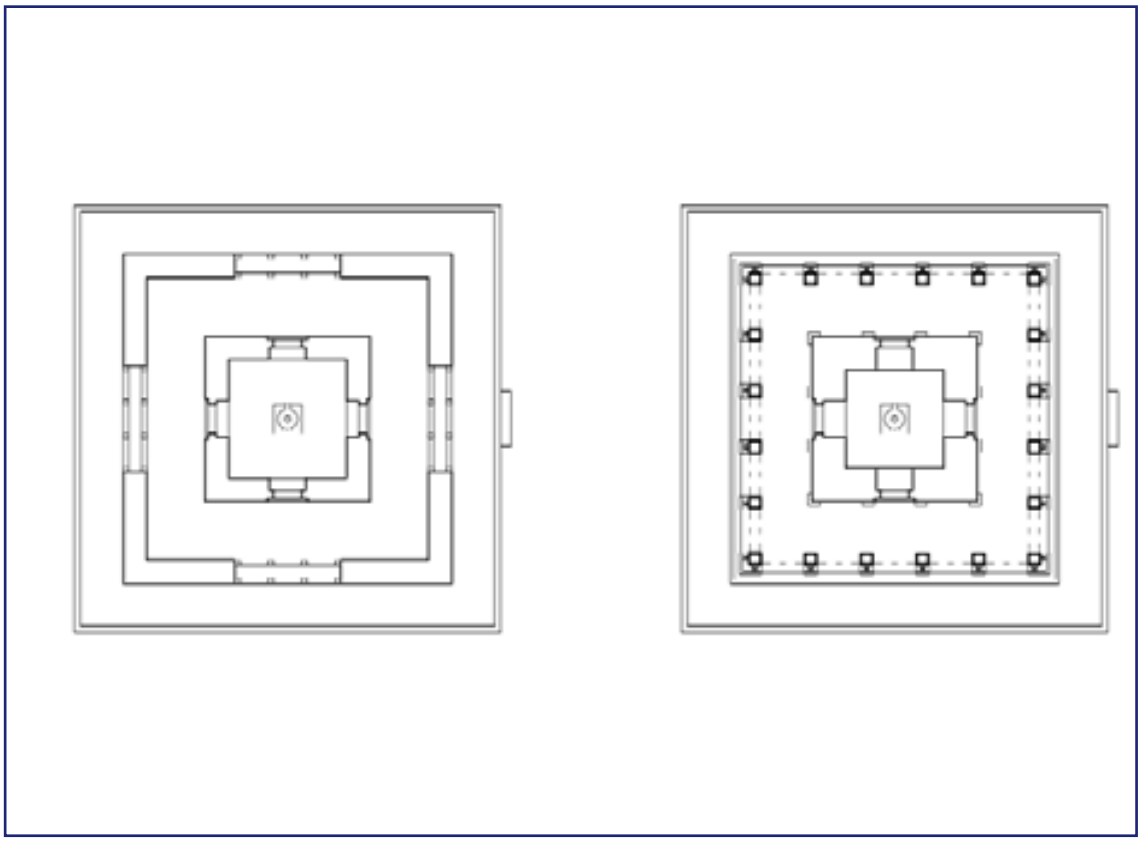


Plate 1.5 - Typical plans of *dega* temples

Some of the most well known temples with traditional features are Changu Narayan, Taleju in Kathmandu, built in 1576 and Kumbheswara in Patan, built in 1392 and entirely renewed at the end of the 16th century. Among the best examples of temples with a peristyle are the Maju *dega* temple in Kathmandu (Plate 1.6), the Biswa Nath in Patan and the Nyatapola in Bhaktapur. This latter example demonstrates the maximum stylistic and technological evolution of *Newar* artists. It is in the construction details that there is a difference between the *dega* temple and the Chinese and Japanese pagodas *"Nel tempio nepalese i componenti strutturali sono essenzialmente impiegati per assicurare la stabilità statica, quindi ne deriva una forma essenziale di facile lettura e di determinazione architettonica. Nell'architettura cinese si osserva invece una forte componente estetica nel risolvere la soluzione statica, rispetto alla quale prevale fortemente il risultato formale accentuato dalle notevole accentuazioni simboliche e dai virtuosismi compositivi"* (12).

Continuous contact with Hinduism in Nepal lead to the evolution of the *shikhara* stone temple. Over time it developed its own distinct morphology and style. Subsequently temples built, in a mixture of Hindu-Islamic styles, were built and dedicated to the Radha-Krishna cult, noteworthy for their galleries and balconies. Two examples of this type of temple are found in Patan. In the pictorial and sculptural fields of art there were also many developments during this period.

The *Newars*

The birth of the *Newar* style of architecture also arose from the technical and organisational skills of *Newar* society, considered to have originated in the Kathmandu Valley and from which the style got its name. From its origins, this society, present on a large scale in and around the Valley, created sculptural and architectonic works of high quality. Among them are the admirable examples found in Changu Narayan, Pashupatinath, Chabahil, Swayambhu, the most significant remaining one being of the Licchavi period.

When the Malla dynasties first arrived in the Valley around 1200 A.D. *Newar* society was included in the Hindu cast system and many of them became Hindu. The most direct consequence of this change was the gradual specialisation of activities carried out by the different clans, who maintained and often improved their skills and traditions over time. Among them, Awal, Maharajan, Silapakar, Shakya, Prayapati families historically worked on production and building of different elements of construction using clay, wood and stone of the Valley. These family names soon became synonymous to the activities they were involved with.

Malla dynasties gave them plenty of space for self-expression. During the 500 years of their reign it was possible for the *Newar* people to improve and direct their expressive skills towards specific objectives. They became highly specialised in both arts and crafts and passed down all their knowledge in *Newar* working technologies and construction systems by word of mouth from father to son.

The most beautiful works of architecture, like the Nyatapola in Bhaktapur and Khumbeswara in Patan, were built during the 18th century. Over the years maintenance and conservation became an important activity of *Newar* workmen who repaired, and replaced parts of these buildings and even reconstructed them totally.

The *kuldeuta* (deity guide) of the *Newar* workmen is Vishvakarma for the Hindus. Vishvakarma is referred to in the Mahabharata as *"Master of a thousand handicrafts, carpenter of the gods and builder of their places divine, fashioner of every jewel, first of craftsmen, by whose art men live and whom, a great and deathless god, they continually worship"*. Bernier further explains that "*He has always been the patron deity of craftsmen in Nepal, and the facade of his temple in Patan is completely covered over with metal repoussé for which his charges are famous. It is the only temple in Nepal that is decorated to such a degree with metal*". Also the Hindu reference texts used by the 'architects' (*sthapati*), the known Vastu-Sastra, from which the wide Nepalese version, called Manasara, comes from, are said to be revealed by Lord Viswakarma. "*A guide for craftsmen employed in building, the Manasara is one of the thirty-two Silpasastras that were first revealed by Vishvakarma, Lord of the Arts and Architect in the Gods*" (13).

This manual precisely expresses the rules for drawing and production of every object. For architecture, it specifically describes the proportions that have to be respected for every building or statue, but it also specifies the methodologies and religious techniques adopted when constructing the cities.

The Nepalese people celebrated and continue to celebrate today Vishvakarma in their houses and shops, and during the nine days of *Durga* Puja: "*The god Vishwa Karma, the Great Carpenter, producer of all implements, tools and mechanical things, large and small, inventor of handicrafts and the arts, is propitiated, when factories, workshops and all tools must remain idle*." (14).

The Nepalese Buddhist craftsmen, not linked to Hindu rituality based on sacrifices, consider Viswakarma as a great *bodhisattva*. In the monasteries where they used to study, they not only learned how to improve their skills, but also studied sacred texts of Buddhism, in particular the Sastra and the eight skill of learning, the Ashtadasha Shilpa Vishya.

Plate 1.6 - Maju *Dega*, Darbar Square, Kathmandu

New styles

With the conquest of Kathmandu Valley by the Prithvi Narayan Shah (1756-57) a new historic stylistic period started, the Gurkhali period. In parallel to the continuing development of the *Newar* style that had become manneristic and sometimes eclectic, the Hindu Islamic style developed with the reconstruction of many new palaces and temples. Hanuman Dhoka, for example, many parts of the ancient Kathmandu Royal Palace were replaced with this new style. Many temples have cupolas and external walls plastered with forms typical to the late Islamic period (Plate 1.7).

Plate 1.7 - Jang Hiranya Hem Narayan temple, along Kathmandu *ghat*, 19th century

On an urban level there have also been many restoration and refurbishment projects. With Rana family coming into power further development in this sector can be seen around the middle of 19th century, with the construction of fountains, gardens, streets and in particular new palaces. They started an isolationism policy, closing the borders to foreign visitors while maintaining a strong relationship with Great Britain. British influence took into account the habitual practices and customs of the powerful Rana family, who in turn were influenced by the fashions of the architectonic models that had already been established in India, in particular of the neo-classical style. The Kathmandu Royal Palace was renewed in this style. New residences were built, surrounded by greenery. Even in the cities, many buildings modified their exterior appearance to accommodate this style that became well established and a symbol of power of the family who had dominated the country over the entire century. It drew to a close the character that had for centuries distinguished Nepalese architecture, example of which can still be seen today. Next to the typical *Newar* and Malla structures we find neoclassical palaces that, at the time, helped to develop some of the construction sectors that had until then not been used very much (Plates 1.8 and 1.9).

Plate 1.8 - Royal Palace, partly renewed in the 19th century, Kathmandu

This situation gave rise to a period of standstill and revolution where many people who were not protected or isolated from royal influences, were forced to change their type of work. Others succeeded in generating a revival by heading towards the Terai region in the south, where they had plenty of resources for the new needs. The typical style of the Rana period, with the use of white plaster, developed as a result of the direct links with the Indian border where workmen and the basic material, lime, were more readily available.

Because of the independent status of the Guthi class, *Newar* wood and clay craftsmen working for public building projects, kept busy during this period by maintaining temples, repairing or totally rebuilding parts or entire buildings ruined over time or by the weather or earthquakes. Non specialised workmen were occupied in other types of construction including road and bridge improvement projects.

Others started or continued their trade with neighbouring countries, in particular Tibet, where metal craftsmen for example, used to export big quantities of religious works linked to Lamaism, a religion particularly dear to them. These clans were more often from Patan, the most Buddhist city of the Valley and they still occupy many wards of the city, giving it its distinctive character.

When China and Tibet borders were closed and the pass where one could cross frontiers moved to Sikkim, many traders were badly affected, forcing people to go back to making house tools or to work back in the fields, activities that the *Newar* people had never stopped doing altogether.

Plate 1.9 - Singha Darbar built in 1903 Kathmandu

Recent developments

Only when the monarchy was restored in 1951 was there a slow and unexpected return of interest for the original Malla architecture and the need to safeguard cultural values of the past, that fascinated all first time travellers to Nepal. Nepal had started to emerge from the isolation it had experienced over the previous two centuries.

These historic events have resulted in a continuity within the *Newar* cast system that is now based on trade demands rather than tradition. This has been particularly true for larger towns like Kathmandu, which had always been linked to trade rather than historical tradition. Similarly villages like Bungamati, whose links with the big centres, have always been its major source of profit.

For other bigger urban towns like Patan or Bhaktapur, the emphasis on trade has always been limited to small groups, leaving the historical and traditional influence directed towards the most sought after works. A certain continuity and influence can be seen in some clans while others have experienced certain changes. The stone carvers and metal craftsmen of Patan, and brick and terracotta workers in Bhaktapur and Thimi were positively affected by these historical events as were the wood carpenters in Bungamati. People from Bungamati however, had to adapt themselves to new trade demands and their development can only be traced back two generations.

As confirmed by Toffin (15), the *Newar* cast system is organised according to different specialised activities with the possibility of interchanging between different skills and activities so as to meet needs and trade demands.

Marcel Le Port (16) comments on the importance of collective and cooperative work. Craftsmen who have to work together should not be too specialised and limited in their skills so as to encourage development of a cycle where experts can improve their skills in domains that they would not traditionally be involved in. Near to the Kathmandu area, which has recently seen a lot of immigration and where it is often very difficult to earn an adequate income from traditional trades, this opening towards the outside has become very positive and creative.

Other places like Thimi, Bhaktapur or Patan, remain very much linked to the old casts and for this reason can become a point of reference for the technical and historical development of traditional architecture.

Silapakar families of Bhaktapur are the same today as those who traditionally worked in this field of work with wood and they still hold the same name. In Patan, from Shakya to Tamrakar, the stone carving and metal working tradition is the most intact, providing for all the Valley's trade demands. In Patan there are only three or four Silapakar families. Other wood workers found in the city are often from Bungamati.

In Thimi the situation seems to be much more unified and Prajapati families have more or less colonised the entire city, occupying many streets and squares for firing their vases, pots and plates. This has given a unified appearance to the city as a whole. As confirmed by Toffin (17), it seems that every city has a concentration of specialised activities and the presence of a particular craft activity usually prevails.

In this context this publication will look at the different craft specialisations practiced by the *Newar* casts. The new developments that have arisen over time will be specifically examined along with the analysis of the different materials.

Much research has been carried out on the subject, in particular on problems related to restoration of the many important works built in the *Newar* style. W. Korn, M. Le Port, Sanday, Gutshow, mentioned previously, have provided much technical information on the analysis of building technologies and building elements.

In particular J. Sanday (18), who has carried out many important interventions to the Hanuman Dhoka Royal Palace of Kathmandu, did considerable research on materials and *Newar* building technologies as related to traditional craft activities considered essential for the restoration of the Nepalese architectonic patrimony (19).

As will be discovered later in this publication, Sanday's work, besides contributing to the knowledge of craft skills and of traditional building materials, systems and methods has resulted in a revival of some of the lost traditions, which now can still be found thanks to him. Development of an incentive to continue working in a traditional way was his major contribution to Nepalese culture and if experts in the field of traditional crafts are still to be found today, above all around Kathmandu, it is because of his extensive work in this domain which has allowed many people to rediscover old and traditional working practices.

Modern influences have contributed to the revival of Nepal's cultural heritage, with the criteria and methods of intervention being integrated with local traditions as well as modern innovations.

(1) G. TOFFIN, *Les Palais et Les Temples*, Editon du CNRS, Paris, 1993, p. 83.
(2) N.R. BANERJEE, *Nepalese Architecture*, Agam Kala Prakashan, Delhi, 1980, p. 81.
(3) W. KORN, *The Traditional Architecture of the Kathmandu Valley*, Ratna Pustak Bandhar, Kathmandu, 1979, p. 104.

(4) M. LE PORT, *Les Constructions traditionelle newar de la Vallée de Kathmandou*, in "L'Homme et la Maison en Himalaya", Edition du CNRS, Paris, 1981. R.M. BERNIER, *Wooden Window of Nepal,* in "Artibus Asiae", Vol. XXXIX, Ascona, 1977.

(5) N. GUTSCHOW, B. KOLVER, I. SHRESTACHARYA, *Newar Towns and Buildings: An Illustrated Dictionary Newar - English*, VGH Wissenschaftsverlag, Sant'Agostino, 1987.

(6) S. LEVI, *Lé Nepal,* E. Leroux, 3 vol., Parigi, 1905-1908.

(7) Nepali art is primarily religious and sacred art. Over the centuries, it has expressed the faith and ideals of monks, of their protectors (rich merchants, kings, small landowners and their courts) and of the people of the country. M. SINGH, *Arte Himalayana*, Silvana Editoriale d'Arte, Milano, 1968, p. 11.

(8) P. BROWN, *Picturesque Nepal*, Adam & Charles Black, London, 1912, p.127.

(9) M.S. SLUSSER, *Nepalmandala*, Princetown University Press, Princeton, 1998, p. 128.

(10) In Nepal, as is often the case in oriental countries, the art which develops in the country is religious art. It does not have to be judged according to a western point of view in order for its meaning to be understood: Nepalese artists, like their Indian teachers and Tibetan disciples, do not only allow their fantasies to influence their work. By using symbolic forms, they translate their own experiences and visions. They also represent, through images, the complicated ways the initiated can transcend the temporal setting and reach divine and a-temporal plans. G. TUCCI, *Nepal, alla scoperta dei Malla*, Leonardo da Vinci Editrice, Bari,1960, p. 17.

(11) H. GOETZ, *Civiltà dell'Oriente*, Casini, Roma, 1967.

(12) In the Nepalese temple, structural components are essentially used to assure static stability. A pure form that easy to read and has architectonic clarity is therefore derived from this concept. In contrast, in Chinese architecture, a strong aesthetic component resolves the static solution. A formal result prevails, which is emphasised by an accentuation of the symbolic definition and virtuosity in composition. V. SESTINI, E. SOMIGLI, *La pagoda nepalese nella cultura newari*, in "antichità viva", n° 4, Editrice Edam, Firenze, 1996, p.55.

(13) R.M. BERNIER, *The Nepalese pagoda*, S. Chand & Company Ltd, Ram Nagar, New Delhi, 1979, p. 29.

(14) M.M. ANDERSON, *The festivals of Nepal*, Unwin Hyman Ltd., London, 1971, p. 151.

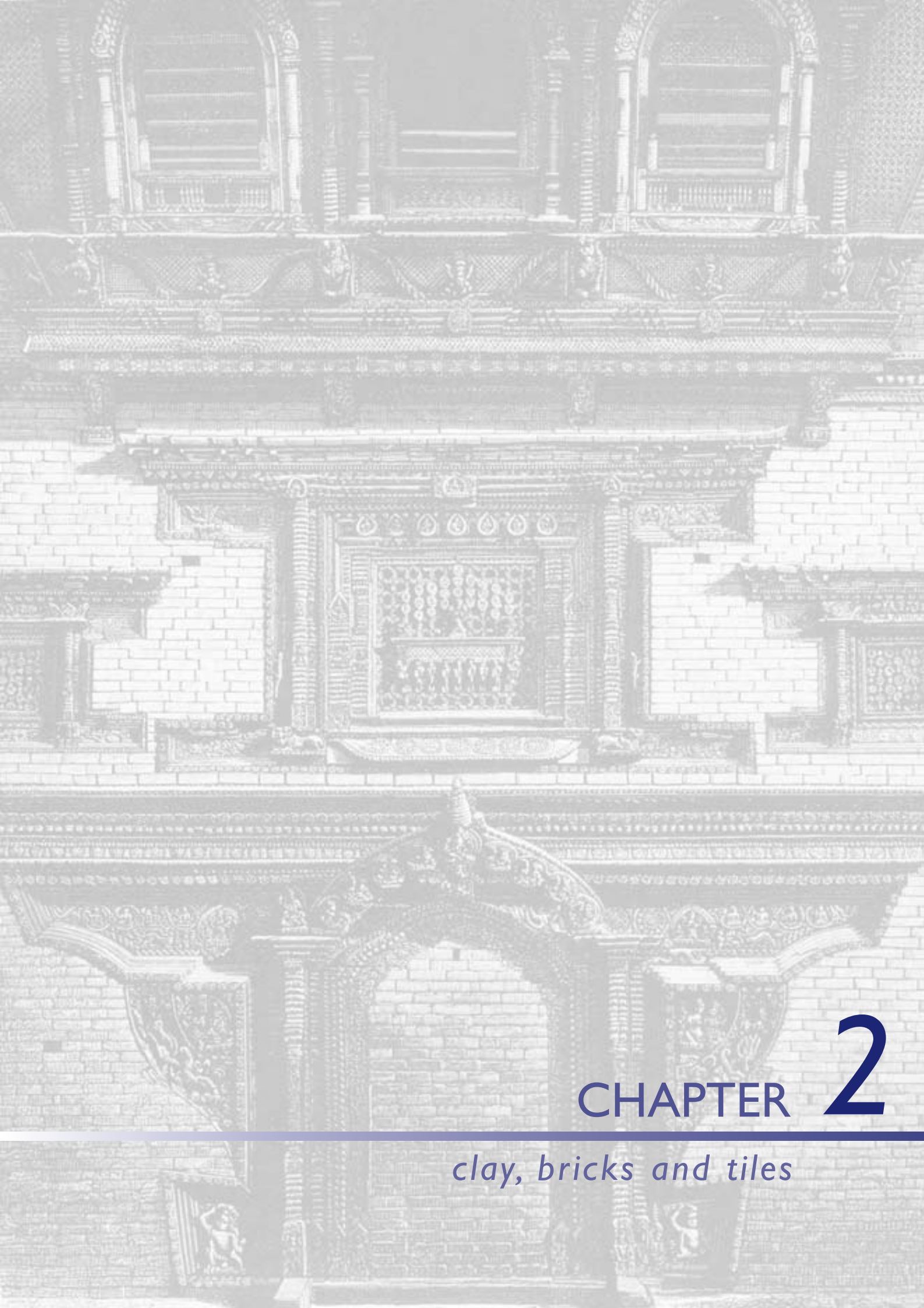
(15) G. TOFFIN, *La comunitè newar*, Edition du CNRS, Paris, 1984.

(16) M. LE PORT, ibid.

(17) G. TOFFIN, 1984, ibid.

(18) J. SANDAY, *Traditional craft and modern conservation methods in Nepal*, in "'Appropriate technologies' in the conservation of cultural property", The UNESCO Press, Paris, 1981.

(19) J. SANDAY, *Conservation of the Hanuman Dhoka Royal Palace 1970-1972*, UNESCO, distr. Lim., Paris, 1973.



CHAPTER 2

clay, bricks and tiles

Typical facade of a *Newar* palace made with bricks and wood

From G. Le Bon, 1886

Clay, bricks and tiles

Brick making and the different production methods used in the Kathmandu Valley have distinguished the architecture for centuries, giving rise to a unique civilisation renowned for its skill in quality building construction.

As compared with other Asian countries many traditional craft practices are still carried out in the Valley giving it its cultural identity and patrimony.

The universal use of fair-faced bricks with their intense colour, visually unifies and gives character to the urban spaces of Nepal. Bricks are used for the construction of palace and temple walls, roofs, pavements in narrow lanes, and streets and squares. Bricks are used for different parts of the building to create different patterns. Their overall use gives a visual continuity to Nepalese architecture.

The types of clay used, the types of bricks produced, the way they are fired and integrated into buildings with resulting improvements comes from the knowledge acquired over many generations up until the present day.

Many authors, among them the well known Father Giuseppe da Rovato, missionary of the Capuchin fathers, Colonel Kirkpatrick and Hamilton visited Kathmandu Valley from the end of the 18th century, until the first years of the 20th century and observed the prevalence of bricks used in the construction of cities. While Father Giuseppe da Rovato limited his observations to generic illustrations of bricks and tiles used in houses, Kirkpatrick noted the good properties of bricks and also researched into why: *"Nepaul in general is remarkable for the excellence of its bricks and tiles, but those of Bhatgong are commonly allowed to be very far preferable to the rest. Certain it is, they surpass any I ever met with India, but it is not equally certain from whence their excellence proceeds. Some of those whom I questioned on the subject, referred it to the nature of the earth used in making them, and some to the water employed in tempering them; while others affirmed it to arise purely from a particular mode of burning them. I had no opportunity of seeing this operation, the success of which, I was told, depended materially on the manner of laying the bricks and fuel, at the time of forming the clump or kiln"* (1).

Hamilton, besides noting the presence of good quality clay, points to the craftsmen's skills: *"The Nepalese possess a great advantage in having excellent clay for making bricks and tiles; and their workmen are very expert. They use moulds nearly of the size and shape of our common bricks, and have also others for the bricks that are used in cornices and other ornaments. For the fronts and ornamental parts of their best houses, they make smooth glazed bricks, that are very handsome. Their bricklayers and masons are also good workmen…"* (2).

Clay, the basic material

There are many types of clay found in the Kathmandu Valley, all with different colours ranging from white to black, and from yellow, red to brown.

From experience and observations it can be seen that these clays are used in different building sectors according to their properties and quality. For common bricks and tiles grey and black clays are most commonly used. Grey and brown clays are best for quality plaster. Grey clays are also used to make mortar, while red clay is used to make paves. White clays (pure kaolin) are used for internal and external paintings, yellow clays for plastering of joints and for mortar used to join trapezoidal-cut bricks (3).

Research carried out to investigate the quality of clay soil used in the Valley analysed the mineralogical properties of different samples taken in different places, destined for different uses. Results showed the presence of Quartz (sand) and Fedspati and a quantity of variable clay substances (silicate of alluminia: in particular Illite and Kaolinite) included between 42% (soil for unfired bricks) and 77% (red clay for paintings) (4).

Some clays are dug from river beds, while others are dug directly from agricultural terraces on hill slopes where a temporary kiln is usually installed near by. Most kilns remain in situ only for a short period of time after which they are dismantled, letting the newly worked soil return to its original state for use in agriculture.

From the excavated clay to the final fired product there is a complex series of tasks for which many specialised tools are required, particularly in the phase of preparation and moulding.

Clay is dug from small ditches (Plate 2.1) no deeper that 2 meters, water is added and the mix is left in situ exposed to open air for about three or four days, after which it is mixed with very sharp sand to modify its plasticity. It is then pounded for some time with a wooden pestle and this mix is shaped in a wooden mould of precise dimensions and shape. (Plate 2.2).

Before firing, the bricks are dried in the open air. They are repositioned from time to time to ensure they are evenly dried so as to avoid cracks forming from uneven shrinkage. In this way the typical common bricks are obtained.

Plate 2.1 - A clay quarry with bricks drying in the open air

Plate 2.2 - Preparation of the clay and its insertion into the mould

The making of trapezoidal-cut bricks, *daci appa* in *Newar,* is more complicated. After an initial rough shape is made in the mould, the definitive shape is obtained by remodelling the brick with a special pestle. For the fair-faced surface, other treatments are carried out, starting with hitting the brick with a wooden fillet (Plates 2.3 and 2.4), and then smoothing with a metal knife. After the bricks are dried the fair-face of the brick is immersed in a semi liquid red clay (5). A different knife is used for cutting bricks (Plate 2.5).

Plate 2.3 - Flattening of the fair-face of the *daci appa* with a mallet

Plate 2.4 - Fair face of brick is smoothed with a knife

Plate 2.5 - Knife used for cutting bricks

The *jhigati* or *djigati* tile is a small traditional Nepalese tile, modelled using a mould that is designed to form a small groove on one face in the longitudinal direction, while on the other face a second groove is made by hand after the tile has been taken out from the mould with the help of some water. The grooves are used to connect the tiles. In some kilns a double mould is used to obtain two grooves at once making the process much quicker (Plate 2.6).

Plate 2.6 - Clay tiles dry in the open air

Bricks with one face with symbolic elements moulded into it in relief are made using negative moulds. The decorative face is retouched and cleaned after it is removed from the mould using special tools designed for the job (Plates 2.7 and 2.8). Tiles used for building hip roofs and the ridge are dried in a bent or angular mould so as to obtain the desired shape.

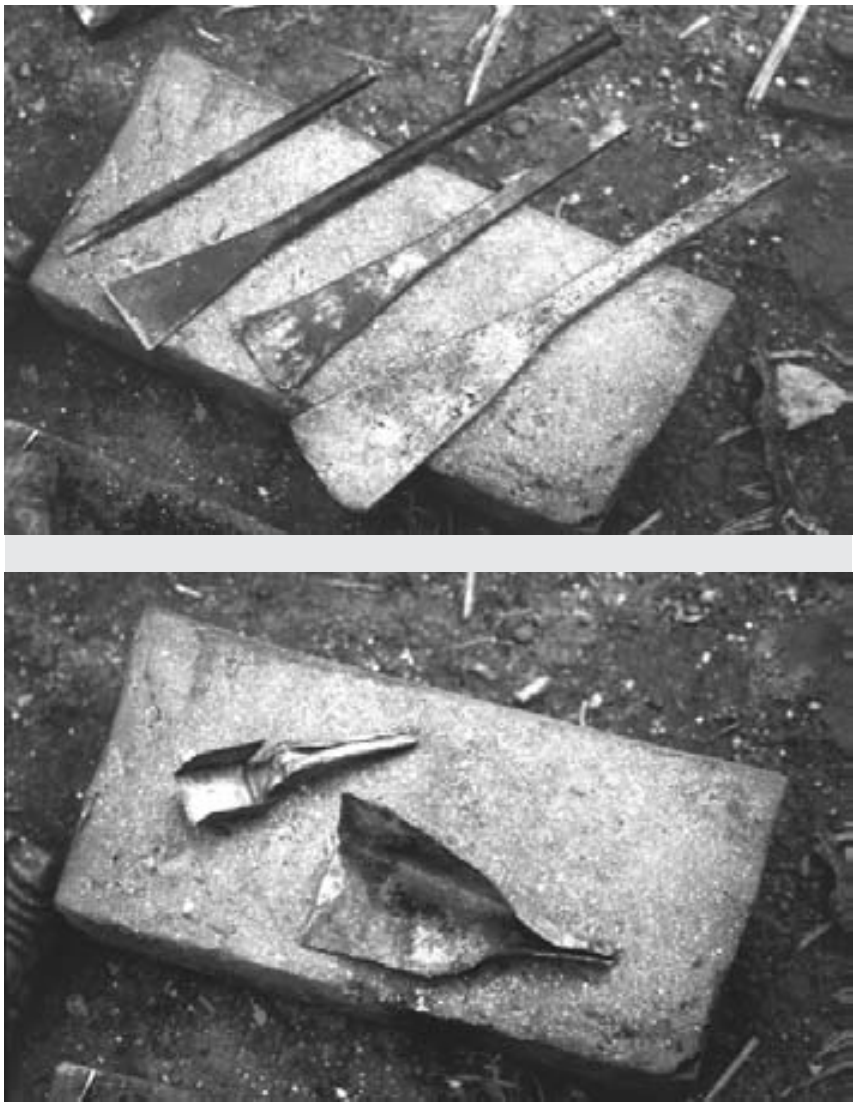


Plate 2.7 - Different tools are used for the final touches to the decorated bricks

Plate 2.8 - Cleaning process

Kilns

Bricks are still fired in traditional kilns. There are two types of kiln typically used: the Hoffmann kiln which has a series of chambers and the Intermittent kiln which has a single chamber.

The Hoffman Kiln

The Hoffman kiln was the first one to use a continuous firing process and rotational fire. It was developed in Europe in the latter half of the 19th century and came to Nepal from India. This kind of kiln has been used in many places around the world.

The Hoffman kiln, used in Nepal and India (Plate 2.9) is different from the European Hoffman kiln for two main reasons. The individual sections are all open to the sky, and the smoke stacks for dispersing the smoke are movable and always placed in the section after the fire. The kiln shape is rectangular with semicircular ends and has a series of more than ten interconnected sections, each one accessible from outside. A big mobile iron sheet separates each section which is loaded with unfired bricks (chambers 16 to 20).

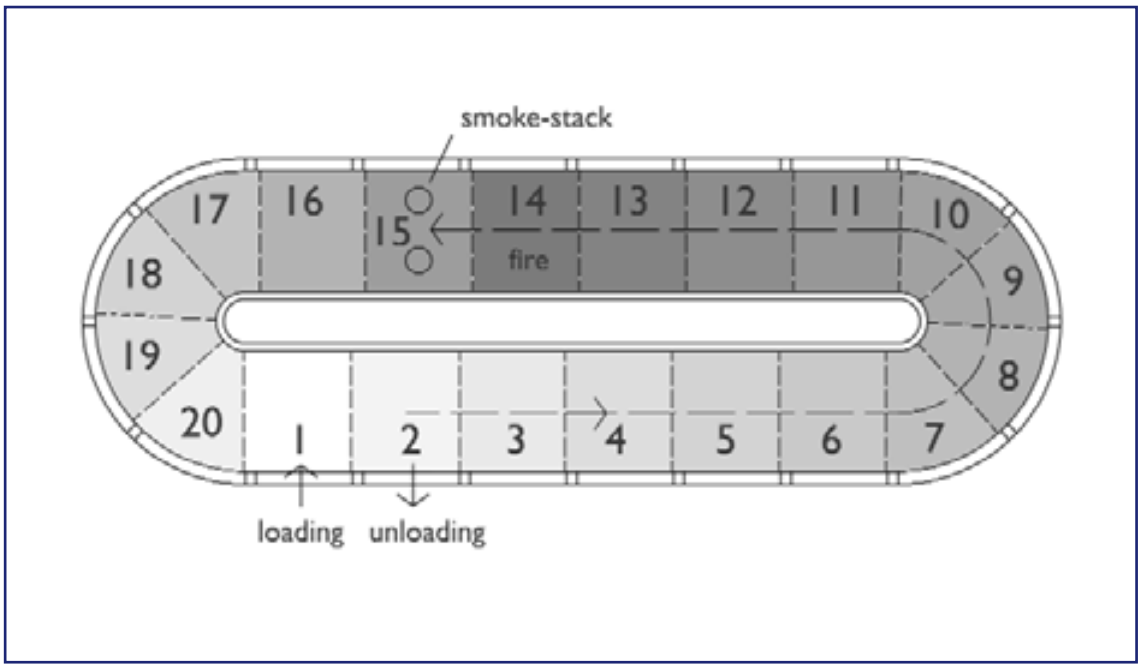


Plate 2.9 - Hoffman kiln

The raw materials are put inside a chamber, for example chamber 1, in such a way as to enable the heat to reach all the bricks. The top is closed with a layer of fired bricks, soil and pieces of bricks to insulate against heat loss. Air from outside comes into this section and is drawn towards the smoke stacks (chamber 15), crossing the burnt bricks in the chambers in between (chambers 3 to 13), cooling the air down. While unfired bricks are being loaded into one section (i.e. chamber 1) the newly fired bricks are being unloaded from the next section (i.e. chamber 2) (Plate 2.12).

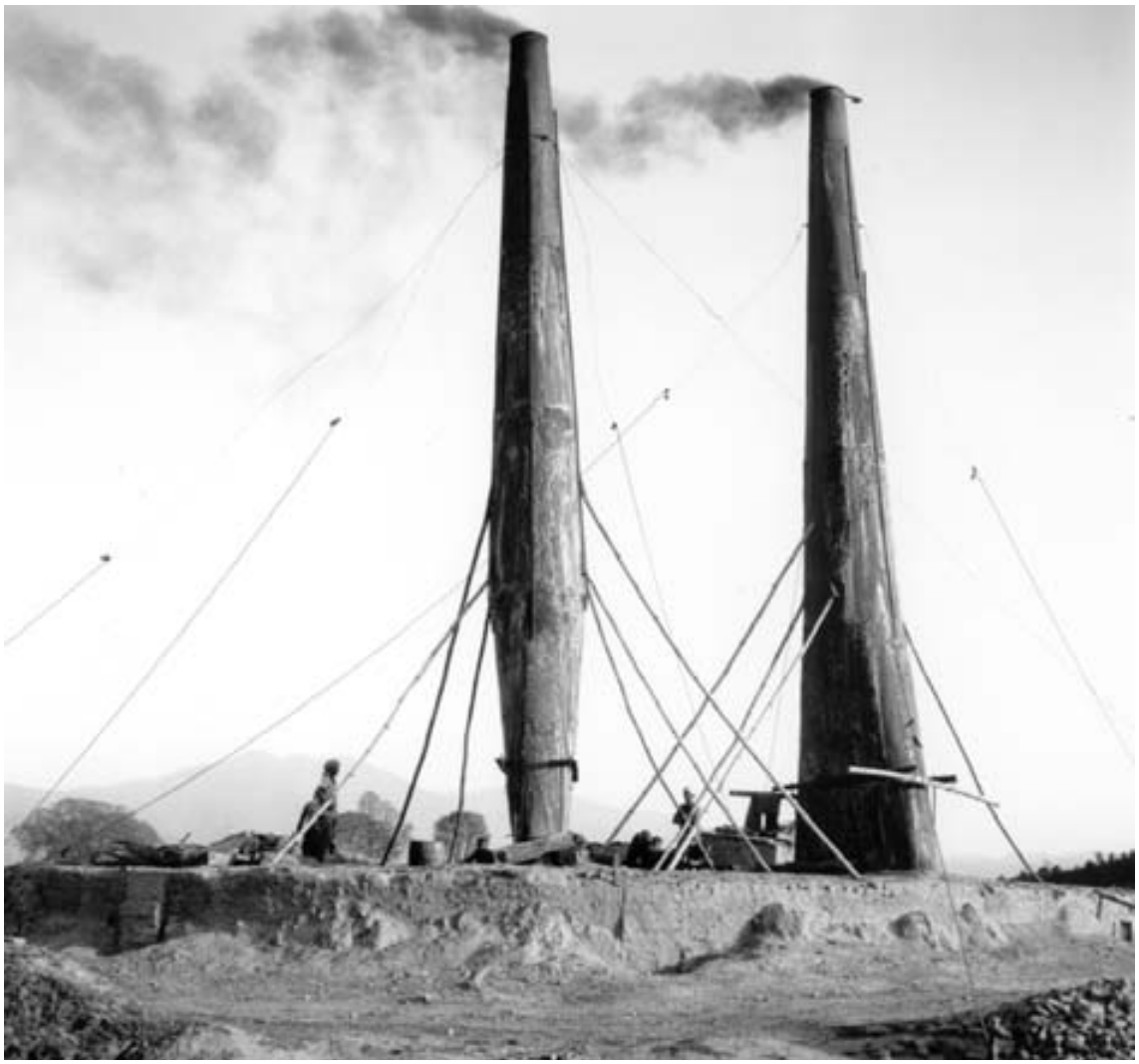


Plate 2.10 - Hoffman kiln chimneys

The fire is lit from above through holes that are covered with metal cups in which coal powder is put (Plate 2.11). Smoke comes out through two tall chimneys placed in the section next to the one where the fire is. In this way heat carried by the smoke preheats the material to be burnt. These chimneys are cone shaped and made from steel sheets (Plate 2.10). They are fixed in place using metal tie beams and are moved everyday to the next bay. The firing time in every section lasts one day. The complete cycle lasts as many days as there are sections. This type of kiln is the most widely used in Nepal and is normally used for the industrial production of standard bricks.

People who work in these kilns generally come from lower casts and have often emigrated from India looking for work. The brick quality is low and there is no great need for technical knowledge to proceed in the production process. An exception to this general rule is a kiln near Thimi where they make special bricks produced for a variety of different uses.

Plate 2.11 - Loading coal into a Hoffman kiln

Plate 2.12 - Loading bricks into a Hoffman kiln

During the dry season in the Kathmandu Valley hundreds of kilns can be seen dotted around the rice fields. The majority of them are taken away during the monsoon season so that agricultural production of rice and wheat can resume. Some kilns remain open during the monsoon period, but they are more involved in selling than in production of bricks.

The Intermittent kiln

The Intermittent kiln is a much older type of kiln (Plate 2.13). Fuel (straw, wood, coal) and the material to be fired are loaded into the kiln at the same time. The fuel is lit, the bricks fired, the fire extinguished, the bricks cooled and finally unloaded (Plate 2.14). This type of kiln is also open to the sky but has a single chamber, on a rectangular base, enclosed by thick walls. All the material to be fired and the fuel is loaded through a big door situated on one of the smaller sides of the chamber. After loading, the door is closed up with fired bricks and the top of the kiln is covered with a brick and earth layer.

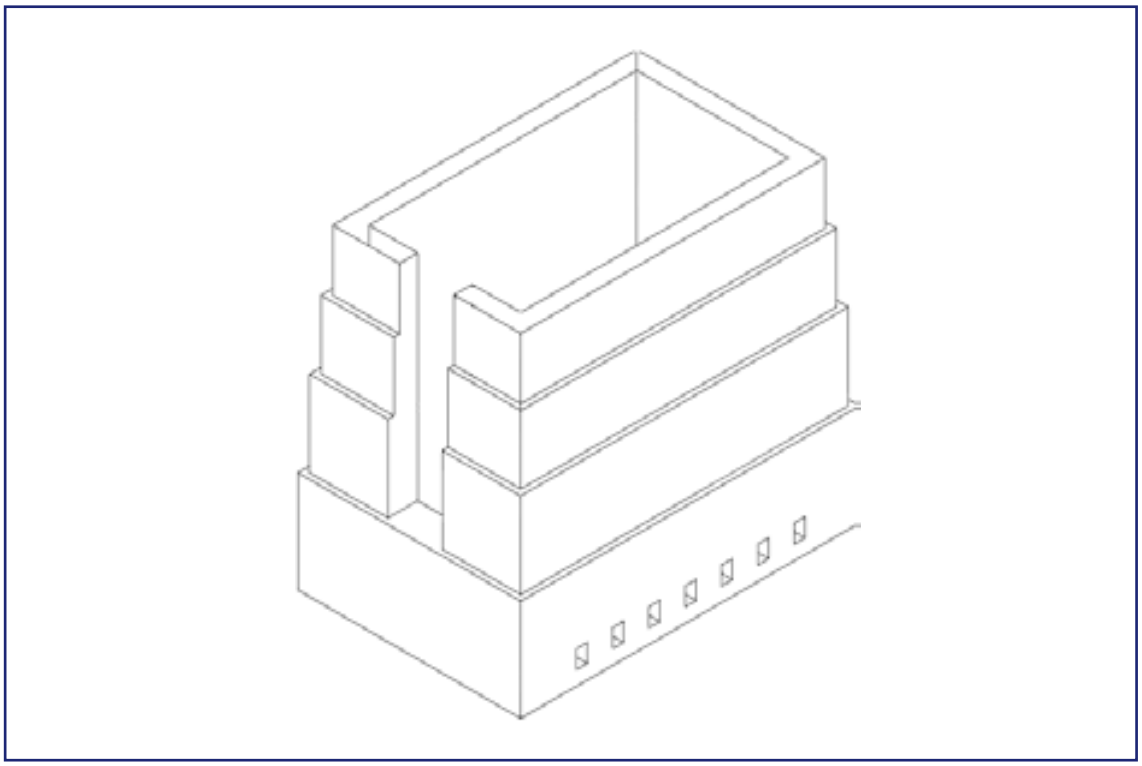


Plate 2.13 - Intermittent kiln

Light is let through small openings in the bottom of the wall. Firing can last a very long time. The kiln is pyramid in shape, and has tapered walls that get thinner towards the top. Inside the walls there are niches where oil lamps are placed, one of these niches is bigger than the others and is where Lord Vishvakarma, the *kuldeuta*, deity guide of most of the working clans is placed.

This type of kiln which is less common, is generally only seen in the most traditional contexts and it is usually traditional *Newar* families who work in these kilns. They know all the production processes and are able to produce, besides the normal bricks, pieces used for frames and friezes, as well as special elements for roofs and pavements. The results are generally of a very high quality.

Plate 2.14 - Bricks are unloaded from an Intermittent kiln

Types of products and their applications

There is no standardised brick dimension used in Nepal, which often results in uneven wall thicknesses. (6). Walls are traditionally built by constructing two brick leaves, one external visible leaf and one internal leaf built using common bricks. The space between the two leaves is filled with a mix of clay soil and pieces of broken brick. The same type of earth used to make the bricks is used to fill the gap between the two walls (7).

Fair-faced external wall leaves are built using a regular bond with small displaced joints obtained using a special brick, the *daci appa*. The use of the *daci appa* brick is a typical feature of external walls found in the Valley. They have very thin joints for aesthetic and technological reasons.

The technological reason arises from the necessity to ensure good resistance against water penetration during the abundant monsoon rains. The joints are carefully filled with a special mortar called *silay* in Nepali, made from oil, vegetal resin and red clay (8). Emphasis on the aesthetic value of these bricks is obtained by applying particular treatments to the visible part prior to firing (Plate 2.15).

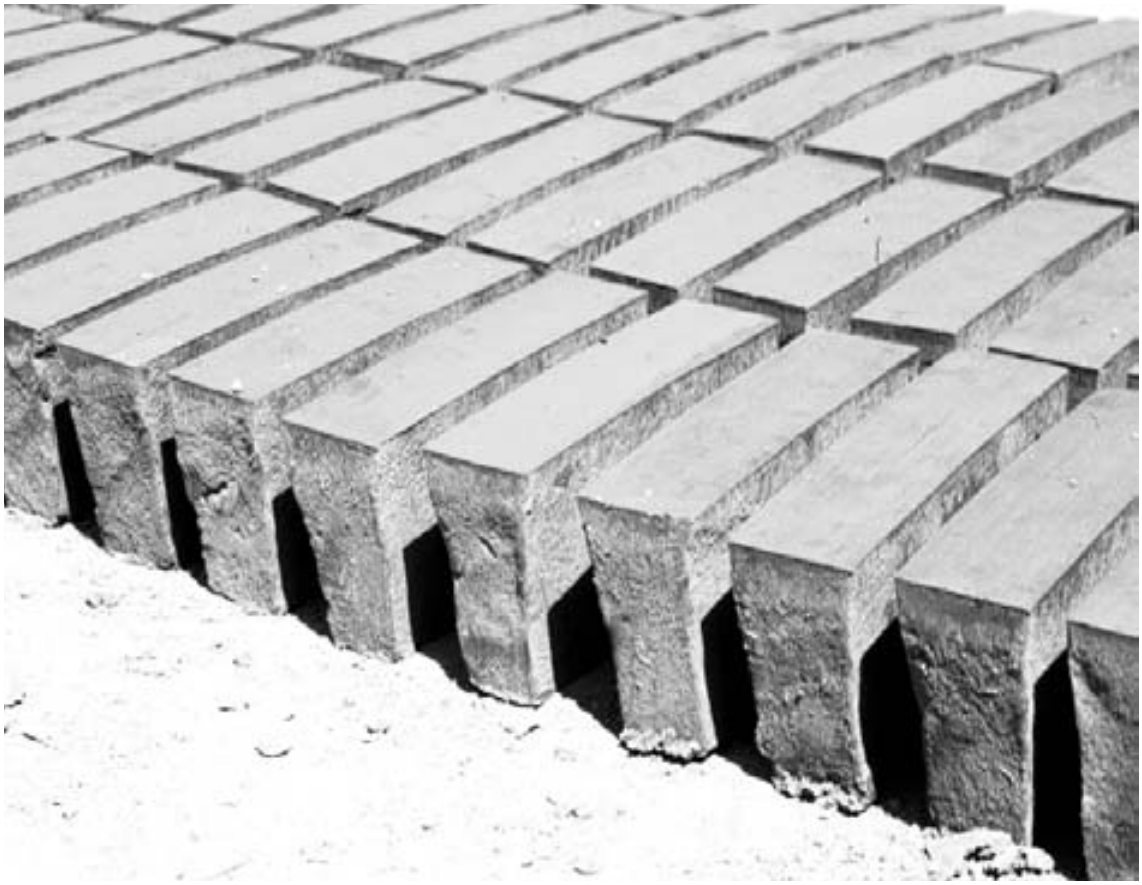


Plate 2.15 - *Daci appa* bricks dry in the open air

The specialised skills required for restoring or reconstructing old buildings has led to the revival of distinct decorative elements, often with compositions of floral and zoomorphic symbols used to make up frames and friezes on the floors and in in the houses. These complex frames found in religious architecture need to be very carefully assembled following a precise sequence (Plate 2.16).

Plate 2.16 - Bricks used for frames and other decorative elements

Other building elements with a specific use like the top frames of windows and doors, the frames in a typical *Newar* house (Plate 2.17), the support of the roof corner pillars and many others are decorated with symbolic images that generate the typical *Newar* style of architecture. Fired bricks with symbolic motifs in relief are also used in the construction of base plinths of temples and the *dhara* type fountains.

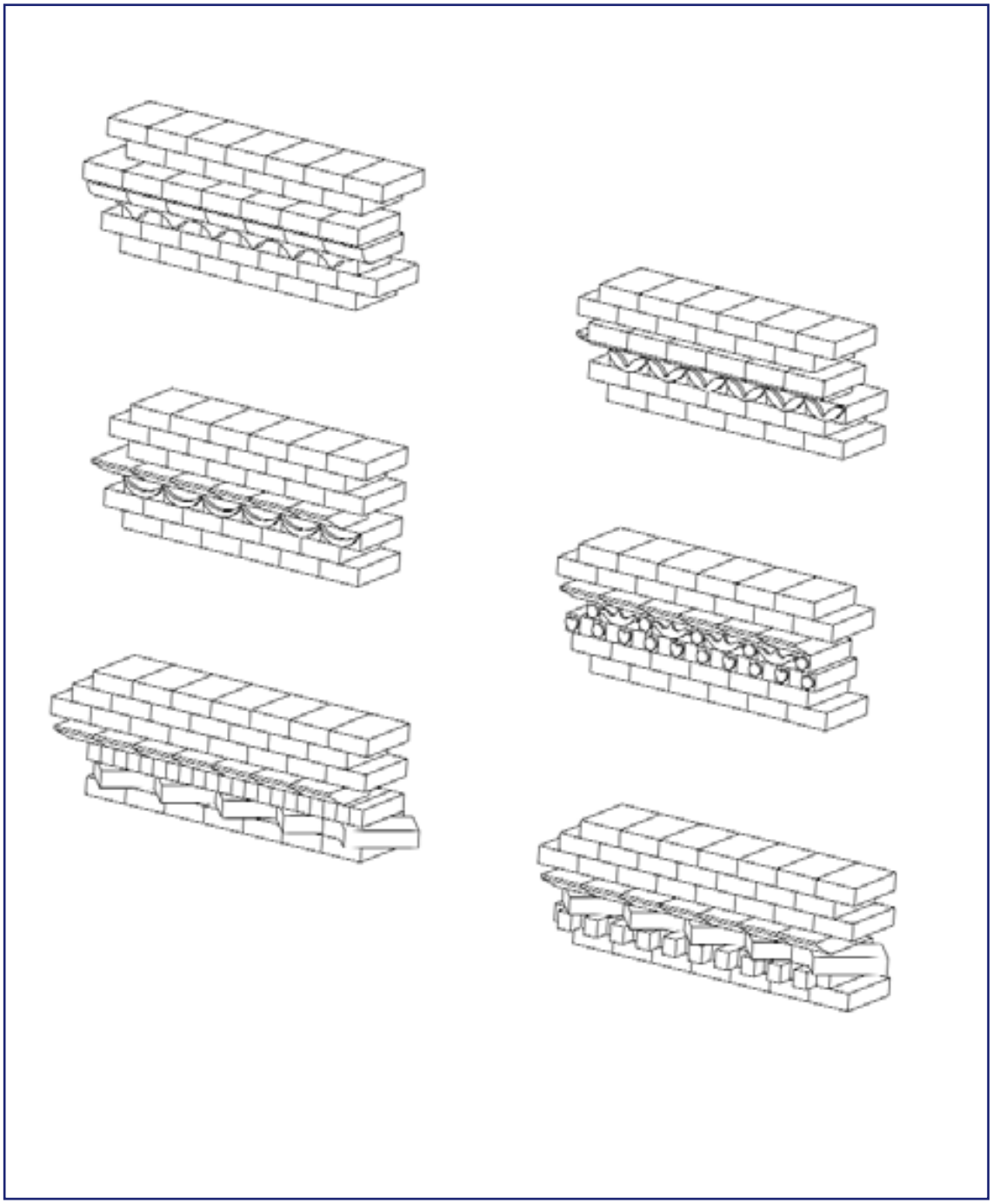


Plate 2.17 - Frames in a typical *Newar* house

Apart from the decorative bricks that are inlaid into fair-faced brick walls, there are other plainer bricks used for laying pavements. These are usually square, triangular or rectangular and laid in different patterns. They are mostly found in the pavements of old roads or inside monasteries, palaces or common house courtyards. Rainwater drainage canals on the roadsides are also made using these plainer bricks (Plates 2.18 and 2.19).

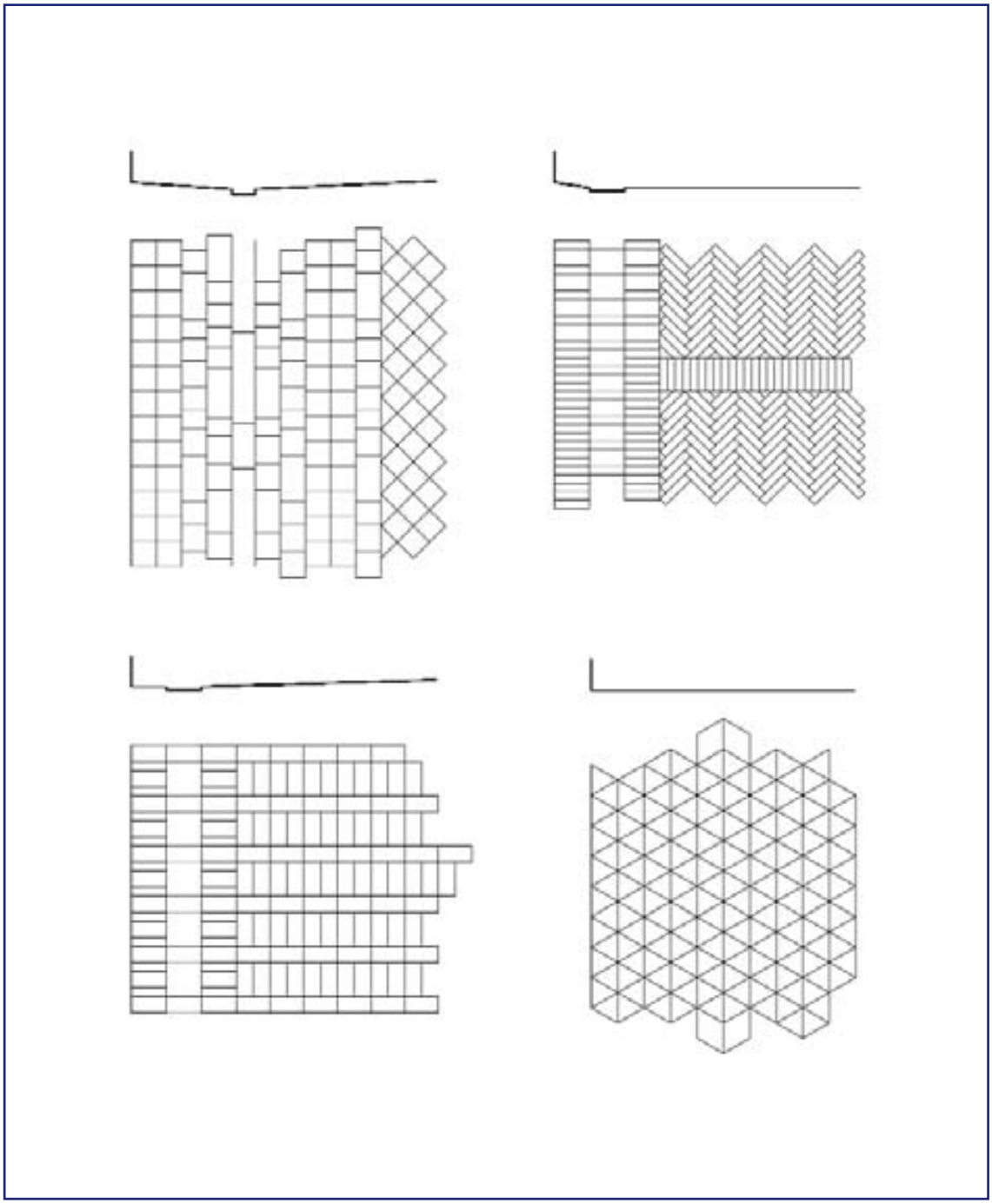


Plate 2.18 - Typical composition of bricks found in pavements

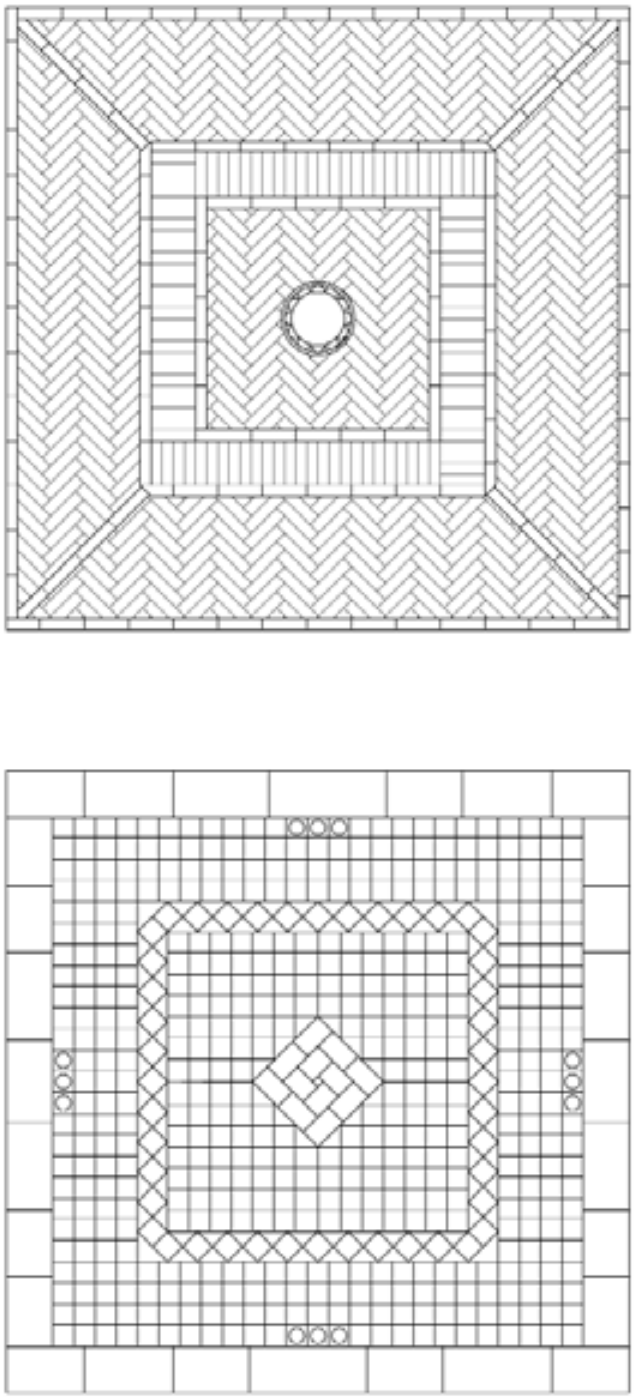


Plate 2.19 - Typical composition of bricks found in ritual platforms

An important group of bricks is the one used for tiling roofs (9). The tile shape drew the attention of father Cassiano da Macerata: *"Tutte le case sono coperte da tetti, e gli coppi sono particolari, havendo la grossezza d'un dito, larghi 8 dita, e lunghi circa un palmo, hanno un incavo al di sopra di un lato, et un altro al di sotto dell'altro fianco in questa forma mediante gli quali incavi si legano gl'uni cogl'altri"* (10). A similar observation was made by Hamilton: *"The tiles are flat, of an oblong form, and have two longitudinal grooves, one above and another below, which fit into the adjacent tiles, and the whole are put on with great neatness"* (11). Other elements commonly used in roof construction are the specially designed bricks used for the ridge tops and hips (Plate 2.20), as well as those designed to be inserted at the end point of the hip at the level of the eaves. These often have a zoomorphic shape and give Nepali roofs their distinctive character.

Plate 2.20 - Typical roofs of small *Newar* temples, Taleju complex

Ceramic glazed tiles are found in some buildings and are usually decorated with geometrical shapes. They originally came to Nepal from India and have usually been added to the original building work at a later date. They are typically fitted during festivals when the temples are renewed. There are many examples of this type of ceramic glazing notably in the temple in Swayambhunath near the big *stupa*, and the external walls of the Macchendranath temple in Patan (Plate 2.21).

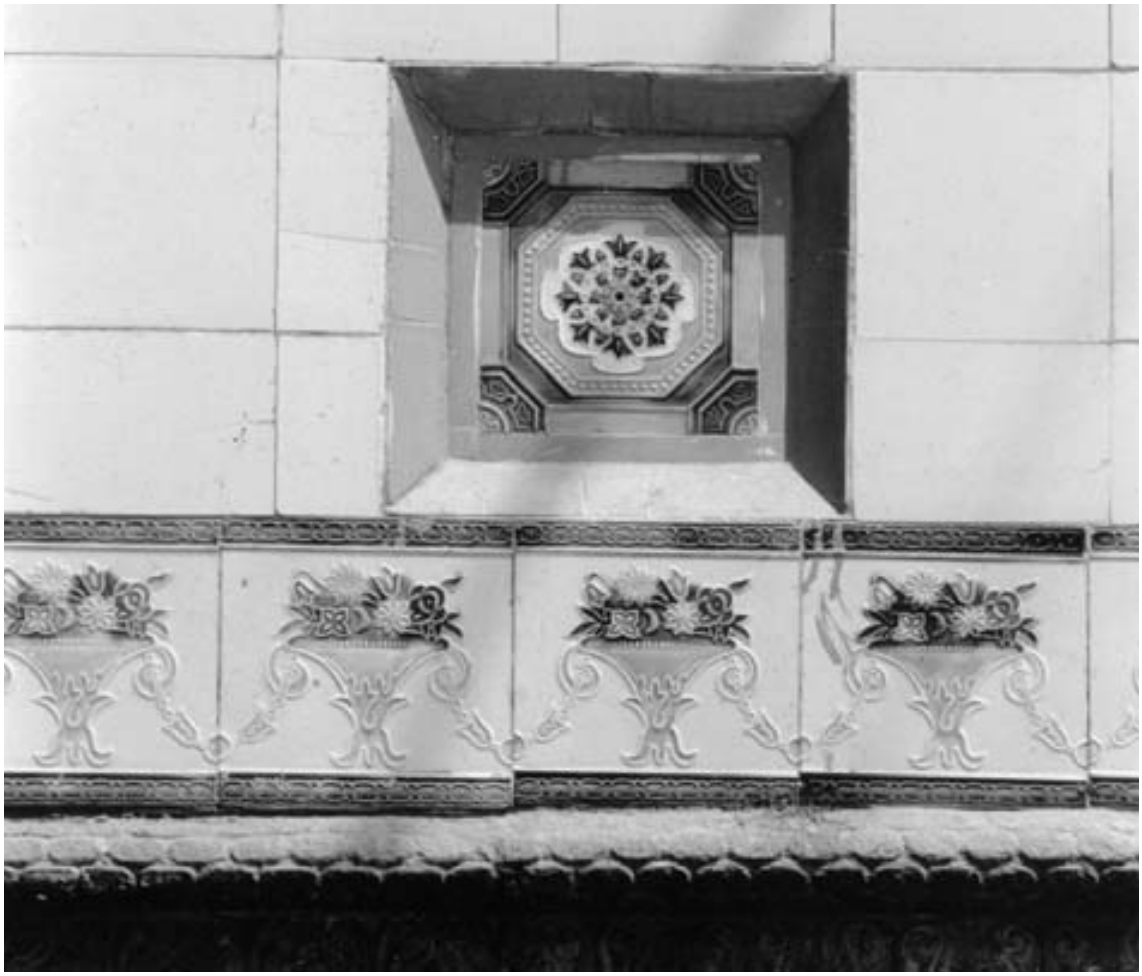


Plate 2.21 - Ceramic tiles on the external walls of the Macchendranath temple, Patan

The abundance of the right variety of clay, together with the craft capabilities of some families has resulted in the extensive production of *terracotta* objects. *Terracotta* is particularly common in the city of Bhaktapur and in nearby villages like Thimi. Many streets and squares are used an open-air workshops where clay is mixed by hand and modelled according to the types of products in demand. These are then left to dry in the open air and fired in rough ovens set up in the same squares. The majority of these products are for domestic use: pitchers of different sizes, pots for water, garden vases, and other types of wares (Plate 2.22). Most of these products are modelled by hand using a manually operated lathe.

Plate 2.22 - Terracotta pots dry in the open air, Pottery square, Bhaktapur

As with firing this type of work is typically done by men. Women decorate the *terracotta* pieces and move them during the drying process. They also colour them by putting the pieces in the same watered down red clay mix as that used for the fair-faced bricks, *daci appa*.

This production process takes place outside and alongside the drying of rice. It gives character to the public spaces in the villages, towns and cities of the Valley during the different seasons. The similar colours found in urban and rural architecture gives it visual uniformity. In this way the architecture is integrated with the environment giving scope for continuous preservation of the architecture while maintaining a harmony and visual continuity with its surroundings.

The traditional craftsmen

Industrial brick production today is not concerned with tradition, but primarily with trade and is a seasonal activity. Different people participate, often without any specialised knowledge. Kiln owners are the only people who are really able to closely follow tradition, but their knowledge often focuses upon economic returns rather than quality, which is considered to be less profitable. As a general principle when buying bricks one goes to bigger kilns to find cheaper products and to smaller kilns to find better quality. A difficult element to be made for example is the *daci appa* brick. Production of these types of brick will most commonly be found in small traditional kilns. But high quality bricks of this kind are only really used for good restoration projects of old traditional buildings like the one found in Bhaktapur. Bhaktapur municipality had an initiative to make available to people the *daci appa* so they could build quality facades for the new houses. In other cities, however, similar projects have not been instigated.

The Thimi kiln

While talking to the owner of the kiln of Thimi, the biggest in Nepal for special brick production, information was collected about the work process involved and the people who worked there.

The kiln has only 25% of the land in property and the rest is rented from the landowners who use it for paddy fields in the monsoon season. Every year the dimension and position of the kiln changes according to production requirements and availability of capital. Production time lasts for 6 months during which all the workers live in small huts built using unfired bricks and roofed with galvanised corregated iron sheets. Employees change from year to year with only very few people returning to the same kiln the following year. Some stay on to teach the new recruits how to work but even if the owner would like to retain the same people the following year they can never be sure. About 300 people work in the kiln. Most come from India and from remote areas of Nepal.

Usually the whole family come to work at the kiln so children can stay with both parents and women can work near their husbands, earning enough money to last the rest of the year. There is no discrimination against women who do the same work as men. Work is paid by piecework, shifts generally lasts 10 to 15 hours per day. There is no kitchen near the kiln and everyone caters for themselves with respect to food, though sometimes the owner may buy rice for them. Every family can cook food both up at kiln and in their shelters.

Generally the *kuldeuta* (deity guide) is Vishvakarma for Nepalese people but at the Thimi kiln, Hanuman is preferred, as many of the workers come from India. There is a place in the middle of the kiln especially dedicated to him and a flag with his image on it is always waving.

The Intermittent kiln is most commonly found in the Bhaktapur region, where they specialise in the production of *terracotta* objects and where there is a long-standing historical tradition in the use of clay. Of the Awal families, only one of them still makes bricks. Many Prajapati families who have the technical know-how to make bricks are more involved in making plates and domestic tools, as the demand for bricks is not high enough. The Awal family was asked directly by the DOA (Department of Archaeology) to continue manufacturing bricks to try and preserve the tradition of brick making. Over the last 30 years there has not been enough work and many people have changed their line of work.

As a result of assistance from foreign countries, however, many of these people have been able to find work in the field of restoration. 20 years ago John Sanday experimented in making different types of brick including the *telia* brick. With the help of two experienced men he was able to produce a brick that was not so very different from those used in the construction of historical buildings. As a result of his excellent work the people of the Valley are once again able to produce traditional bricks. Assistance provided by the German Government since 1971 has also helped reduce the risk of losing this specialised and traditional knowledge that is now currently experiencing a renaissance.

Beside the Awal families found in Bhaktapur and in many other villages in the Valley there are also the Prajapati families, who have great experience in this traditional field of work. Many are working in kilns again. Awal and Prajapati families probably have similar origins and only later differed in the work they did. The most significant thing is that they can intermarry and can have relations that are not strictly endogamous. This has resulted in a relationship between casts developing, an example of a living tradition. One old Prajapati man recounted how they originally came from the East where they used to wear the Brahmin rope. The story goes that when they did a *puja* for Taleju, the deity they were carrying to Bhaktapur, it was necessary to take the rope off. Nowadays they still go to the Taleju temple to pay homage, with pots and dishes as an old worship ritual and they still make pots for Taleju annually. Taleju is the royal divinity dating back from the time the Malla reign was established. They have been working for this deity ever since. There is no written account of their history only stories recounted orally from generation to generation. There are no books, no manuals, no educational institutions, only the experience of individual craftsmen and priests who have passed on their knowledge and skills to their sons. Only the names given to the different bricks remind us that there is no translation to any other languages except *Newar*.

(1) KIRKPATRICK, *An Account of the Kingdom of Nepaul,* William Wilder, London, p. 163. 1811.

(2) F. B. HAMILTON, *An Account of the Kingdom of Nepal,* A. Constable, Edinburgh, p. 39, 1919.

(3) According to Gutshow there are many types of clay used of which eight are described. Their *Newar* names, colours and applications are specified (N. GUTSCHOW, B. KOLVER, I. SHRESTACHARYA, ibid.).

(4) At the Study centre of the Consiglio Nazionale delle Ricerche (CNR) in Florence experiments were carried out on samples of clay (see Appendix 1).

(5) John Sanday, in his preliminary research into the restoration of Hanuman Dhoka Palace, found some traditional techniques for the fabrication of fair-faced bricks on site. On this subject he notes that the bricks called *telia*, which in *Newar* means covered with oil, were used in the Malla period, this technique was later abandoned.

Sanday also describes the process of glazing that results in a very smooth finish on the visible part of the brick. *"The clay used for the glazing is taken from a special stream in a small village on the outskirts of Kathmandu called Hadegaon."* (J. SANDAY, p.23, 1981, Ibid.) After a complicated process it is stored in a godown to mature for several years.

Laca is the Nepali term for the fine red clay used for colouring and waterproofing the fair-faced bricks. It forms a lucid glaze of a typical red colour commonly seen in Nepalese architecture. (N. GUTSCHOW, ibid.).

(6) Dimensions of the different bricks differ according to different authors: Sanday (5.5 cm x 10 cm x 20.5 cm), Gutschow (6.5 cm x 14 cm x 21.5 cm; 4 cm x 12 cm x 19 cm), Le Port (7 cm x 12 cm x 24 cm; 5.5 cm x 14 cm x 21 cm; 7 cm x 14 cm x 21 cm).

Bricks used in the old Royal Palace of Patan measure 5 cm x 13 cm x 20 cm, while newly produced bricks measure 5.5 cm x 11.5 cm x 23.0 cm.

(7) According to Gutshow, two types of clay are used in wall construction: Yellow clay is used as a mortar to join the *daci appa*, while normal clay is used for the inside walls and mixed with pieces of brick.

(8) W.KORN, ibid.

(9) Tile dimensions according to Sanday (1981, ibid.) are, 10 cm x 20 cm, while those mentioned by Toffin are 11 cm x 24 cm (G.TOFFIN, *Toits de tuiles de la vallée de Kathmandu*, in "Architecture, milieu et societé en Himalaya", Ed. Du Centre National de la Recherche Scientifique (CNRS), Paris, 1987).

(10) All houses are covered with roofs covered in special tiles which are a finger thick and 8 fingers wide and a hand span long. There is a groove on the upper face and another on the under side so they can be linked together. L. PETECH, *I missionari italiani nel Tibet e nel Nepal*, parte IV, Libreria dello Stato, Roma, pp. 24-25, 1953-56.

(11) F. HAMILTON, ibid., p. 39.

CHAPTER 3

wood

Wooden pillar from a house in Patan

From G. Le Bon, 1886

Wood

Kathmandu, the modern name of the main city of the Valley: *"is said to be derived from an ancient building, which stands in the heart of the city near the darbar, and which was originally and is still known among the Newars as Kathmandu, from kath 'wood' (of which material it is chiefly composed), and mandi, or mandon, 'an edifice, house, or temple'."* (1). Hence Kathmandu means 'city of wood', as it probably was originally before the destruction of many of the wooden buildings.

The architecture of the Valley typically consists of a combination of a structural wooden frame and masonry or brick walls. Kasthamandapa is an example of a temple built using this system. Kasthamandapa, meaning the wooden house, was originally built during the Licchavi period (3rd - 7th century A.D.) and is considered to be the oldest known wooden building still standing in Nepal (2), (Plates 3.1 and 3.2). The wooden structural system is not always apparent as the wooden components are so decorative and do not look structural. There is intricate carving work on the pillars, brackets, struts, beam frames of the peristyles, window and door frames, of symbolic, often coloured figures. The over all impression is as though sculptural works have been inserted into the walls rather than forming an integral and critical part of the structural support.

An old legend is recounted about Kasthamandapa that says that it was built using a single *Sal* tree, the commercial name of the *Shorea Robusta*, in Nepali *Ograth* (or *Agrakh*), one of the most famous types of *Shorea*.

The combination of wood and brickwork for structural purposes is also found in the multi-storied temples, in the frame system of the peristyle and the wall of the central cell. The central cell is square in plan and made with thick walls that rise upwards giving the building structure its rigidity. The same combination between these two structural materials is also found in *Newar* houses.

This construction system, which gets its aesthetic and structural values from the association between wooden elements and brick walls is commonly used in Nepal and is an original expression of the *Newar* civilisation. The wood structure of Nepali roofs has a very different structural concept when compared with works found in other countries with similar cultures i.e. Japan. *"Infatti il sistema costruttivo che sorregge gli aggetti delle coperture giapponesi è del tipo mensolare, composto da elementi multipli e da travi sovrapposte che consentono alle coperture stesse di avere una forma curvilinea, mentre il sistema nepalese si avvale di puntoni"* (3), which basically means that there are simple elements, whose structural function is immediately apparent.

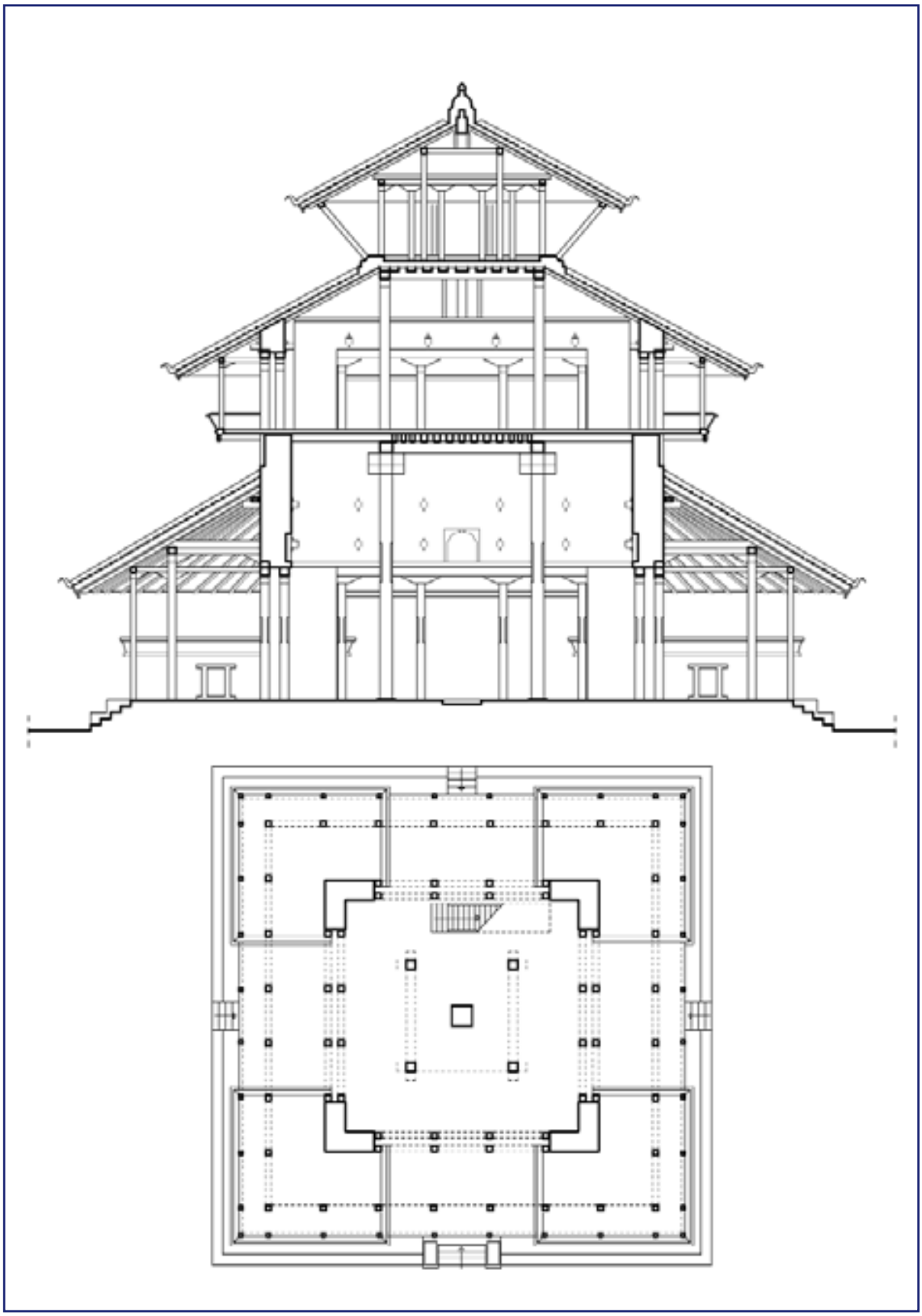


Plate 3.1 - Kasthamandapa, ground floor plan and section, Kathmandu

Plate 3.2 - Wood structure of the Kasthamandapa first roof

Traditional types of wood and their origin

The Terai region, a 26 to 32 km wide broad belt of alluvial and fertile plain in the southern part of the country, is rich in *Sal* and *Sisau* forests (Plate 3.3). Until the last century, this species of tree was also found around the slopes and hills in the Kathmandu Valley. *Sal* is a high quality wood that is very strong and durable. It is used for the construction of structural elements like pillars, struts and beams as well as for windows, doors, grates and mouldings. The trees are big and grow as high as 30 meters, with a broad cross section that allows for very sophisticated works to be produced. A resinous oil is obtained from the *Sal* tree. It is called *Dammura Comune* (*Sal Dhoop*). Sometimes it is dark in colour and called *Dammura Nera*, once commonly used to protect and conserve the wooden structural and construction elements of buildings exposed to open air. Some types of incense, butter and soaps are also obtained from the same oil.

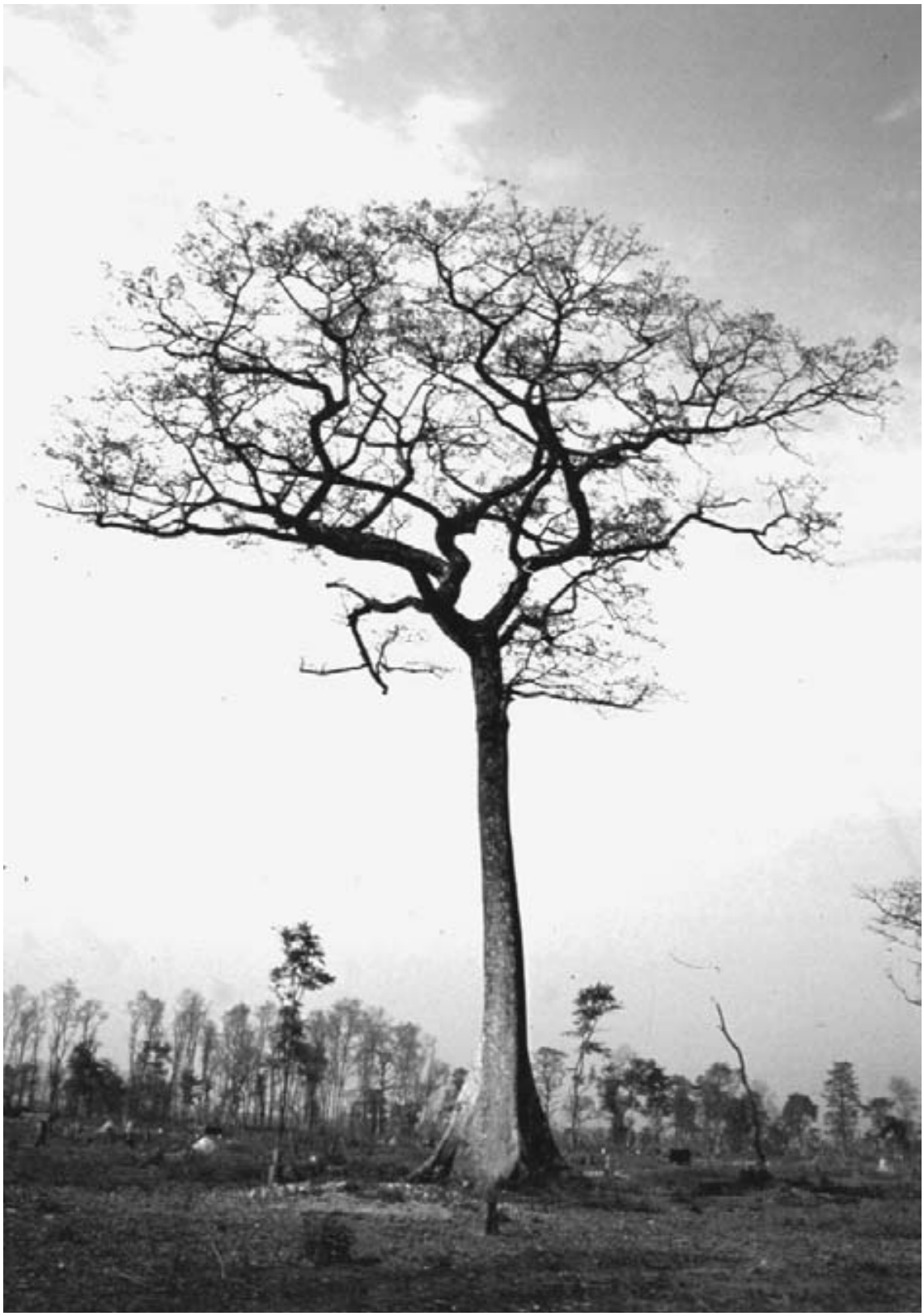


Plate 3.3 - *Sisau* tree

Apart from the *Sal* tree which comes from the Terai region, the most common species used for construction, according Le Port, are *Gwaisasi* (*Schima Wallichi*), *Salla* (*Pinus Roxburghii*) and *Utis* (*Alnus Nepalensis*). All are found growing on the slopes and hills around the Valley (4).

Sal and *Gwaisasi* are used for the construction of external exposed parts of the building because of the strength and resistance of these woods. *Gwaisasi* is of a lower quality than *Sal*. These woods do not normally require any special treatment for protection. Other types of wood that are softer and of a medium quality are used for furniture. They are much more vulnerable to xylophages insects and need to be treated so that they last longer.

According to Sanday, besides the *Sal* tree, the most commonly used species are *Chaap* (*Michelia Champacca*) *Haldup* and *Sisau*. Sanday said that *Sal* wood *"is generally carved in a green state, since when seasoned it tends to be very brittle along any sharp edges, whereas when the sap is still in the timber it cuts more easily"* (5).

According to research findings there are many different types of wood used in construction in Nepal and different types of *Shorea*, e.g. the *Sal* and *Sati Sal*. The *Sati Sal* is harder to come by, therefore more valuable, and is protected by the government. Beside these trees there are the *Sisau* trees which, like the *Sal* tree described by Sanday, are strong and resistant and used for external parts of buildings (Plates 3.4 and 3.5). Other types include the *Bakaina* tree, *Alp* tree, *Padke*, *Simal*, *Karma*, *Sisame* mostly used for furniture as they are soft and have excellent properties for this kind of work.

Plate 3.4 - Cross section of a *Sisau* tree

Plate 3.5 - *Sisau* wood pile

Plate 3.6 - Cut wood for beams in a Terai store

These days production and cutting of trees is only done in the Terai region. Deforestation of the hills around the Valley and in the nearby valleys has been so prevalent, resulting in forests being replaced by arable land with not enough trees to meet market requirements.

The Terai region is very fertile and the forests growing there can supply all the country's requirements. The Forest Office of every district is responsible for managing the deforestation process. Most lands are managed together with the autonomous Community Forests that are managed by the local people and government. Once a year, before the ideal period for cutting, usually wintertime, until the end of February, they get together and decide which parts of forests can be cut.

Most forests north of the Terai plain region, the Shiwalik zone, are managed by local Community Forests, woodcutting is organised in the fields. People cut trees of a predetermined size and keep them in piles until a customer comes to collect them (Plate 3.5). The cut pieces are piled according to their size to allow exact calculations to be made of what materials are available in what quantities. Afterwards they are moved with the help of trucks to stores or directly to the buyers of Kathmandu. Logs are usually left as they are and more precise cutting is carried out in the building yard to produce the final cut pieces (Plate 3.6).

Most stores and transformation industries are found in Patan Industrial Estate where production varies from big structural elements and some decorative parts for historical buildings, to carved windows and doors, to common furniture. Smaller wooden elements are usually made directly in the store, while wood to be used for construction needs to be prepared in the building yard.

The ever-growing shortage of *Sal* tree plantations has obliged the Department of Forests to protect some of these species. Today the majority of forests are found in the southeastern part of Nepal, around Jhapa, near Sikkim. Despite this prohibition there is still some illegal felling of trees.

Construction elements

In general, building proportions and their details, both inside and outside buildings are quite similar particularly in relation to the dimension of the building elements, such as doors, windows, walls, columns and beams. A true uniformity also exists in the building materials used especially bricks, clay and timber. This makes it relatively easy to identify the basic and common construction details of traditional buildings in the Kathmandu Valley (6).

One of the most interesting features of this wood construction technique is the assembly of different components using special joints for each element, nearly always avoiding the use of fixing devices made from materials other than wood. This means that subsequent repair operations are relatively easy, as only the deteriorated components need to be replaced (Plate 3.7).

Many authors have written about the construction systems used in Nepal. Among them, in chronological order, are Korn, Sanday, Le Port and Gutschow (7). Their research, carried out over many years, covers many important architectonic typologies with their respective construction elements.

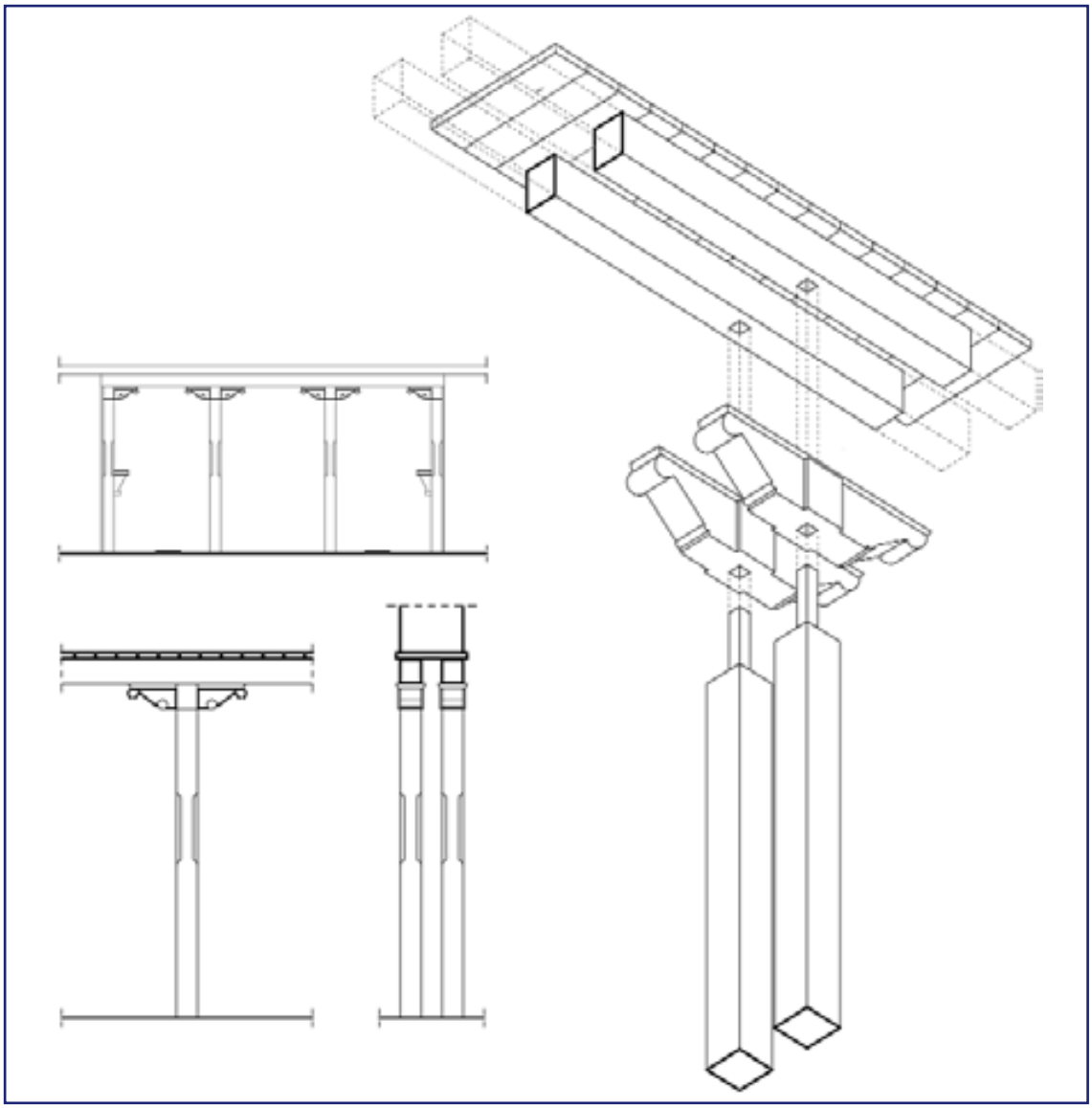


Plate 3.7 - Kasthamandapa, details of the frame and supporting wall

Roofing

Wood technology is particularly evident in roofing systems and gives the architecture its distinct *Newar* style of a steep roof pitch and large overhanging eaves. The Nepali roof has an essential role to protect the building from the severe monsoon rains and from the often extreme exposure to sun, particularly strong at high altitudes. In general climatic conditions have influenced the overall Nepali architectural forms (Plates 3.8 and 3.9).

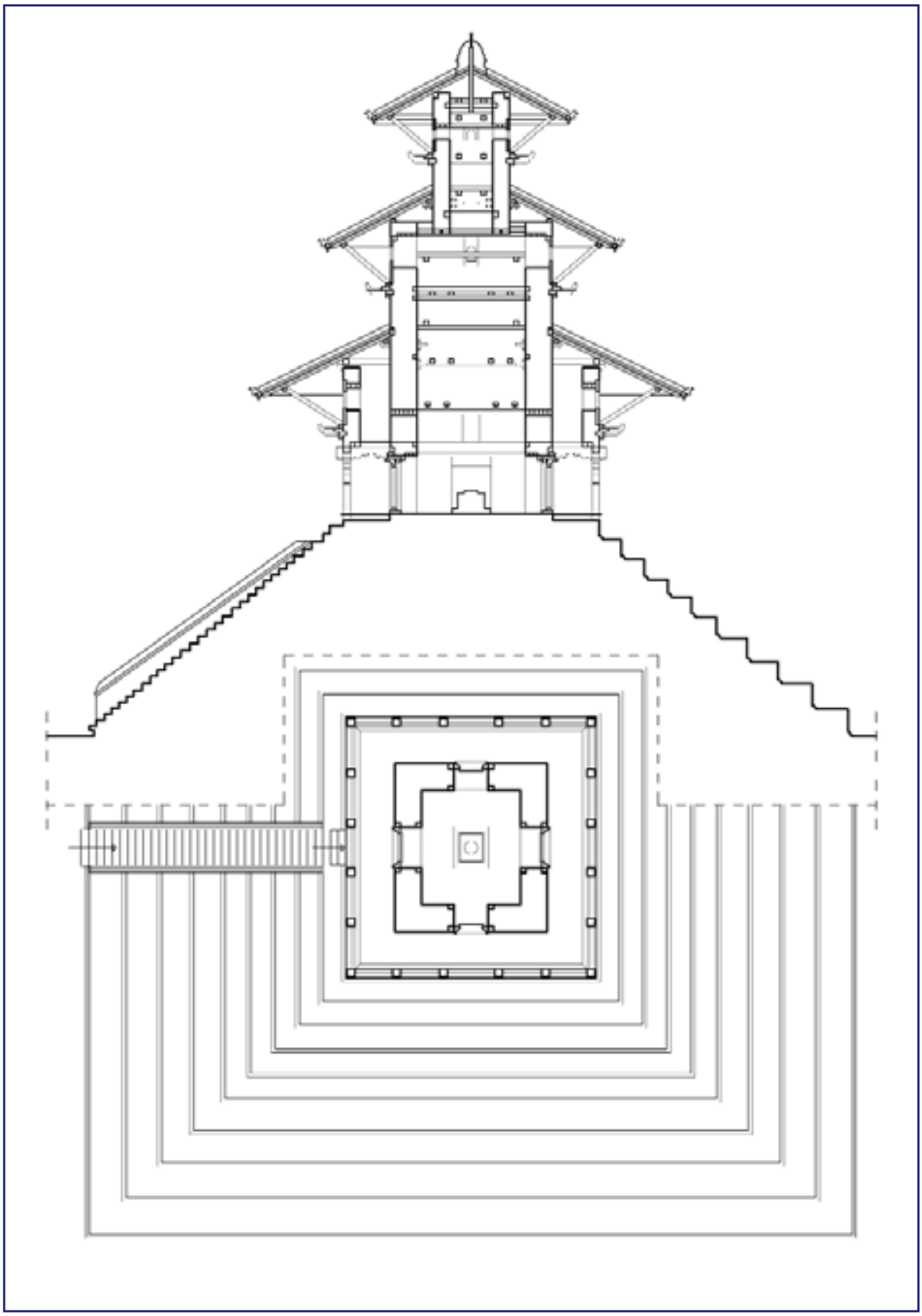


Plate 3.8 - Maju *Dega*, Kathmandu, plan and section

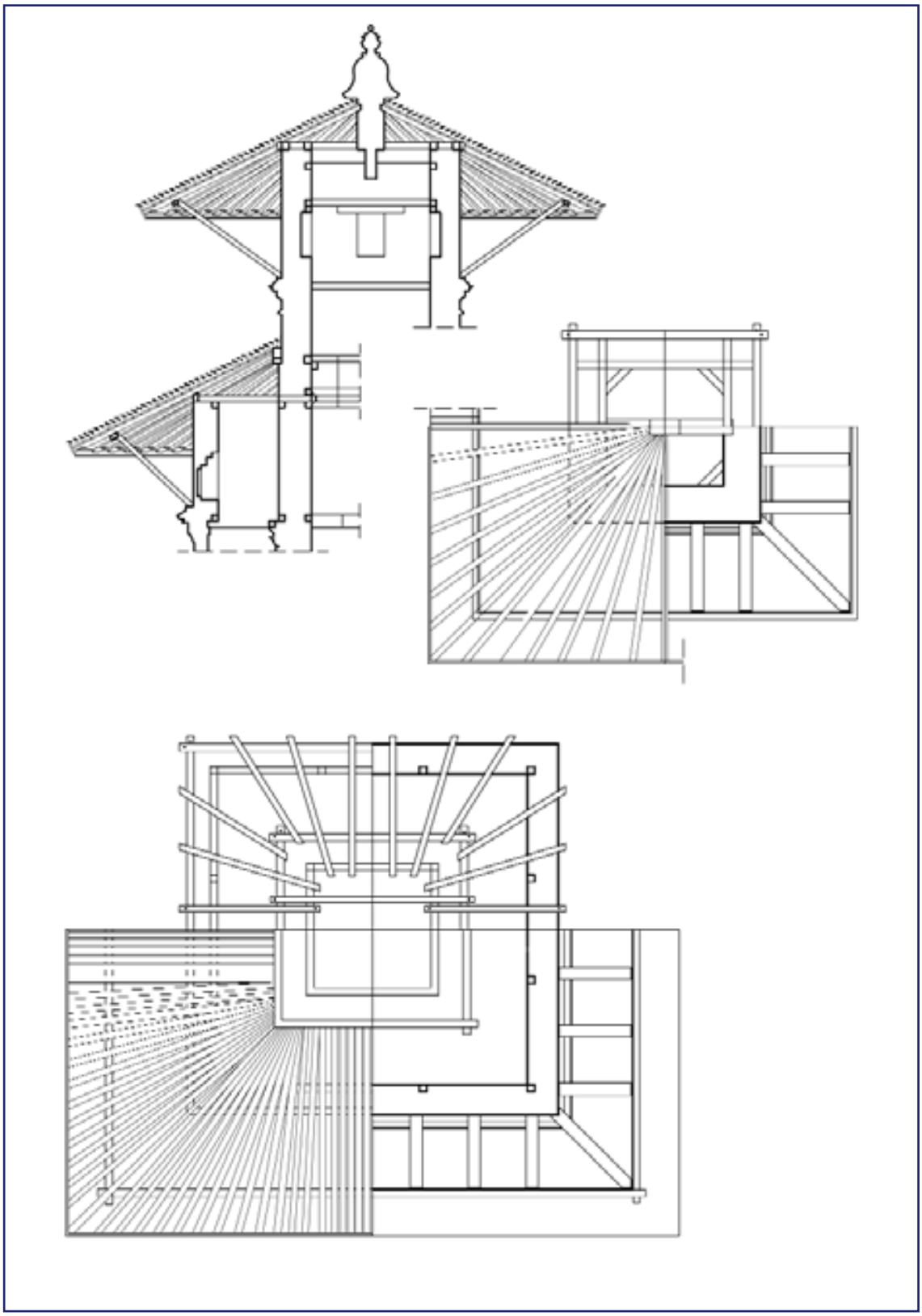


Plate 3.9 - Biswa Nath, Patan, construction system of a *dega* temple

Temple roofs have symmetrical pitches springing from the central point of the cell. The number of tiers varies from a minimum of two to a maximum of five. The pitches are made up of small rafters that spring from the corners in a radial arrangement. At the different levels they are supported on the walls. On the outer side there is a large overhang supported by an eaves beam which in turn is supported by carved wooden struts. On the inner side the rafters are anchored to a tie beam fixed to the walls. All elements are joined using wooden wedges (Plates 3.10).

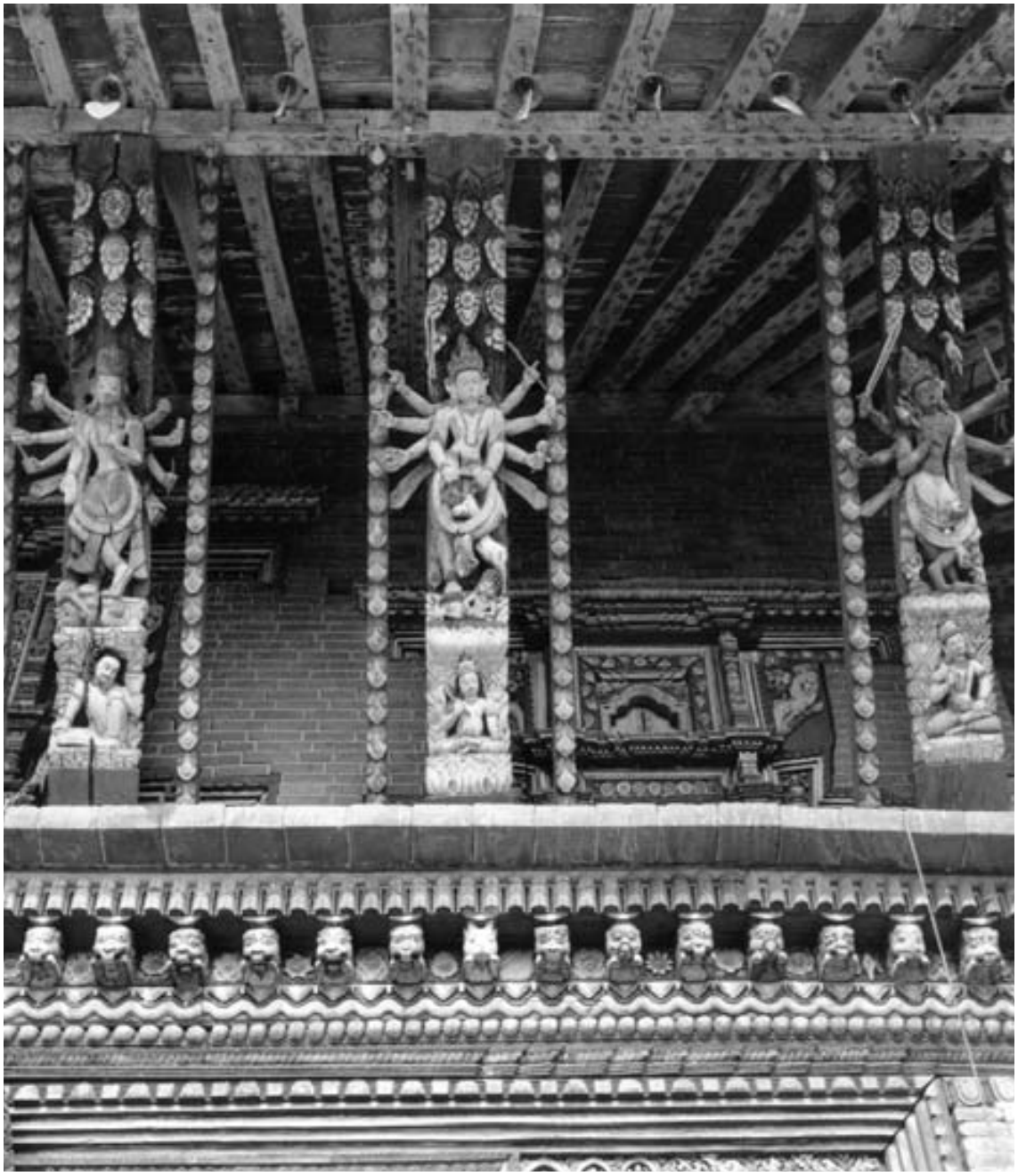


Plate 3.10 - Wood struts and frames of the Changu Narayan temple

Domestic roofs generally have two steep pitches of about 40°-50° in order to make full use of the available space. A ridge beam rests on a central pillar and on the lateral gable walls to form the structure. Two principal rafters are tied up to the central pillar, leaning against the lateral walls on a wooden wall plate which transfers the thrust to the walls. Purlins rest on the principal rafters and then secondary rafters rest on these purlins following the slope of the roof. These extend beyond the wall to form the overhanging eaves. The overhanging structure is made in two different ways. The first way provides support to the secondary rafters via an eaves plate fixed parallel to the wall and supported by a series of secondary struts. The second way is similar to the first but some extra tie beams are inserted to provide additional support to the eaves. The wooden elements are held together using wooden wedges (Plates 3.11 and 3.12).

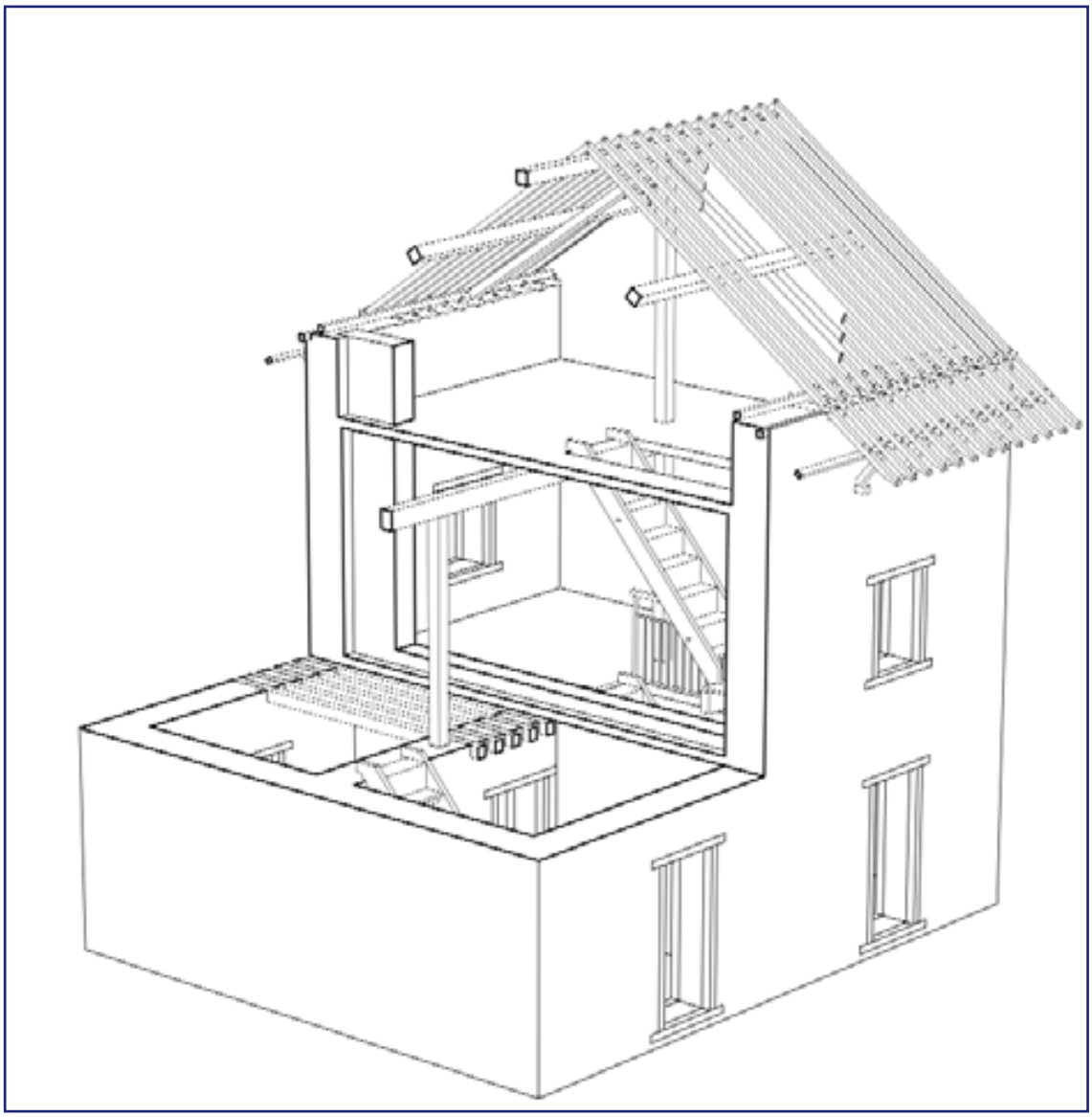


Plate 3.11 - Axonometric section of a *Newar* house

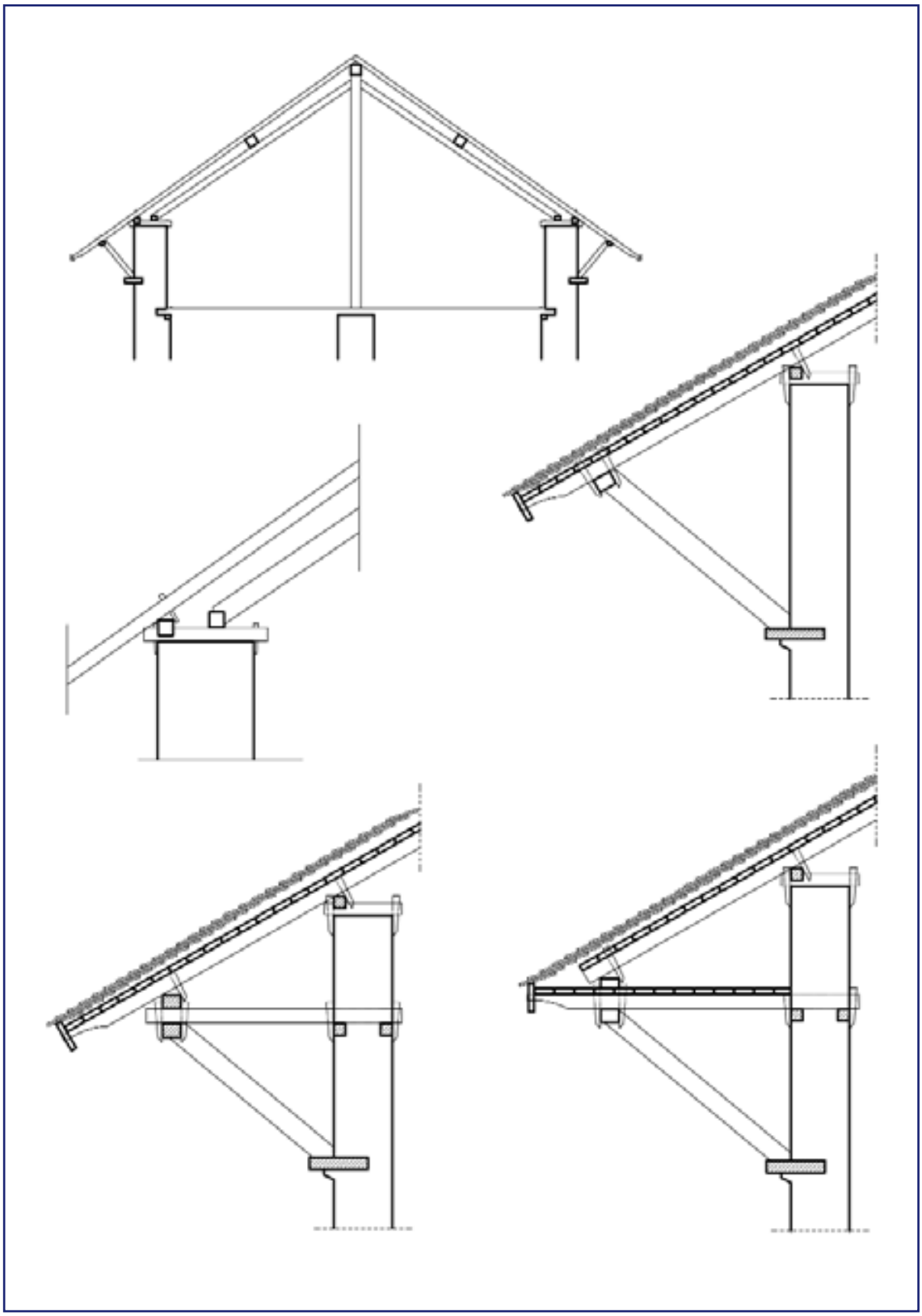


Plate 3.12 - Overhanging eaves typical of traditional *Newar* buildings

Vertical elements

Most Nepalese architectural patrimony has a common element, the vertical components. These are found being used in a similar way in temples, Buddhist (*bahal*) and Hindu (*math*) monasteries, royal palaces and houses.

In all these buildings the main structure is always designed according to the same principle. Pillars are lined in parallel rows. At the top they are joined to a double corbel and above that to a beam. This simple system thus develops into a structural frame which in most cases supports a thick brick wall.

The base of the pillars rest in a cavity notched to a wooden beam or stone plinth and fixed to it with wooden wedges. A similar system is used to connect the top of the pillars to the corbels and wooden beams. All parts are joined without using nails or other metal pieces, following traditional construction methods of the *Newar* style.

The frame structure, made by assembling columns and beams, has a structural as well as aesthetic function. Decorative features so characteristic of the *Newar* style enhance the structural architectonic elements. Aesthetic appearance varies according to the type of carvings in each construction element. By looking at examples of pillars it was found that some are very old (1200-1482), while others belong to the second half of the Malla period (1493-1756) and have very elaborate carvings, while most recent examples have been influenced by the Moghul period.

The importance of pillars, structurally and aesthetically, can be seen by looking at temples, in particular the *dega* type temples built with a peristyle. This type of temple was developed during the second half of the Malla period. The pillars are aligned along the external perimeter creating a corridor around the central sacred cell which is built using bricks. Hidden within this cell is a vertical wooden structure of pillars which ensures the structural stability of the construction (Plates 3.13, 3.14, 3.15 and 3.16).

A similar structural system is used in the internal courtyards of Buddhist monasteries, Hindu priest houses, and royal palaces and gardens, where the external open gallery is always built with a structural frame similar to the *dega* temples. There are also the *mandapa* architectural works which have a square plan. The vertical structure is built with wooden pillars only, that divide the space into nine squares.

Newar multi-story traditional houses use the same structural frame system, with pillars and beams, used to build the inner courtyards. At the upper floors the central brick wall of the ground floor is substituted with the same structural frame system.

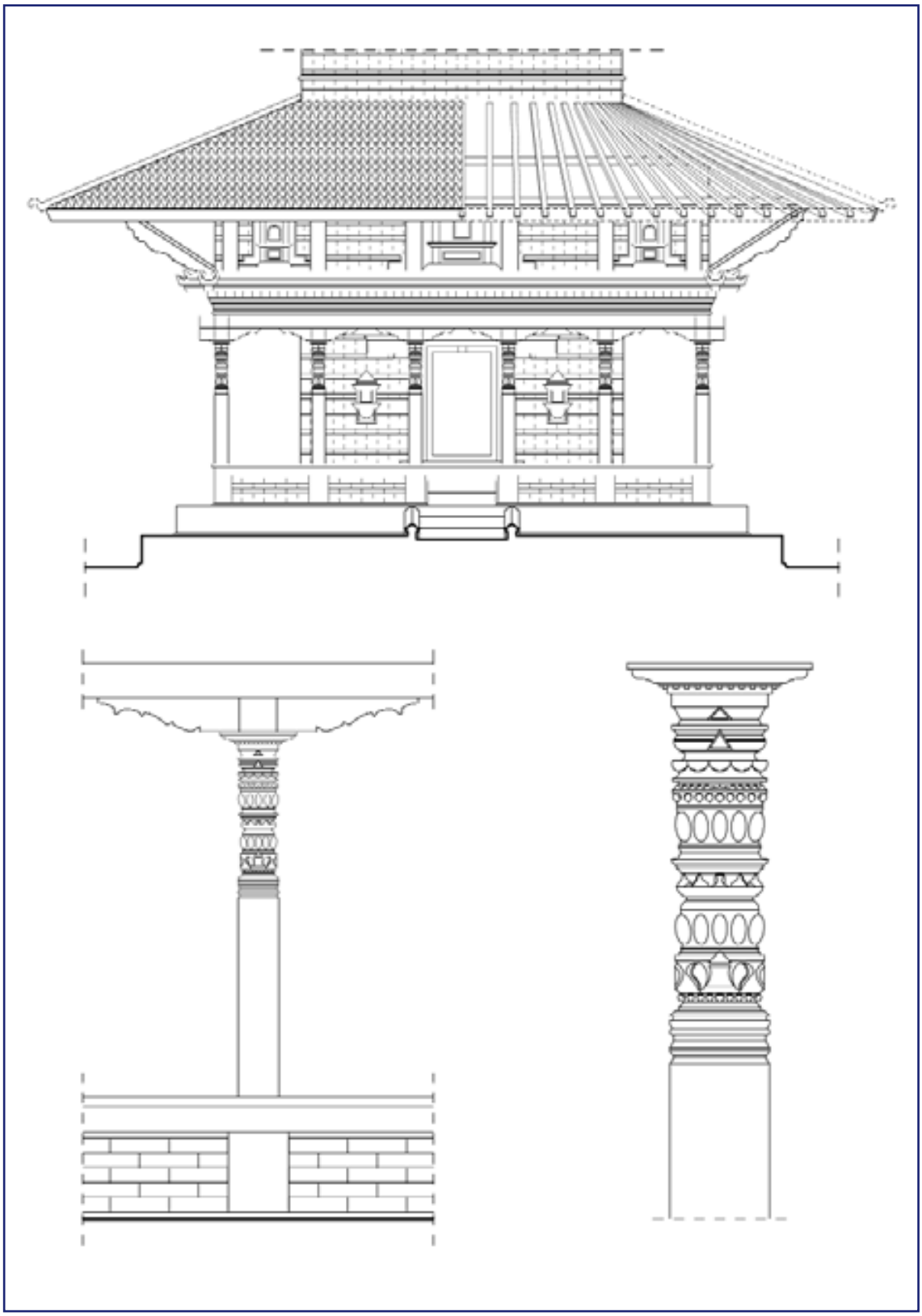


Plate 3.13 - Maju *Dega* Peristyle, Kathmandu

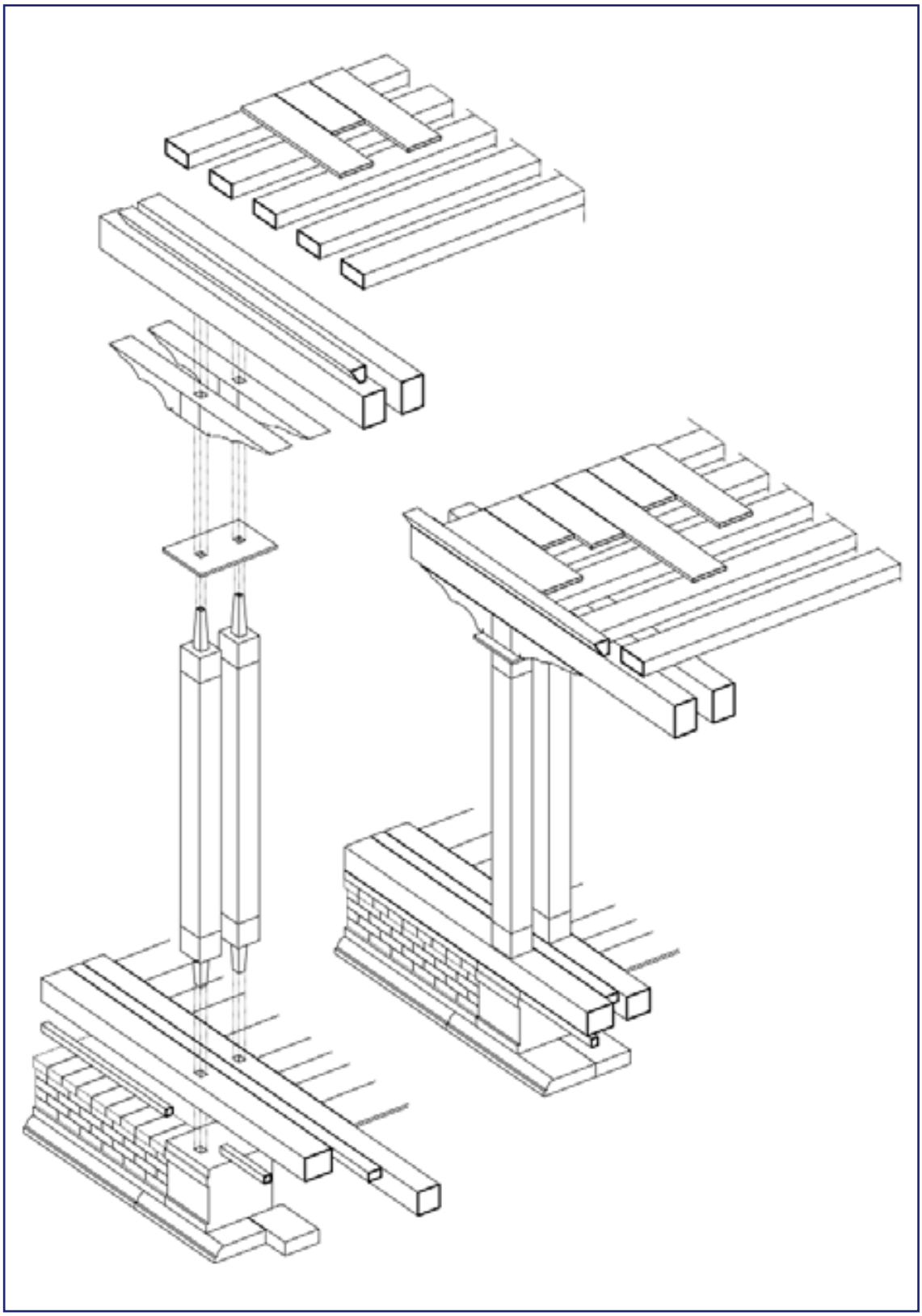


Plate 3.14 - *Pati* frame construction system, Shankhamul complex, Patan

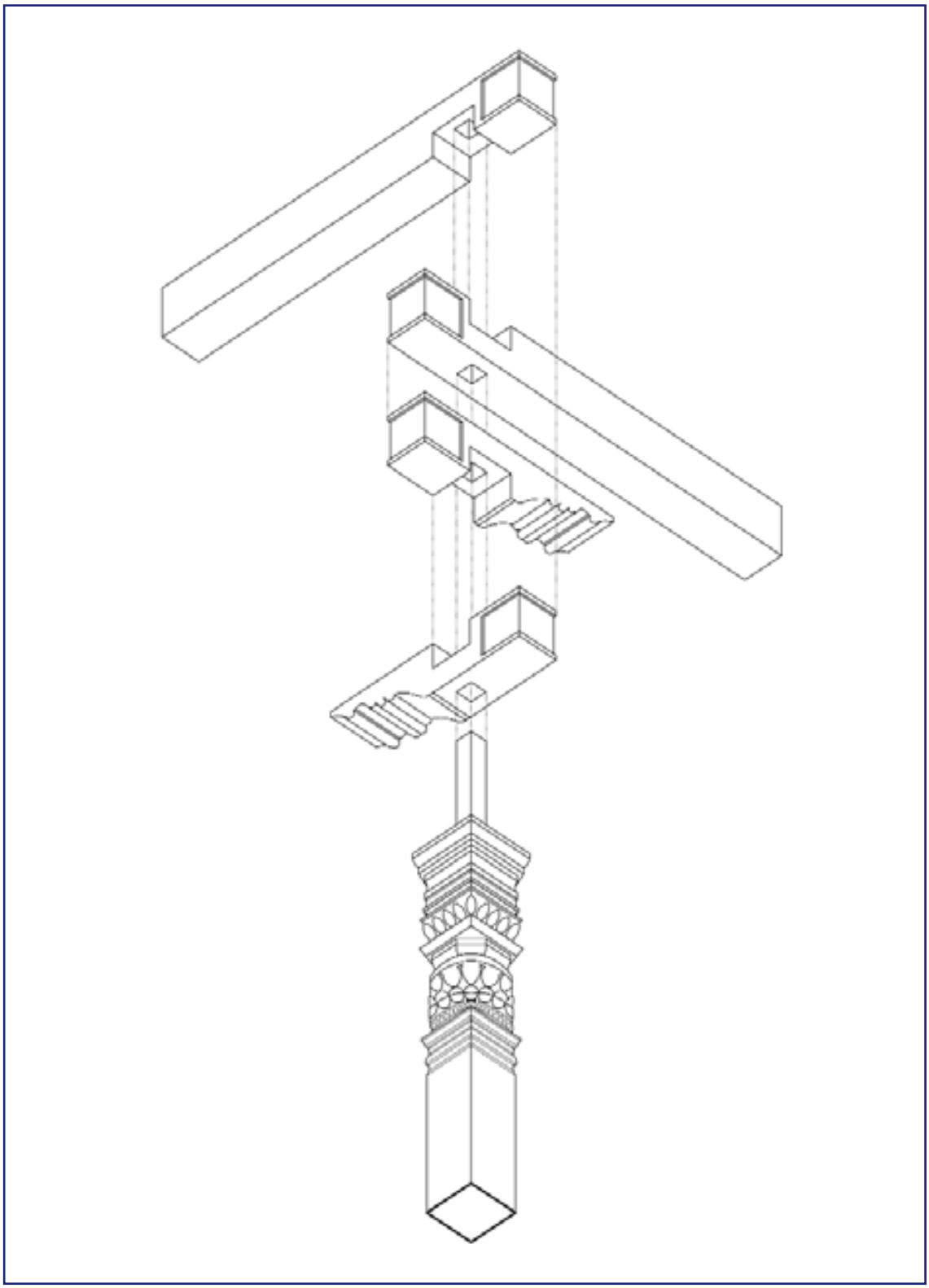


Plate 3.15 - Maju *Dega*, Kathmandu, construction system of a corner pillar supporting the peristyle

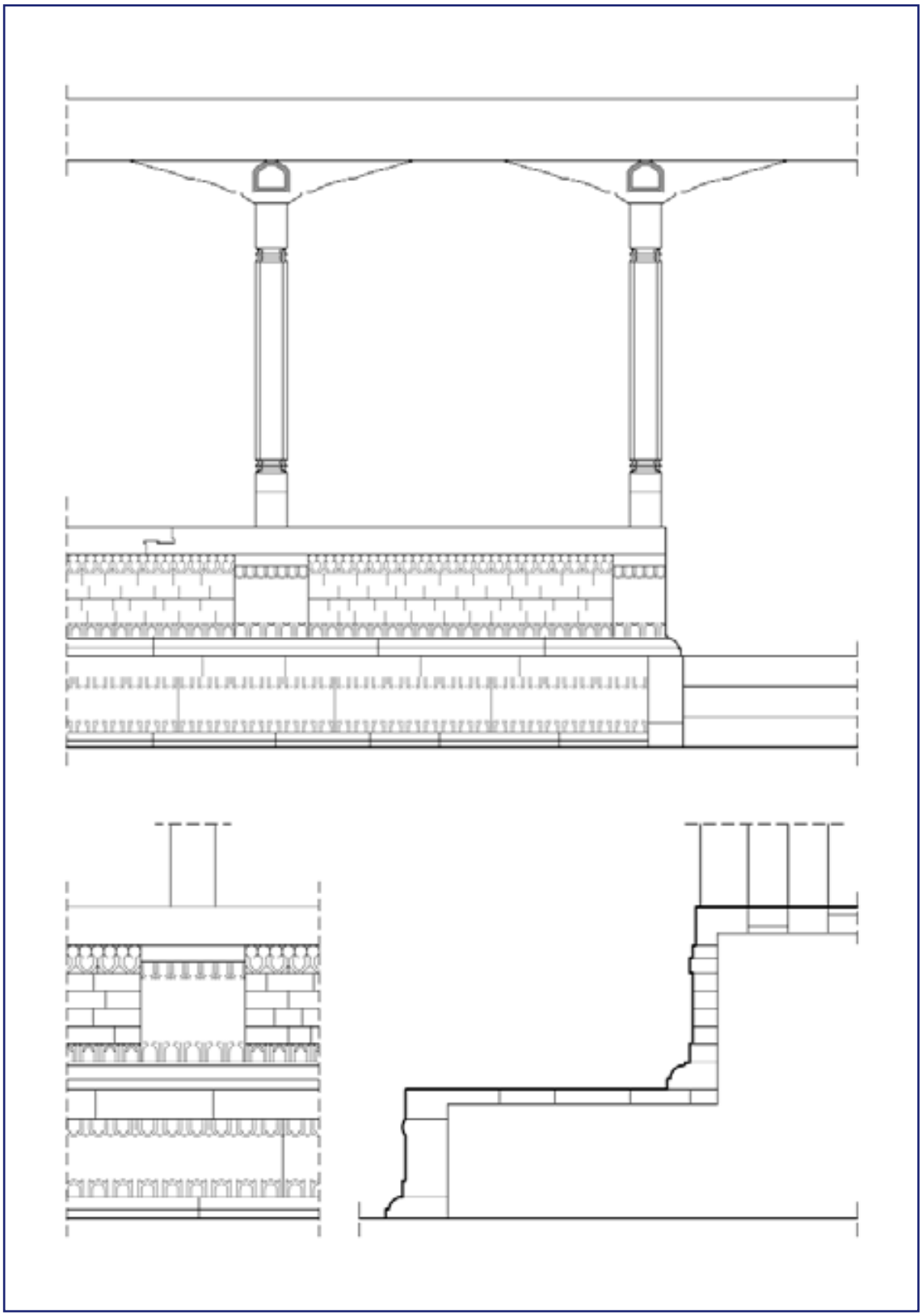


Plate 3.16 - *Pati* frame, Shankhamul Complex, Patan

Stairs

Stairs are always made of wood and their design is very similar in all the different building types, from traditional houses to royal palaces. Their main characteristic is that they are very steep, narrow, and in one continuous flight due to the limited height between stories. Two or three steps and a landing, built with bricks, are positioned at the beginning of the flight. The structure is very simple; two inclined wooden beams support the steps which are inserted into horizontal notches. The entire system is held together with two joists fixed into position with wooden wedges (Plate 3.17).

Plate 3.17 - Stairs in a *Newar* house

Floors

Floors are built using simple battens, rectangular in section, upon which planks are laid. These in turn support the final floor finish. Given that Nepal is located in an earthquake zone, *Newar* carpenters have developed their construction techniques accordingly to provide additional bracing by linking the vertical and horizontal structural components. This connection is made using wedges that are fixed through the wall along the perimeter connecting the joists that run inside and outside the building. The floor is then joined to the horizontal frame using battens, some of which also run through the wall and are fixed in position using wooden wedges (Plate 3.18).

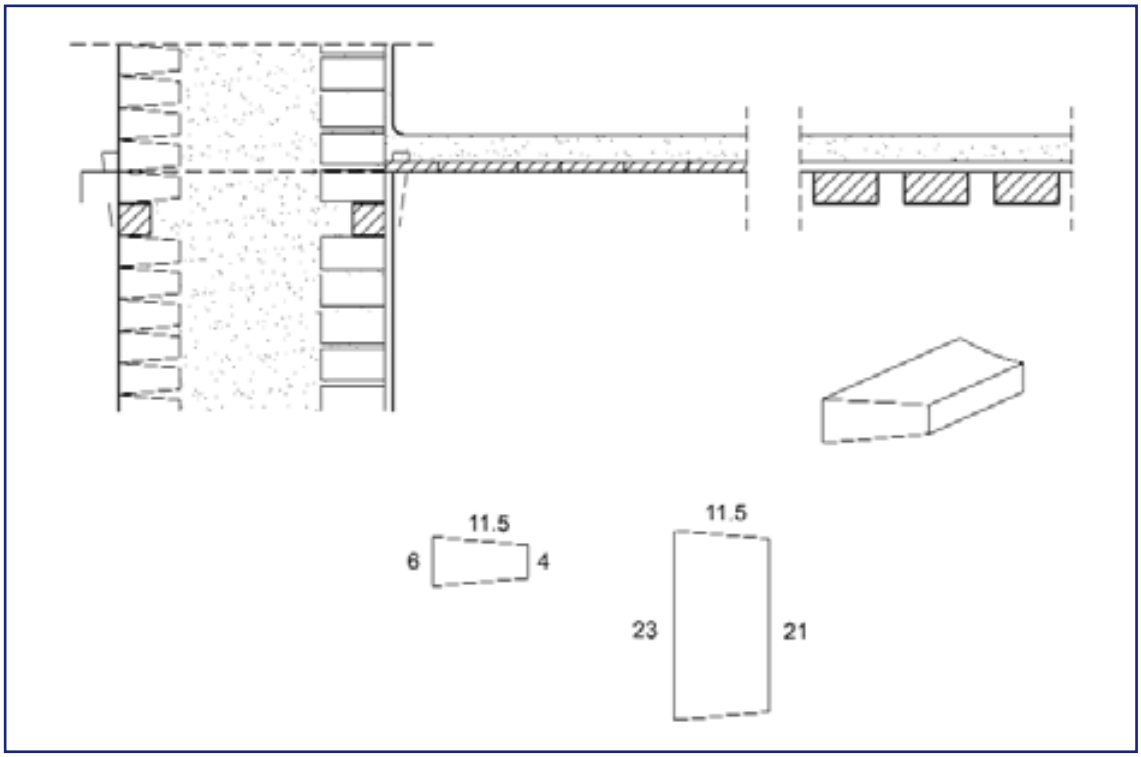


Plate 3.18 - Details of a connection between floor and wall in a *Newar* building, and details of a *daci appa* brick

Doors and windows

Another important area of wood technology is in the construction of doors and windows, two elements that also contribute to giving the *Newar* architecture its recognisable style. In particular, as Bernier observes (8), *"The walls of palaces, house, and temple made porous, moving, and visionary by the abundant inclusion of carved windows, screens niches, and doorways. The scheme of carving appears at first to be endless in variety, but is made comprehensible through division into clearly recognizable categories based upon aesthetic and religious considerations. They are single windows, window groupings of three or five, and balconied windows"*. W. Korn has categorised this typology by showing four basic types of door and four types of window, and the subsequent variations. (9)

Windows and doors are composed of many elements that are always assembled in a specific order so that they are always structurally compressed (10). Generally the doors and the windows consist of two frames, one internal and one external structural part, joined together using wooden ties. The external frames are inserted into the openings in the walls as completed units, and are then fixed in place with a frame that accentuates the horizontal elements. The upper part of the frame acts as a lintel to carry the upper wall. This is a particularly ingenious system that gives strength to the frame as well as to the entire wall. The opening becomes an integral component as well as an aesthetic and decorative element. Every window is characterised by a grill that serves as a filter between the inside and outside of the building.

The doors and windows vary in design and importance according to each particular building and to the floor level (Plates 3.19, 3.20, 3.21, 3.22, 3.23 and 3.24). In houses, the first floor is usually used as a sleeping area so the windows are simple, usually with very plain decorations carved on the frame. On the second floor, where the main living area is located, beautiful facades, bigger than first floor and carved with symbolic designs are always found.

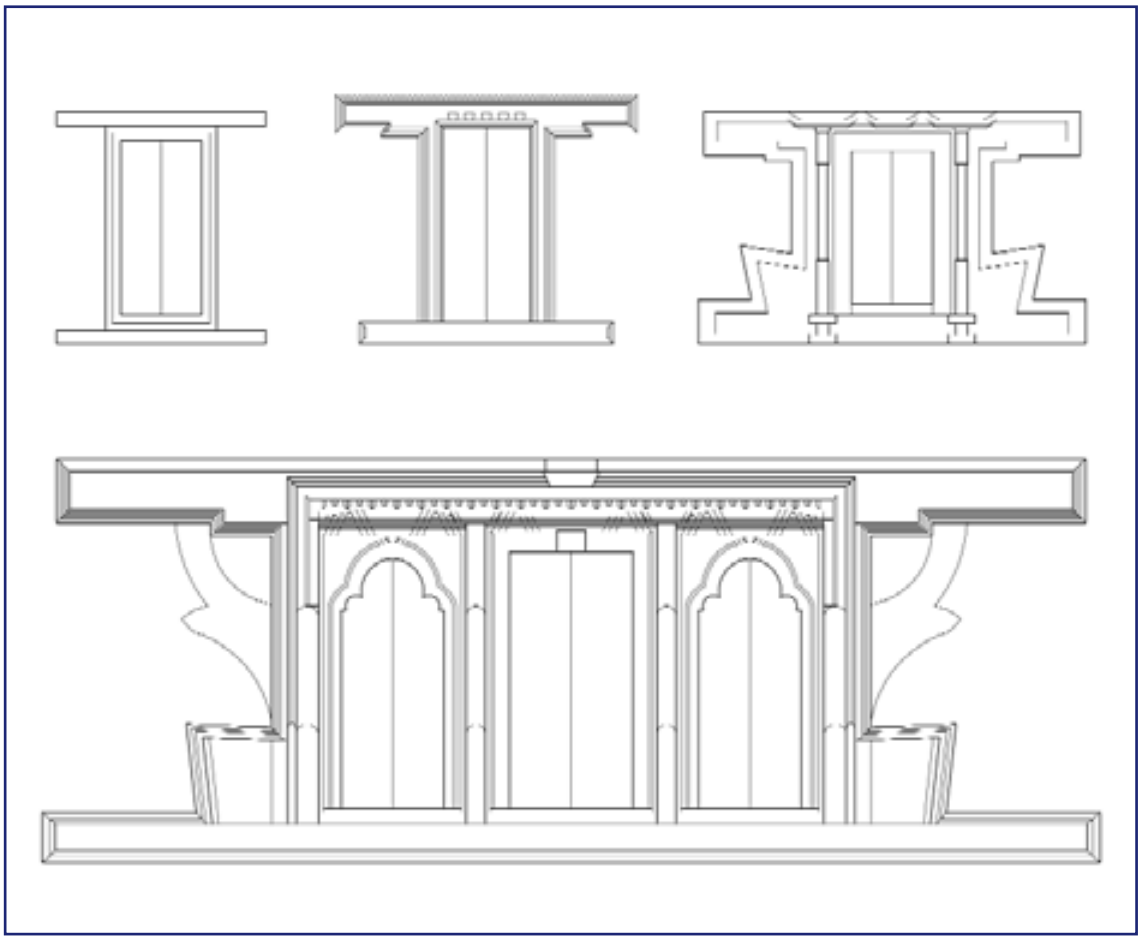


Plate 3.19 - Typical *Newar* door frames

Plate 3.20 - Typical door of a *dega* temple

Plate 3.21 - Window being assembled

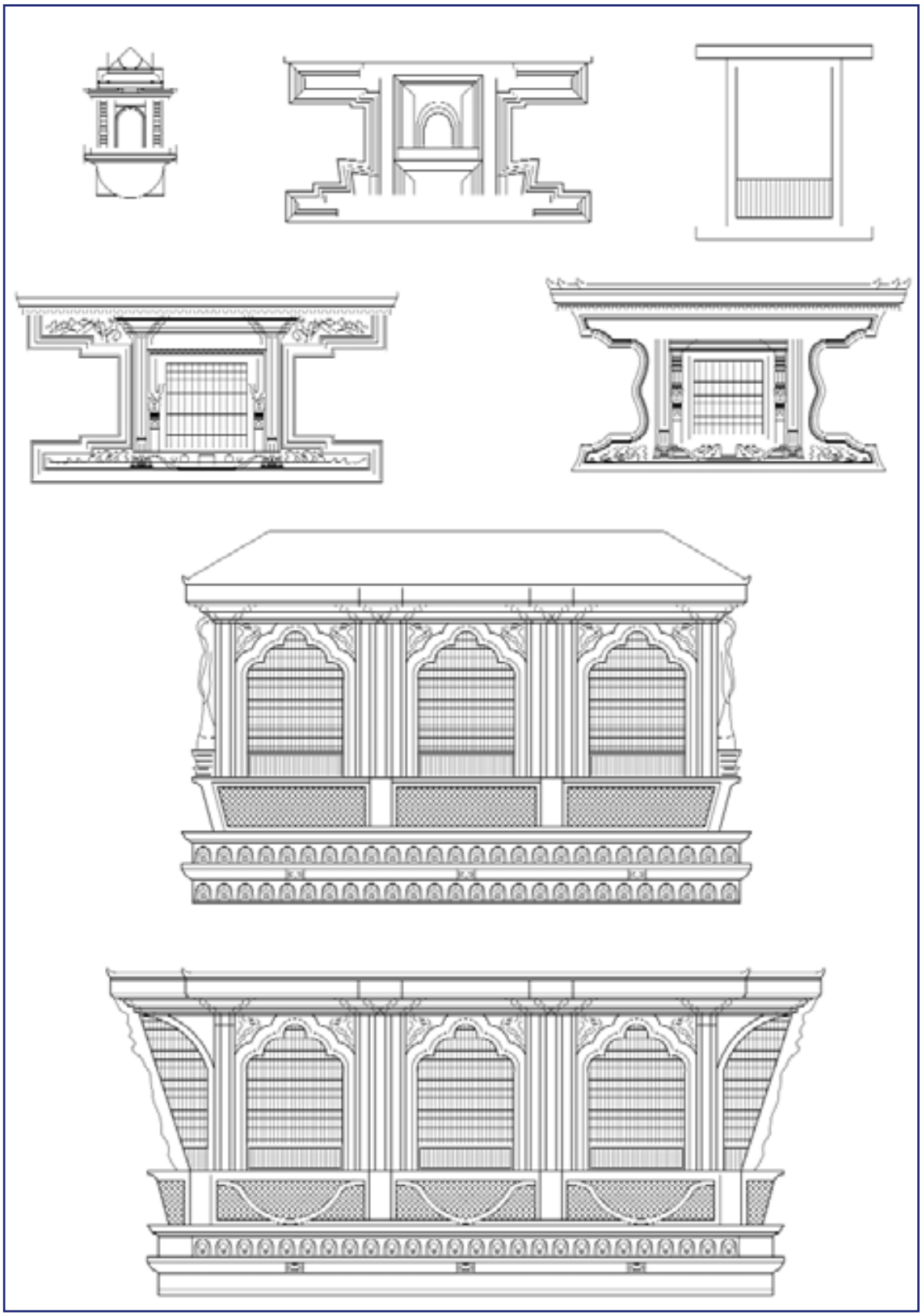


Plate 3.22 - Typical *Newar* windows

Plate 3.23 - Window with three openings in the Royal Palace of Kathmandu

Plate 3.24 - Windows of a typical *Newar* building

Traditional craftsmen

Craftsmen who are able to work with wood like the old Malla craftsmen are mainly found in the Kathmandu Valley. Woodcarvings made by these craftsmen and found in the structural parts of *Newar* houses have their own particular quality and distinctive pattern that is so typical of their cultural heritage.

The Nepali woodcraft tradition has three types of craftsmen: the designers, the woodcarvers, traditionally from the Silapakar family and the carpenters, commonly called *sikarmi*. The designer and woodcarver are often the same person. Like in other production sectors the organisation is kept within family groups where knowledge and experience are handed down of from father to son thus maintaining a continuity of the highly specialised skills.

The work of woodcarvers is a broad specialisation and belongs to the *"knowledge concerning iconography and religious significance of decoration. The complexity of an ornately carved deity, multi-handed and holding symbols all of religious significance, requires not only great knowledge of the religious texts but also the skills of a craftsman competent to execute the work"* (11).

Woodcarving descends not only from the noteworthy skills acquired from experience, but above all from individual skilled craftsmen that are able to produce results that go beyond those defined as traditional crafts.

Wood carvers focus their activities above all on religious architecture with both its decorative and structural elements. Sometimes they work in collaboration with a carpenter whose practice of traditional work is not usually so well developed.

Most of their work, in particular nowadays, consists of copying old pieces that replace damaged components, or for rebuilding parts of the building. The creative input is not so much but traditional methods and techniques are respected, as confirmed by Sanday. *Newar* craftsmen are generally very competent at this replication work.

Typically they work with pictures or drawings, often at a different scale from the piece that is to be reproduced. They are able to change the scale of the work, maintaining proportions and reproducing the elements in a very precise way (Plate 3.25).

Work management at the building yards where wood components, to be used in combination with masonry elements for building construction are produced, is organised so that wood craftsmen work directly in the yard, organizing themselves according to their particular skills. For woodcarving reproduction work the first stage of work consists of reproducing drawings at a scale of 1:1 of the

Plate 3.25 - Wood strut being carved

chosen piece, respecting the dimensions and decoration and referring wherever possible to old examples or pictures of old pieces. The next step is for carpenters to cut the raw wood onto which they draw, in pencil, the motif to be carved. Finally the most demanding part of work is the woodcarving itself. This can take days, and obliges the rest of the yard to organise their time accordingly. This process usually requires three specialists, one for cutting, another for drawing and another, the one with the most expertise, for carving (Plate 3.26).

Plate 3.26 - Silapakar wood carver in a building yard

People working in the building yards are nearly always from the same family. Because this type of woodcarving is more complex than the commercial carving for tourism and furniture production, an expert craftsman should always be present to oversee the work.

Fortunately the woodcarving tradition has not disappeared and there are still many Silapakar families to be found in the Kathmandu Valley, particularly in the Bhaktapur area.

Over the last two generations in some villages, like Bungamati, other family groups have become specialised in the production of wooden decorative pieces for new houses and hotels, as well as of objects destined for tourists, thus adapting to market demands.

On most village roads it is possible to admire craftsmen working intently on a variety of different works including miniature reproduction pieces of traditional *Newar* architecture. In Bhaktapur the same craftsmanship has developed, even though the carving specialists of this town mostly still belong to Silapakar families.

Wood carvers worship Vishwakarma, who according to a legend of Mahabharata, built a beautiful palace, the Mani Mai Sabhat, for their king who was so impressed by the window carvings as well as the beauty of the queen, that he was distracted enough to stumble over and fall into the water pool in the middle of the court.

Wood carvers worship Vishwakarma during Dasain and like the other casts who have the same *kuldeuta* (deity guide) they usually also have an altar for him in their houses. There are no temples dedicated to him except a little rock in Bhaktapur, considered to be Vishwakarma.

(1) H.A. OLDFIELD, *Sketches from Nepal*, W.H. Allen and Co., London, p. 102. 1880. Ibid. also M.S.SLUSSER, G. VAJRACARYA, *Two medieval Nepalese buildings: an architectural and cultural study*, in Artibus Asiae, Vol. XXXVI, 3, Ascona, Switzerland, MCMLXXIV, p. 169.

(2) Plans and sections show clearly the global structure of the building where on the ground floor there are four visible wall pillars defining a central square. In the centre are four wooden pillars constituting the base of a wood frame system that rises up to the level just below the highest roof, while on the external perimeter of the construction a double alignment of frames, again made of wood, supports the first roof. The corner pillars give rigidity to the entire structural system. Double wooden frames are inserted to support the part of the wall that runs up to the first floor. The same thing is repeated on the first floor with masonry corner pillars and wood pillars in between, while at the last level another frame is inserted at the centre

(3) The construction system of overhanging roofs found in Japan consists of a bracket composed of many elements and superimposed beams which combine to form a curvilinear roof. Nepali roofs typically have struts. - V. SESTINI, *The Timber Structure of the Bishwa Nath Temple in Patan*, Nepal, in "Plastici di strutture di legno", extract from the periodical "bollettino ingegneri, n° 12, Firenze, 1999.

(4) M. LE PORT, ibid., p. 95.

(5) J. SANDAY, ibid., pp. 13-14.

(6) W. KORN, ibid., p. 104.

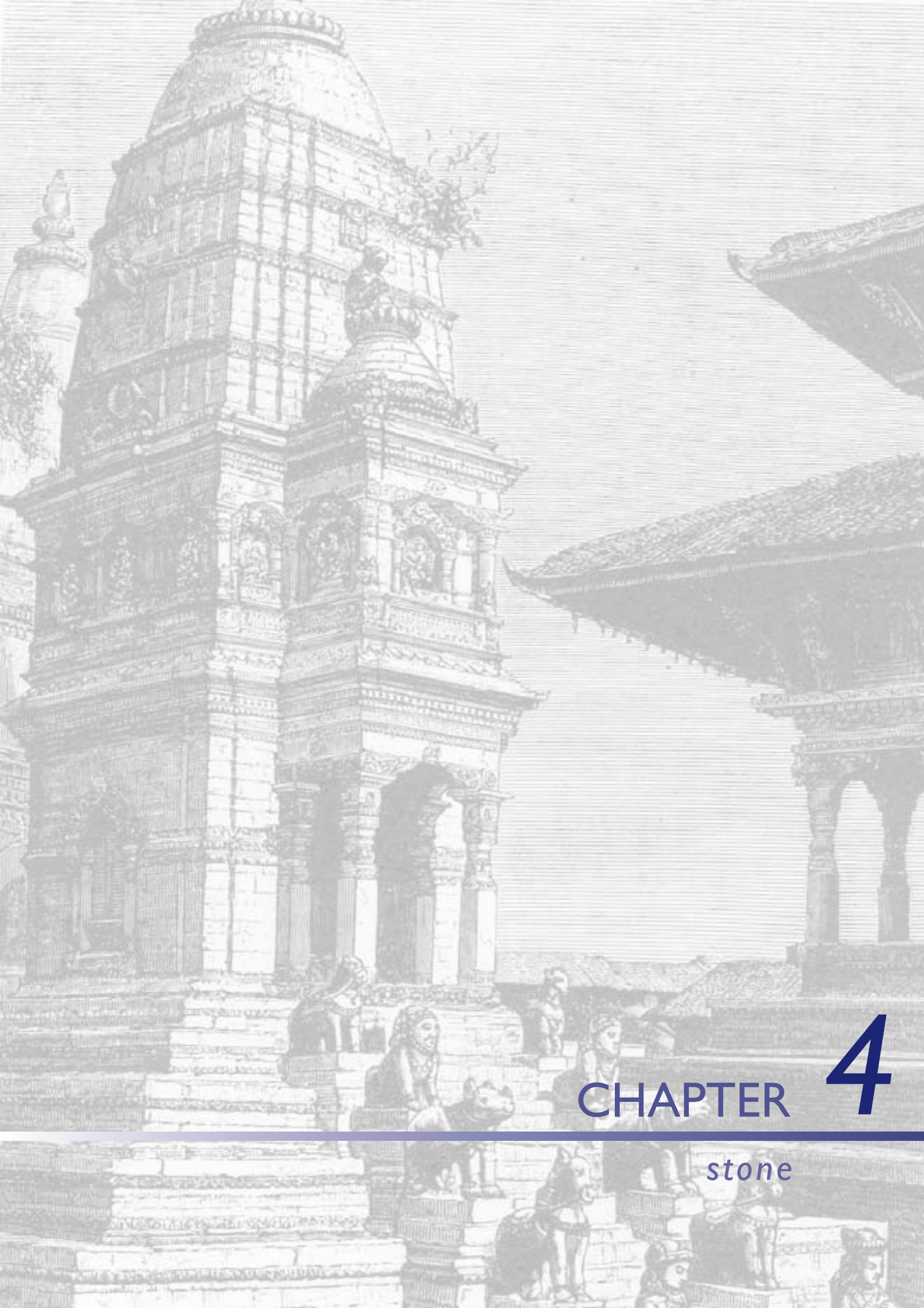
(7) S.B. DEO, *Glimpses of Nepal Woodwork*, in "The Journal of the Indian Society Art", new series, Vol. III, 1968-69; W. KORN (1979), J. SANDAY (1981); M. LE PORT (1981); N. GUTSCHOW, B. KOLVER, I. SHRESTACHARYA(1987), ibid.

(8) R.M. BERNIER, *Wooden Windows of Nepal, An Illustrated Analysis*, in "Artibus Asiae, vol. XXXIX, Ascona, 1977.

(9) W. KORN, ibid.

(10) M. LOBSIGER DELLENBACH, P. DE CHASTONAY, *Artisanat népalais: construction d'une fenêtre*, in "Archives suisses d'Anthropologie Générale, Genève, 1954.

(11) J. SANDAY, in "'Appropriate technologies' in the conservation of cultural property", p. 12, The UNESCO Press, Paris 1981.



CHAPTER 4

stone

Shikhara stone temple, Bhaktapur
From G. Le Bon, 1886

Stone

The urban areas of the cities of the Valley are enriched by the presence of many monuments made from stone. Sometimes painted images are inserted into the stone as can be seen in some 19th century books (see bibliography). It is unusual to find written documentation by historians on the subject.

As an exception, Colonel Kirkpatrick observed the scarce use of stone in buildings and its dependence upon available transport. *"The houses in Nepaul are universally built of bricks, because the use of stone, though everywhere procurable within an easy distance, would be intolerably expensive in a country not admitting either of wheel carriages, or of water transportation"* (1). He also noted the use of stone for carving religious sculptures.

Stone has been used for the construction of historical monuments since the Lacchavi and Thakhuri periods, in particular sculptures inspired by Gupta art. There are many bas-reliefs and statues of gods of both Hindu and Buddhist pantheons inserted into the religious buildings and royal palaces that date from between the 3rd and 10th centuries and even beyond. The most important examples are found in Changu Narayan and in Pashupatinath.

Constant contact with India up until the 13th century, has lead to a mixture of religions, styles and artists that have with time, become integrated into the Nepalese culture. This has given rise to many significant religious sculptures in the historical cities of Kathmandu, Swayambhu and Changu Narayan and Pashupatinath.

Thankfully, due to the hardness of the stone used, many of these works are still intact and unlike the wood structures, allow us to understand what sculptures and monuments looked like in the past.

Of big historical rather than artistic importance are the sculptured stone tables found inside many of the bigger religious centres. They help identify the exact period of the temple, often not possible by just looking at the temple itself.

Around the 13th century, the north of India was invaded by Muslims. Nepal became isolated, and began to develop its own style of architecture, the Malla period, which gave rise to works of great historical significance. This was not so much the case of stone works because of the difficulty in finding suitable stone to work with.

From the 17th century stone was widely used for the construction of many of the *shikhara* temples found in the Valley that were of hindu-islamic origin and had come from the Indian regions of Orissa, Bengala and Rajasthan.

With its introduction to Nepal, *shikhara* temples under went a morphological transformation in relation to the original models, but maintained the use of stone, which was a material better for expressing the specific symbolism of each monument.

There are also many examples of *shikhara* temples that are partly built using bricks, both visible and plastered. The Maha Buddha of Patan, a *shikhara* totally built in bricks moulded in relief, is famous for using this technique.

The *shikhara*

In Nepal, the *shikhara* temple is normally dedicated to Hindu pantheon gods, though there are also Buddhist examples i.e. Maha Buddha (Plate 4.1).

All parts of the *shikhara* are made using stone: from the basement steps, often enriched with carved frames, to the central cell and curvilinear tower whose walls are constructed using many individual and regularly hewn stones. The peristyle pillars and beams are monolithic (Plate 4.2).

Plate 4.1 - Maha Buddha *shikhara* temple, Patan

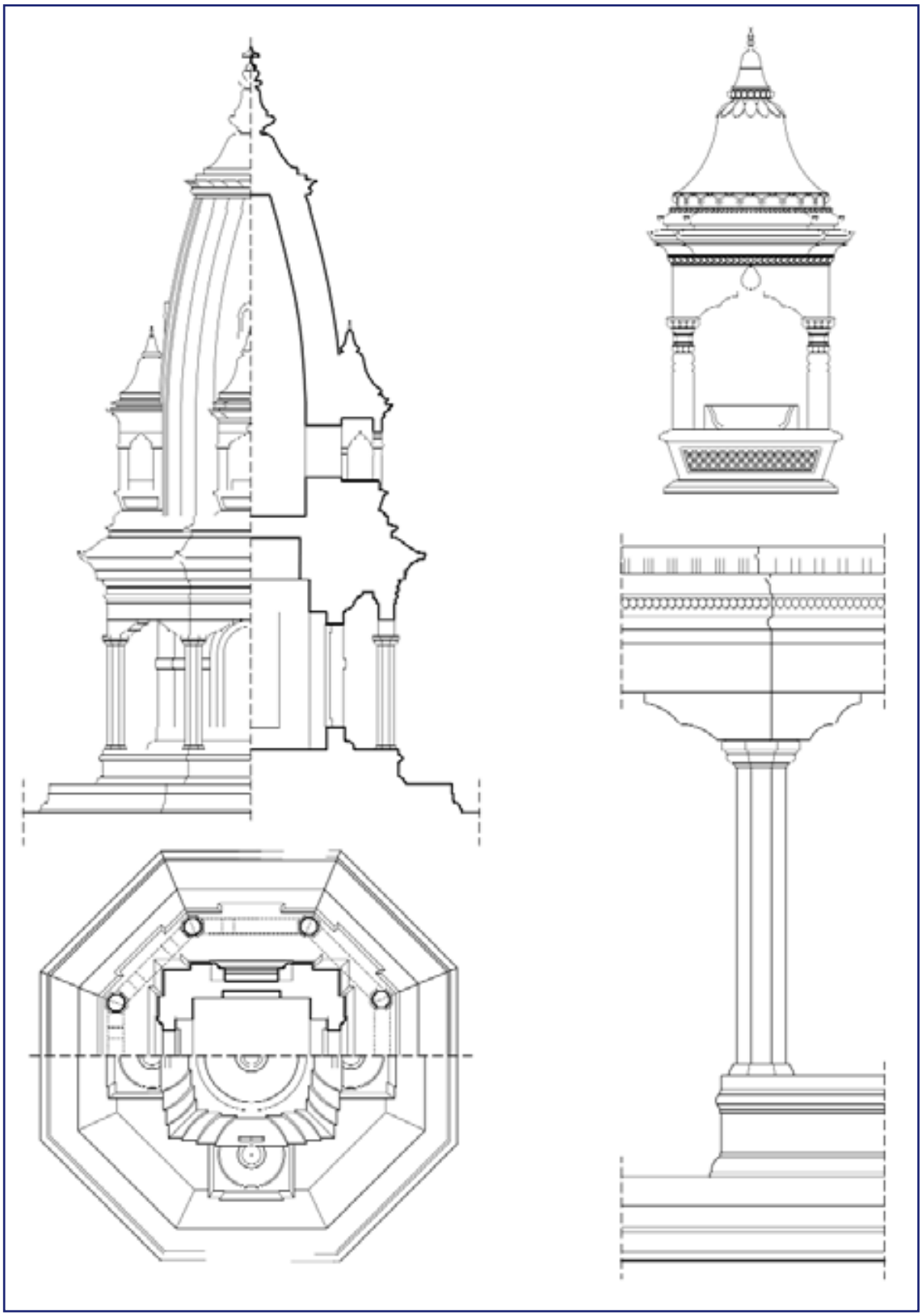


Plate 4.2 - Gandswara Bitrag *shikhara* temple, Chobar village

Stone is carved by local craftsmen who use many different types of chisel, specially adapted to carve the symbolic decorative friezes, tabernacles, and pinnacles.

The main *shikhara* are found in the Darbar squares of the three ancient cities. One of the most significant is the temple of Krishna Radha in Patan, built in 1637, which *"costituisce una delle creazioni più ambiziose di tutta l'architettura. La cella si trova al piano primo, la galleria di questo primo piano è abbellita da avancorpi coperti da cupole finte; padiglioni a colonnine riprendono lo stesso ritmo ed ornano due piani fittizi supplementari. La forma di questi padiglioni è ripresa dalle architetture rajput e moghul. L'insieme possiede una grazia aerea che lo riaccosta più particolarmente a celebri creazioni dell'arte moghul"* (2).

Plate 4.3 - Krishna temple, Darbar square, Patan

Another interesting *shikhara*, dedicated to Krishna worship, is found in Patan (Plate 4.3). It was built in 1723 and has an octagonal form with a peristyle at the ground floor and a balcony at the first floor. Other important and famous *shikharas,* the Vatsala and the Durga temples, are found in the Darbar square of Bhaktapur (Plate 4.4). Another interesting example is found in Bungamati. Here the basement, the cell, the peristyle and the four little towers in the four corners are all made from stone, while the curvilinear tower is plastered.

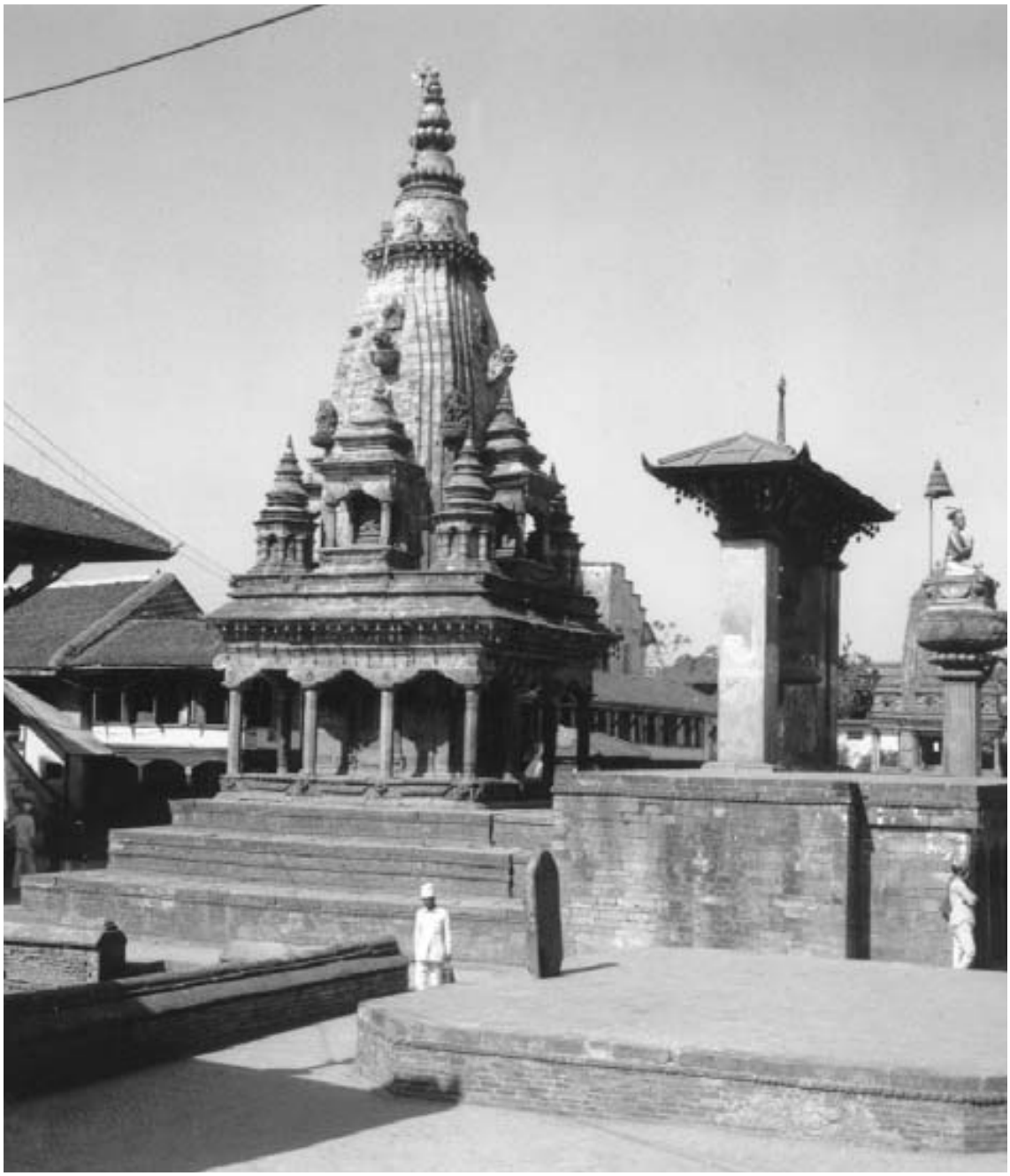


Plate 4.4 - Vatsala Devi *shikhara* temple, Bhaktapur

Public works and fountains

Stone was also used around the middle of the 19th century, in the big restoration projects carried out by the Rana family, beginning with Bhimsen Thapa. New public structures like tanks for the water provision, squares, fountains, bridges, gardens and the restored *ghats* of Kathmandu and Patan were built around this time.

The fountain of Bhimsen (Plate 4.5) Thapa is made entirely from stone. It is situated near the minaret in the south of Kathmandu city and was built during the first part of 19th century, a period characterised by the iconographic details and dimensions of the stone carvings.

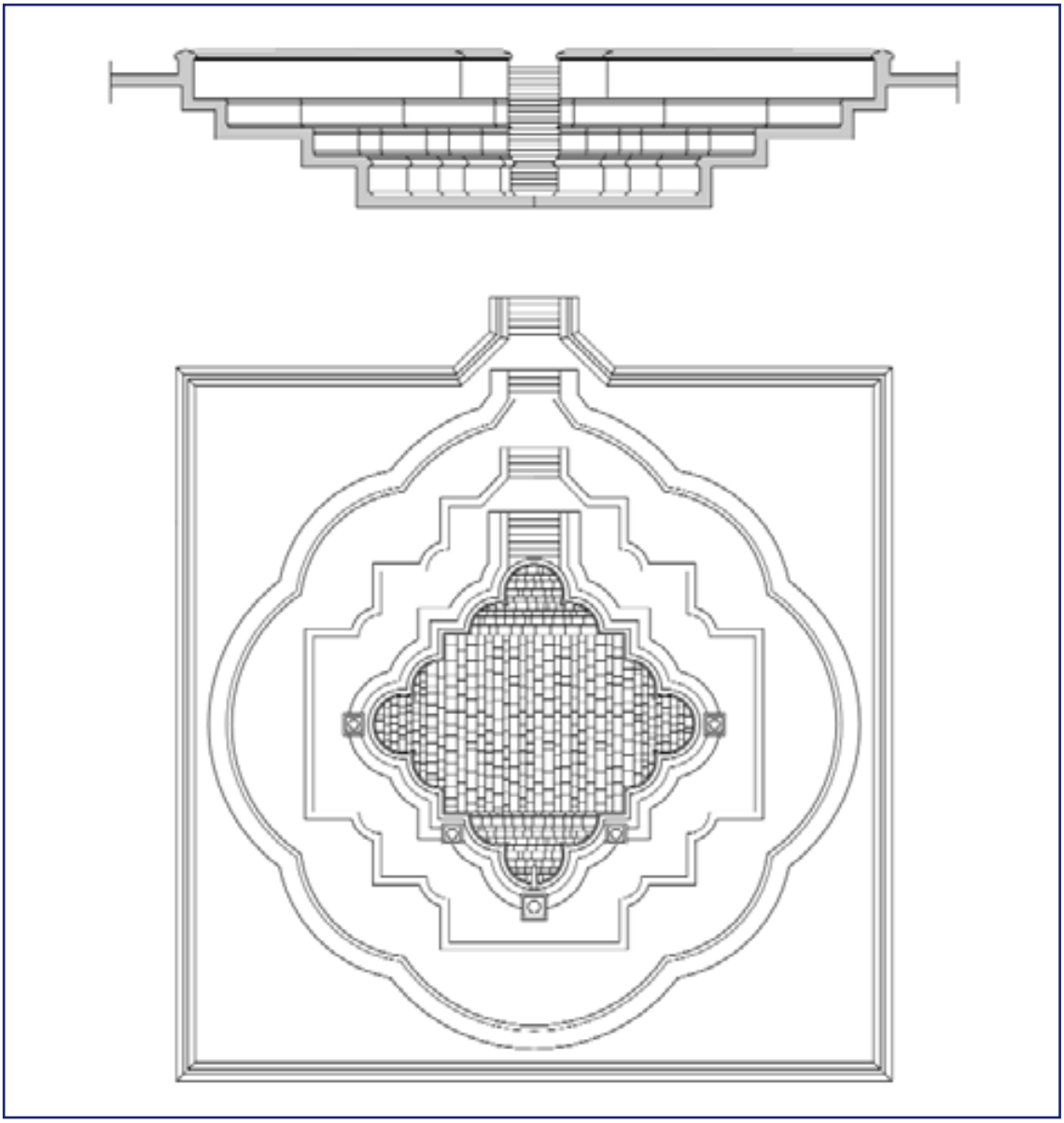


Plate 4.5 - Bhimsen Thapa fountain, Kathmandu

The urban fabric is full of fountains from different periods, all generally made from stone and decorated to different degrees according to their importance. A particularly relevant example is the Sundari Chowk in Patan, built in 1670, where the polilobate pond is a *dhara* type and has bas-reliefs inside it as well as different sculptural-symbolic elements made from stone inserted in the courtyard (Plate 4.6).

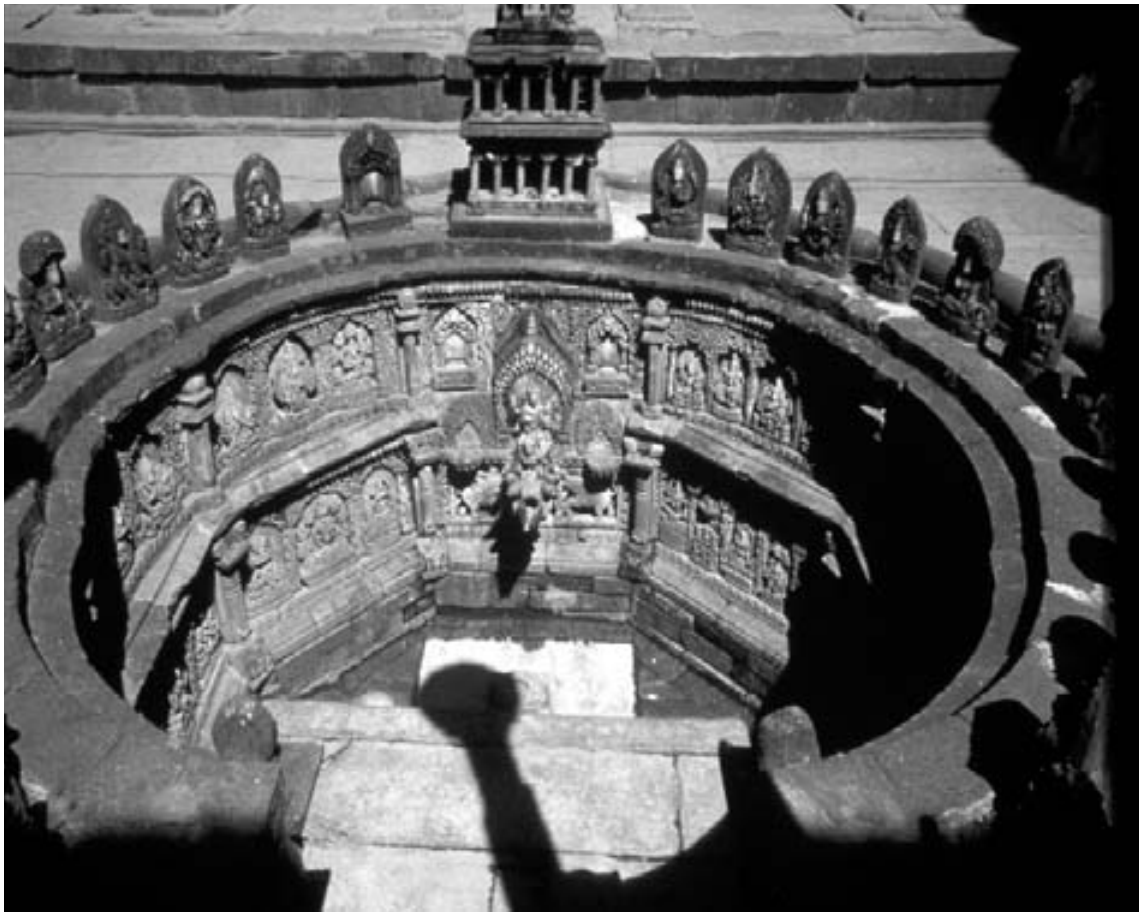


Plate 4.6 - Sundari Chowk, Patan Royal Palace, Patan

In the *ghats* of Kathmandu and Patan a large amount of stone was used to build the stairs going down to the water; the *bhakhari*, the circular platforms in between the stairways; the *brahmanalas*, the stone chutes that reunite the dead body with the river waters, as well as the pedestrian pavements found at the top of the stairways (Plate 4.7).

Intricate geometric stone carvings, carved from regular hewn stones are found in the *bhakhari.* In the *brahmanalas,* symbolic figures related to water cult are found at the bottom of the bas-reliefs (Plate 4.8).

Plate 4.7 - Detail of Shankhamul *ghat*, Patan

Plate 4.8 - Dead body chute, *brahmanalas*

During the Licchavi period, as well as the *dhara* type fountains there were other water tanks called *Jharu,* which were built in the towns or next to places of worship or pilgrimage. However, for a long time these fountains have not been used (Plate 4.9).

Plate 4.9 - *Jharu* fountain, Patan

Sculptural works

Nepalese stone sculpture started with the construction of religious buildings. Symbolic sculptures representing animals, mythological figures and sometimes warriors are usually found next to the temple entrance doors, in particular the main entrance, to protect the god's house from demons (Plates 4.10 and 4.11).

Plate 4.10 - Patta, one of the two Rajputs warriors, Dattatreya temple, Bhaktapur

Plate 4.11 - Statue of a king, Biswa Nath temple, Patan

Other noteworthy examples are the elephants that stand in front of Kirtipur temple that recall, with their posture of crushing a man, the conquest of the Valley by Prithvi Narayan Shah and the famous battle where the rebel population had their noses and ears cut off.

A famous example is the series of five pairs of carved stone figures standing on plinths along the side of the stair in front of the Nyatapola temple in Bhaktapur (Plate 4.12). It was noted by D. Wright who described it in his work *History of Nepal* of the year 1877: *"The staircase leading to the entrance guarded on each platform by two colossal figures. The lowest are statues of Jayalla Malla and Patta. Two champions of Bhatgaon Raja, which of whom is said to have had the strength of ten*

men. The next are elephants, ten times as strong as the men. The third are lions, ten times as strong as the elephants. The fourth are sarduls or griffins, ten times as strong as the lions. And the fifth are Byaghrini, two goddesses of supernatural power" (3).

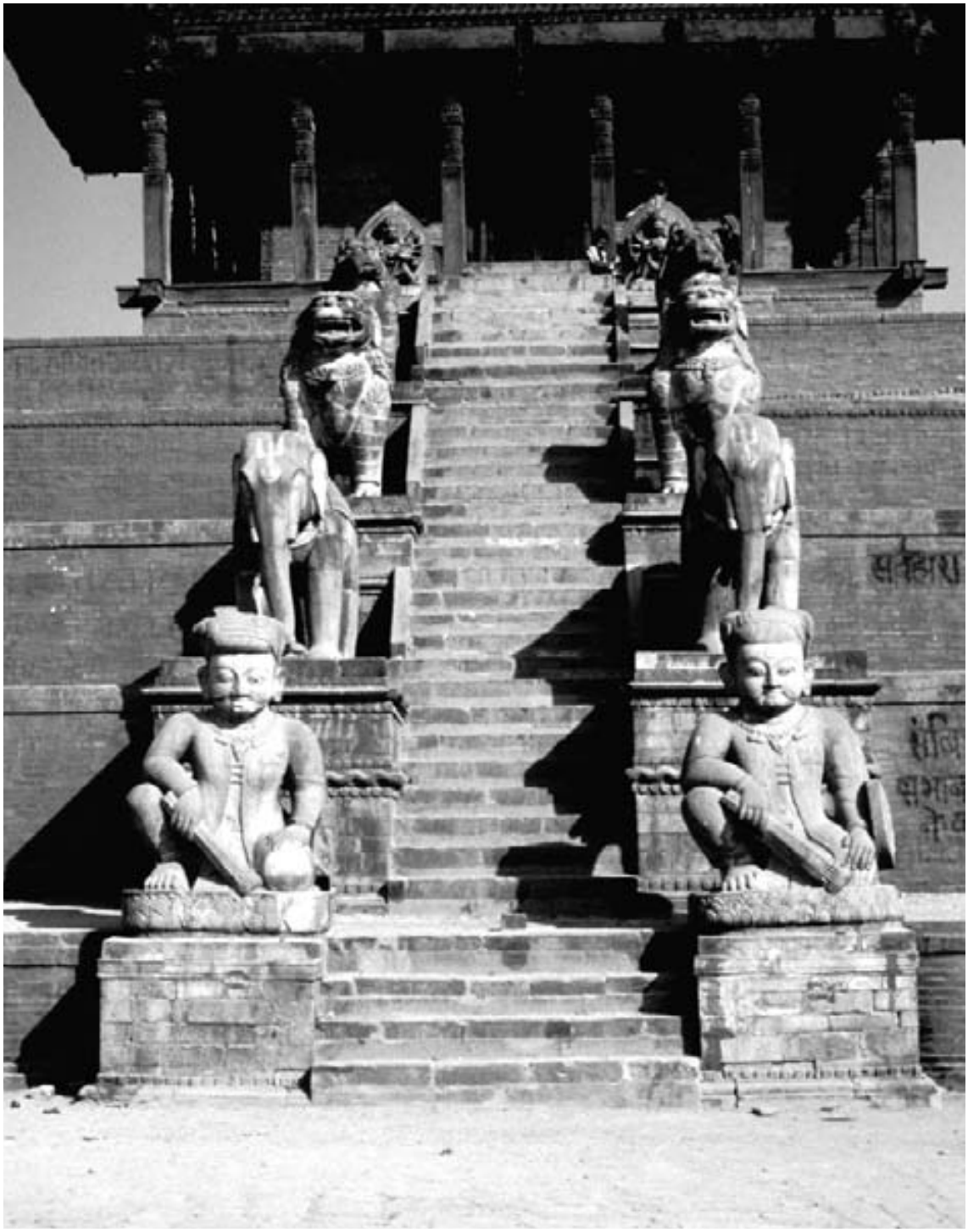


Plate 4.12 - Stairway to the Nyatapola temple, Bhaktapur

Other zoomorphic figures, most commonly lions, are usually found next to the entrance doors of particularly significant buildings such as temples, and royal or noble palaces. Wright observes: *"At some of the doorways are placed a couple of large stone lions or griffins, with well-curled manes"* (4) (Plate 4.13).

Plate 4.13 - Stone pillar and lion statue, Bungamati village

In the case where the figures are placed in front of the main temple entrance doors they represent the 'vehicle' of the deity worshiped at the temple. The most represented are the Nandi, the bull of Shiva; the Garuda, the griffin of Vishnu (Plate 4.14); and the Chuchundra, the mouse of Ganesh. Shiva, Vishnu and Ganesh are the most worshiped deities in Nepal, to which most parts of of the temple are dedicated. In some larger works the carvings are made by combining many separate hewn stones, each precisely worked and assembled to obtain the finished piece.

Plate 4.14 - Stone Garuda, Vishnu 'vehicle', Shankhamul complex, Patan

Chaitya and *stele*

Stone is used in *chaitya* (Plate 4.15), small commemorative *stupa*, of different periods, both Buddhist and Hindu, placed inside sacred complexes, house courtyards, and along the streets and squares. Gutschow gave a broad and detailed typological and historical description in his extensive book "*The Nepalese Caitya*", 1997, which gives further information on the subject (5).

Plate 4.15 - Buddhist *chaitya* inside Seeto Macchendranath temple, Kathmandu

Stone is also used in many commemorative steles found in squares next to the royal palaces, or inside sacred complexes. Steles are square in section, rising from a stone base with a symbolic representation of the universe, most commonly the tortoise (Plate 4.16). At the top of the pillar there is typically a lotus flower capital on which a bronze statue is placed. The statue is usually of a king, or an important symbolic figure like the Garuda.

These stone works demonstrate the stone's working properties, together with its resistance to heavy monsoon rains and to the seasonal climate changes.

Plate 4.16 - Stone stele, Changu Narayan complex

Houses

The brick walls of *Newar* houses stand on stone foundations. The stones used are typically found along the river beds and are neither cut or squared. Bricks pieces are also used for this operation.

Stone plates are laid underneath the foundations that symbolically represent the base of the universe. A ceremony is usually held when the foundations are laid and the house-owner puts a small vase with coins and rice grains, an offering to the house and soil gods, under the stone plates. This ritual is complex, as Toffin explains, and develops in different stages which are repeated again in later phases of the construction process (6). Sometimes in rural adobe houses not only the foundations are made in stone but also the walls up to the first floor. In urban settlements the entrance ways into the houses are also made in stone.

The widespread use of stone was still common up to thirty years ago when sewage flowed along the streets in ditches covered by big stone plates.

The pavements of some squares, like the Darbar square of Kathmandu are also made using stone plates of many different shapes but most commonly square. They are more resistant to the wear caused by the continual flow of cars and motorbikes, as well as to the monsoon rains.

Quarries

There is no written documentation about the location of quarries where stone was excavated in the past. This is unfortunate as it could provide valuable information, for example, when damaged pieces from monuments need to be replaced or restored today (7). The only readily available information is of the location of mines to be found around the hills of the Valley, where the stone is close to the surface. These mines are small and easy to excavate but often have to be closed to avoid collapse.

Nowadays stone is quarried in the surrounding hills and mountains of the Valley, particularly in the south near Parping village and Kirtipur city in a place called Macche Narayan Gaon and near Chobar gorge. Marble stone is said to be found near Godavari.

There are two main types of stone: a white stone (*bhuiyo o khairo dhunga*) and a black stone (*kalo dhunga*)(8). Both are metamorphic stones with fine packed grains. The white stone is mostly used to build pavements and is more easily quarried than the black stone which is mostly used for carving statues. The black stone is much stronger and more resistant and is very elegant and beautiful once it has been polished. Religious works of importance are made in the place where the stone outcrop is found, as is the case of the sleeping Vishnu in Banepa *ghats*, carved in situ by a famous artist of Patan, Dharma Raj Shakya. For the Boudhanilkhantha Vishnu, dating from the late 7th century, stone was probably extracted from Chobar gorge.

Traditional craftsmen

Sculptural art in Nepal, including works made in bronze as well as the other sectors, is religious art, with not only religious but also pragmatic functions. The two main religions of Nepal, are Buddhism and Hinduism, which both originally came from India. With them came the artists who created rigorous geometric forms to which each aspect of the cult refers. Beside the buildings themselves there are the sculptural forms with their precise physiognomy and design that the Nepalese artist never changed.

Due to the difficulty of transporting stone over great distances most of the works are carried out in the countryside. Bronze figures, however, are often brought from greater distances to the site as finished pieces. The stone craftsmen have developed a highly specialised ability to reproduce forms that closely respect the more accepted symbols of Indian art.

As Sanday says: "*It also appears that the stonecarvers do not have the same affinity with their material, as do the woodcarvers. (…) Today, the woodcarver will often double as a stonecarver, and many of the woodcarving families are descended from a stonecarver family. Most of the stonework carried out today consists of paving for roads and block cutting for kerbs around temple platforms*" (9).

Most stone-carver families are from Patan and their work places are located along these roads in the northeast area of Patan. They are organised in groups and still work in the same way today as they always did. They all descend from the Shakya family and have recently opened a big workshop in the 'Industrial Estate of Patan' where the Valley's stone carving production is concentrated. Only one Shakya family, still working with stone, lives in Bhaktapur. Patan families, however, are considered to be the best stone carvers in the Valley (Plates 4.17 and 4.18).

Plate 4.17 - Stone carver, Patan

Plate 4.18 - Stone carving tools

In general, nowadays, most stone carving production is for hotels and the tourist structures, because demand for new places of worship is not so common. In the commercial and tourist sectors, religious decorative features are often produced by integrating them into furniture pieces. *Chaitya*, lions, Buddhas, are the carved figures often found in the big sumptuous hotels and restaurants of the royal towns.

The Shakya families of Patan, together with metalworker families, give the city its character because they still maintain a well-defined autonomy and tradition. The legend of the birth of their profession reflects the mythical tradition of every family whose ancestors form an integral part of their present-day life and history.

The story goes that Abharay Raj Shakya, who built the Rudra Varna Mahavihar of Patan in 6th century was a skillful artist working for the king and able to work with many different materials including stone, *terracotta* and metal. He got married twice and went to live for a while in Bodhgaya, India, where he had 6 children. During this period he noticed that a stone had been following him. He decided to take it back home and put it near his bed. One night he had a dream where the

stone revealed its real nature. It was Buddha himself speaking to him. The Buddha told him to go back to Patan and build a temple in his honour. He went back to Nepal where, with the support of many gods, like Indra, who sent helpers, he built the great and famous Mahabuddha temple. From that moment he became father of all artists of the city and started to teach them many different skills inside the Vihar courtyards (10). Gutshow also recounts this legend, specifically referring to the construction of Mahabuddha temple (11).

Each family was related to a Vihar and the younger generations were able to learn the different types of skill and later decided which they preferred; stone, wood or metal work. They learned Sastra texts and the Ashta Shilpa Vishya, the eight skills of learning.

(1) KIRKPATRICK., ibid, p. 178.

(2) G. BEGUIN, *Nepal. La valle di Kathmandu*, in "Dimore umane, santuari divini", Il Bagatto, Roma, p. 229, 1987.
Translation of Italian quote - *constitutes one of the most ambitious works of architecture of all time. The cell on the first floor has a gallery which carries delicate projecting domes supported on pairs of decorative columns; this rhythm continues upwards giving the impression of a further two stories. Their form is derived from rajput and moghul architecture. The whole has a grace that approaches the famous creations of moghul art.*

(3) D. WRIGHT, *History of Nepal*, Cambridge, 1877, p. 17.

(4) D. WRIGHT, ibid, p. 10.

(5) N. GUTSCHOW, *The Nepalese Caitya*, Ed. Axel Menges, Stuttgart/London, 1997.

(6) G. TOFFIN, *Pyangaon, communauté newar de la vallée de Kathmandu*, Edition du CNRS, Paris, 1977.

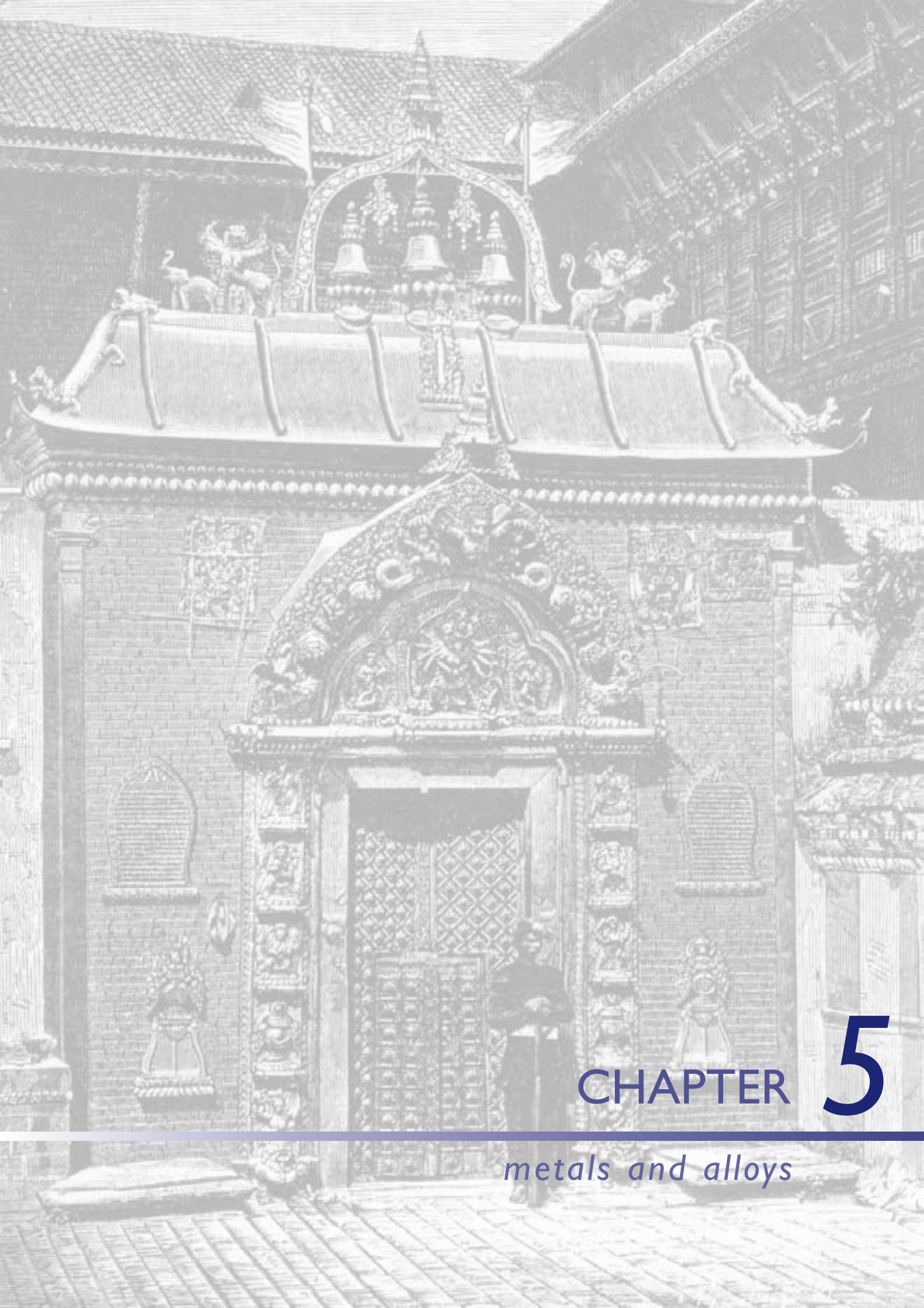
(7) The replacement of deteriorated parts of buildings using traditional methods which in some cases results in total reconstruction.

(8) For the results of the analysis see the Appendix I.

(9) J. SANDAY, ibid., p. 14.

(10) Personal communication of Budhaju Shankya, Patan.

(11) N. GUTSCHOW, ibid., p. 308.



CHAPTER 5

metals and alloys

Golden Gate to Bhaktapur Royal Palace

From Jo Fergusson, 1910

Metals and alloys

Kirkpatrick, while studying Kathmandu city, noted the presence of temples *"with two, three, and four sloping roofs, diminishing gradually as they ascend, and terminating pretty generally in pinnacles, which as well as some of the superior roofs, are splendidly gilt, and produce a very picturesque effect" (1)*. To this observation, Kirkpatrick adds some technical notes concerning the presence of mines in the country where different types of metals are quarried. Wright also observed: *"The roofs of many of them (the temples) are entirely of brass or copper gilt, and along the eaves of the different stories are hung numerous little bells, which tinkle in the breeze."* (2)

Hamilton (3) wrote about the existence of industries in Patan and Bhaktapur where copper, brass and *phul* is worked. He further noted that iron mines of different quality found throughout the country and quarried by the Kami family, a special category of workers. The best iron is used for the fabrication of knifes and swords.

Gold, silver, copper, brass and bronze are metals and alloys that *Newar* craftsmen have always worked with to produce masterpieces in the different artistic fields, often of a quality exceeding a simple craft activity. In particular, metals have always been used in religious urban architecture to emphasise the presence of their gods, demonstrating their ability to combine these noble materials with traditional ones.

Many temples have roofs clad in gold gilded copper. One of the most famous of this type is the temple of Kwa Baha, inside an old Buddhist monastery of Patan, better known as the 'Golden Temple'. Most gates to temples have a *Torana* made of gold gilded copper with many symbolic figures moulded on it in relief. The gate of the Royal Palace of Bhaktapur is entirely decorated with elements made of gold gilded copper.

The rings on *stupa* spires are usually made of gold gilded copper, as can be seen on the thirteen rings of Swayambhunath *stupa* and on many other *stupa* of the Valley, including the final roof (*gaju*) of many buildings.

For all these detailed works, the copper plates are worked when cold. The pinnacles are composed of many parts which are shaped by a series of beating operations using specially designed tools as well as many hammers with differently shaped heads according to what particular task they will perform. Chiselled copper plates cover the spouts of many *dhara* fountains, while others are made from gold gilded brass.

This process is called '*repoussé*', the hammering of sheet metal into relief, alternating the beating between the front and back of the sheets. This translates into English as 'pushed again'. Because of the unforgiving nature of this technique where, unlike casting, it is difficult to rectify mistakes, the practice of this technique is relatively rare. In Nepal, however it is a continuing tradition used mainly in Patan.

There are typically many bronze statues of deities, kings or zoomorphic and symbolic figures in front of temples or near to sacred areas, often placed on top of the stone pillars (Plates 5.1, 5.2 and 5.3).

The casting technique used in the making of all these works is called '*lost wax*' or '*cire perdu*', where bronze is cast into a clay mould that previously contained a wax model that has since been melted away. This method is still used today in many craft laboratories of the southeast zone of Patan.

Plate 5.1 - Stone stele with bronze Garuda statue

Plate 5.2 - Double *dorje* on top of a lotus flower pillar, Bodhnath

Plate 5.3 - Stele with a stone capital and a golden bronze statue of Buddhapindra Malla

The '*lost wax*' process

When using the '*lost wax*' process to make an image cast in metal the first step is to sculpt the image in the wax (Plates 5.4, 5.5 and 5.6). The wax mixture is prepared by melting together beeswax, vegetable oil, and resin from the *Sal* tree. The front and the back halves of the object are produced from separate sheets of wax. The two halves are then joined by heating their edges over a brazier and pressing them together. Refinements can be done at this stage by adding soft wax or by cutting away wax with thin steel blades. The clay mould to surround the wax is made in four stages. First the wax model is dipped in a fine sieved mixture of clay, cow dung and water. Four clay layers are applied by hand and dried in the sun. If the image is to be hollow the mould is also coated inside and requires a clay core. For hollow cast images, iron nails are driven through all exterior clay layers, the wax model and into the clay core. The nails keep the core from displacing when the wax

Plate 5.4 - Preparation of a wax model in a laboratory of a Patan Shakya family

is removed and the molten metal added. On the day of casting the clay mould is heated and the wax drains away. The empty mould and metal laden crucibles are stacked in separate kilns and fired for several hours. When the heated mould is removed, the master craftsman rapidly fills each mould with the exact quantity of molten metal needed. To assist the cooling process, the metal filled mould is immersed in water, removed and finally broken open to reveal the image. Afterwards another craftsmen proceeds with the cleaning process, smoothing and chiselling the image, using delicate tools.(4)

According to Ray, the most commonly used technique in historical times was the one technically known as '*retardataire*', but he confirms that '*lost wax*' technique was also known to *Newar* craftsmen (5).

As the traditional metal casters and artists possessed a highly advanced knowledge of the properties of alloys, they developed several alloys, each to be used for different purposes such as images, household utensils, or cooking pots and dishes. These workers used alloys composed of five metals called *Panch Dhatu*. They sometimes make alloys consisting of as many as 8 components, metals and alloys, called *Ashta Dhatu*. The first images found having been made with these alloys are nearly 1500 years old (Min Nath and Macchendra nath images in Lalitpur). The *Panch Dhatu* is made mainly with copper, but also brass, a mix of copper and tin, bronze, gold and silver. The *Ashta Dhatu* is made with copper, bronze, brass, zinc, lead, iron, gold, and silver.(6)

Plate 5.5 - Final touches being made to a wax model in a laboratory of a Patan Shakya family

Plate 5.6 - Wax model, laboratory of Patan

Bell casting

Of particular interest is bell casting. The Nepalese bells have specific shapes and dimensions. They need to be different from each other so that their individual ring-tones are distinct from one another. Traditionally there is one 'female' and one 'male' bell next to the temple entrance gates. They can be distinguished by their different rings. The bells have a particularly strong and sibilant sound so the worshipper's message can be transmitted directly to the divinity. Other musical instruments, mostly of Buddhist origin, like plates and singing bowls have the same function. They are all cast with a particular alloy made using several different metals (Plate 5.7).

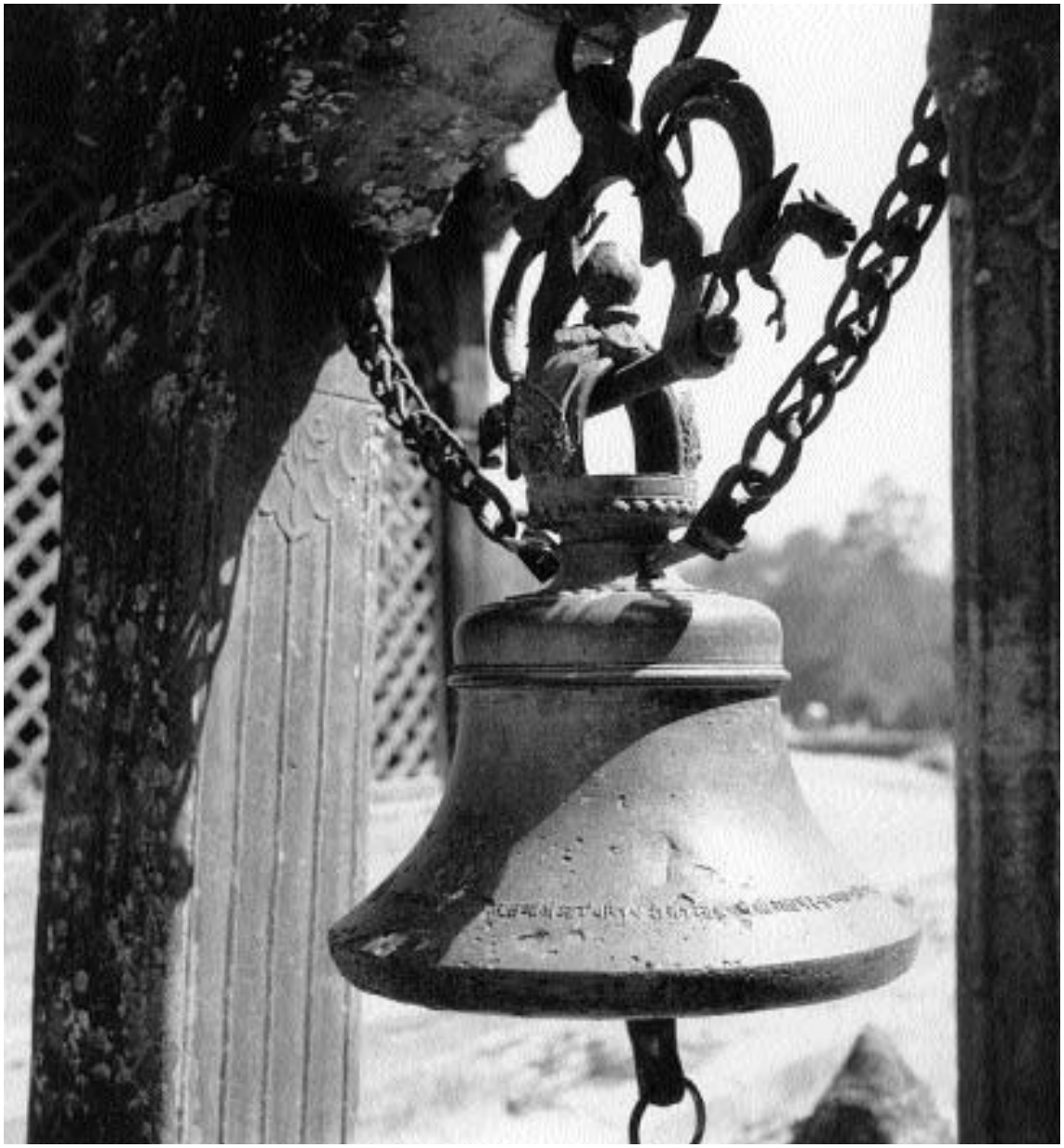


Plate 5.7 - Bronze bell next to Gokarna temple

Bells are present in every religious context. It is the only object that is never absent however big or small the temple is. In most cases the bell is found next to, or on the entrance gates of temples, inside the temple, in the worshipper's hand, and around the sacred complex. The bells are of all shapes and sizes. Sanday explains very well how the bells are cast and how the high quality results leave no doubt that bell making is a well established Nepalese tradition. He also describes the *'lost wax'* process: *"The first stage of the procedure is the making of the wax model of the bell which is then coated with a very fine textured clay mixed with dung to porridge like consistency. The bells are then dried in the sun after which a second and perhaps a third coat of the same mixture is applied and then sun dried. A much coarser clay mixture is then prepared by the addition of rice husks and applied. By this time each bell has an outer coating about ¼" thick carefully moulded by hand. The bell cast is then permitted to dry for about five or seven weeks until it is felt that the moulds have dried sufficiently to be capable of withstanding the molten metal. The moulds are heated over a fire to melt out the wax through a hole in the mould. Then a specially prepared alloy made from brass, tin and copper is poured back in through this hole. This work is carried out early in the morning to avoid the heat of the day. The crucibles in which the metal is melted are made from a coarse clay mixture. It takes many hours to melt the metal and the moment of pouring is very critical and has to be expertly judged. Once poured, the mould is allowed to cool after which the clay is broken away revealing the newly formed metal bell inside. The metal is then cleaned and all extraneous pieces are removed in preparation for the clappers and wind leaves which are now to be fixed."* (7)

Iron

Despite the presence of mines in the country, iron does not have any practical use in Nepalese architecture. As mentioned in Chapter 2 - Wood, nearly all joints are made using wood only, with no use of metal. Doors hinges are also made of wood.

The principle families working with iron, the Kami or the Kow, are members of lower casts in the Hindu context, They originally came from India during the latter part of the 12th and 13th century migrations (8). For the most part they have slowly integrated themselves in rural areas, where they provided and maintained farmers with tools for daily use. The use of iron, however, is widespread for making steel which is used for the fabrication of white weapons, symbols of the Ghurkha army (9).

With the stylistic transformations of the 19th century onwards, significant technological changes under British influence can be seen. In this period the introduction of the neoclassical style in palace architecture lead to the production of iron components such as gazebos, roofs and greenhouses. The main innovation, however, that characterized the area along the river in the Valley was the construction of a series of suspension bridges. They were all made in Europe, in particular in France and Scotland, and then assembled with great difficulty, in situ (10). Their origins are well documented on plaques fixed to the bridge pillars.

Suspension bridges are only used for pedestrian passage. Along the Bagmati river, there is one situated in Kathmandu and the others are located in the south of the Valley near Kirtipur city and near Chobar gorge. There is another further down the river. Another small iron suspension bridge, divided in two spans, crosses the Vishnumati river connecting Kathmandu with the Swayambhu's Sanctuary. Unfortunately there is no information to be found about previous bridges that crossed the Bagmati river in the Valley (11) (Plate 5.8).

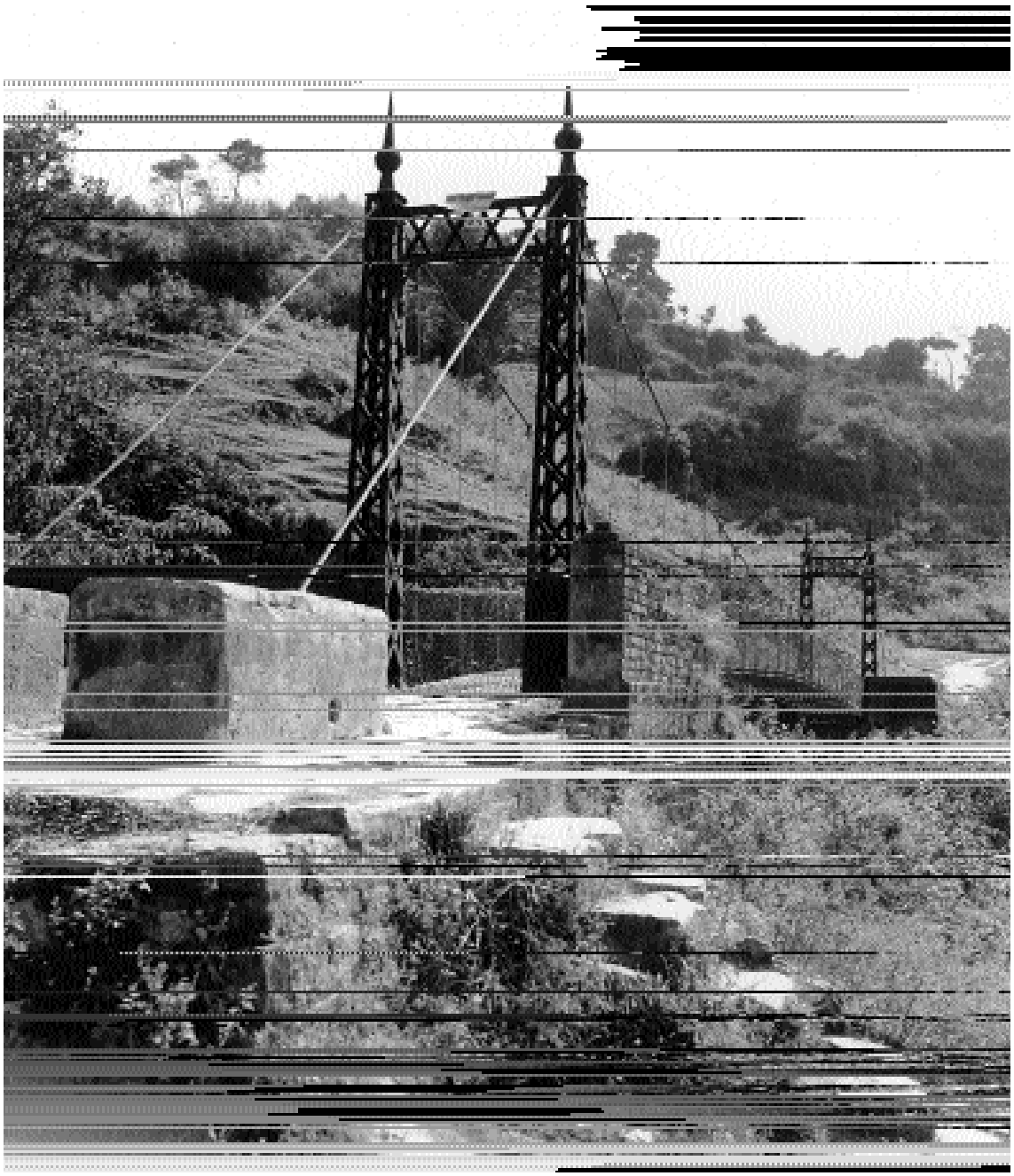


Plate 5.8 - Suspension bridge crossing the Bagmati river near Jalbinayak temple, built in 1906

Traditional craftsmen

During the first Malla period, trade with Tibet flourished and many craftsmen preferred to move to Tibet which was not under a cast regime. They were then better able to develop their technical abilities while maintaining their artistic Indian tradition, in particular in metalwork which was in greater demand in Tibet. For example the famous Nepalese artist Arniko, invited in the 13th century to the Mongolian court to build temples and statues in Tibet and China, that gave rise to a real and proper school of metal craftsmanship. They later returned to Nepal where they settled, for the most part, in Kathmandu and Patan where, associated with monasteries and the Buddhist tradition they continued to develop their craft skills, mostly in metal works (12).

Even though, in general, art was religious and therefore had to conform to some extent to a given set of parameters, in the metal sector, craftsmen had more scope to develop their artistic capacity, much more so than in the stone sector. Figures of kings, 'vehicles', or important divinities were mostly made in copper and bronze and craftsmen were able to give them more details (Plates 5.9 and 5.10).

Plate 5.9 - Preparation of a prayer wheel using the *repoussé* technique

In Patan museum there is an 18th century metal smith's reference manual concerned mainly with the making of sheet metal images of the Buddha. Various details are shown, accompanied by precise measurements. Even though a little difficult to decipher, this manual shows the precise knowledge of metal craftsmen who have had a strong tradition in metal casting for many centuries.

Later, families who worked with these materials were divided into casts according to the material they worked with i.e. copper, bronze, gold or other, in this way they became even more specialised in their work. Their names are Tamrakar, Shakya, Pemsakar, Kansakar, etc. though nowadays this division is not so apparent and clearly defined.

Plate 5.10 - Prayer wheel, Adinath Lokeshwar temple

In most cities and even in the smallest villages there was almost always one silver or gold smith, who often made women's jewellery (13). Some, like the Tamrakar copper workers who made pieces for public and architectonic works, worked with a large number of tools used to beat the copper, in particular for the making of the temple pinnacles. Gutshow explains in detail all the variations found in these tools.

The Shakya became specialised in making wax figures for casting statues. They began by patiently modeling the wax to make ornamental objects like bracelets, cloths, crowns or necklaces, that were used to decorate the statues. They often required several weeks to complete the works according to precise specifications. For bigger and more valuable statues it took much longer to complete the work.

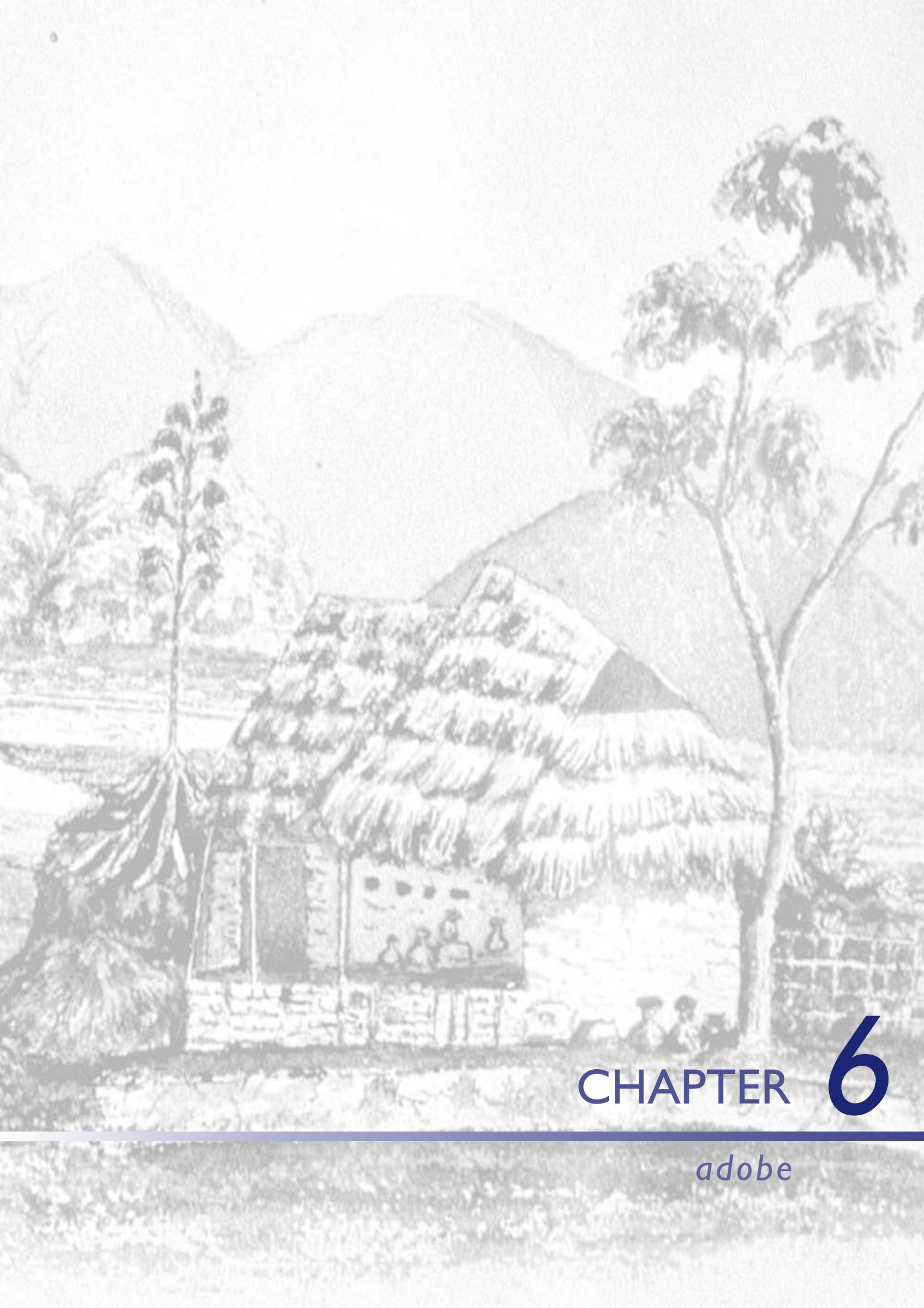
The Rana period had a negative influence on the development of these activities and many people had to limit their production to domestic items only like household pottery, cups, bowls, jugs etc. In the past they exported most of their works to Tibet. Patan city also has an important role in the production of metal elements, as there are many experts here who are specialised in this particular field. Nowadays, thanks to the growing demands of tourists, these activities are undergoing a revival.

Walking along the streets of Patan, especially in the south-eastern zone, the rhythmic beating of hammers on brass or copper, resonates from the inner courtyards and workshops facing out onto the streets.

It is curious that in Patan, Tamrakar families, who specialised in working with copper, are the only ones in the Valley to have a temple dedicated to their personal god Vishwakarma. This temple is the Vishwakarma mandir of Ekagalli, and is entirely decorated with copper. The principal deity is situated on the ground floor and anybody can go to worship it, while Tamrakar *kuldeuta* is on the first floor and only families of that cast can go there to worship.

The story goes that this was once a private house of a Tamrakar family. One day an elderly man came to ask for a shelter. The man who was working there said to him that he could sleep where nowadays the altar is situated. Some time later the the Tamrakar went in search of the old man but was unable to find him. Eventually he found a stone in the place where he had been and suddenly understood that old man was Vishwakarma. When the man became old he decided to move out of the house and to leave the house in his honour. Now all his descendants take care of the place.

(1) KIRCKPATRICK, ibid., p. 159.
(2) D. WRIGHT, ibid.
(3) F.B. HAMILTON, ibid.
(4) Patan Museum Guide, The Patan Museum, Nepal, 2002.
(5) A. RAY, *Art of Nepal*, Indian council for cultural relations, New Delhi, 1973.
(6) C.L. GAJUREL K.K. VAIDYA K, Traditional arts and crafts of Nepal, S. Chand & Company Ltd., Ram Nagar, New Delhi, 1994, first published 1984.
(7) J. SANDAY, The *Hanuman Dhoka Royal Palace Kathmandu. Building conservation and local crafts*, in "AARP", London, 1974.
(8) M.S. SLUSSER, *Nepalmandala, A cultural study of the Kathmandu valley*, Princeton University Press, Princeton, 1982.
(9) Prithvi Narayan was a warrior prince that conquered the Kathmandu Valley in the middle of 18th century. His descendants were involved in many conquests. They were very skilled in producing weapons of which the most famous is the *kukri*, a traditional Nepalese knife also used for other purposes. The pictures of the different Maharaja that dominated the country are always painted with this knife beside them. There is a museum in Kathmandu, '*The Arsenal Museum*', noted by Landon (Nepal, vol. I, 1928, p. 260) where various of the weapons owned by the Prithvi Narayan and his descendants are kept.
(10) Cfr. V. SESTINI, *Preesistenze tecnologiche lungo il corso della Bagmati*, in "Bagmati River Park 2000, Preliminary Study", Edizioni Polistampa, Firenze, 1999.
(11) It was a suspension bridge that until some years ago connected Kathmandu with Patan city. It was reticular and its history is now documented on a stone stele placed next to the new bridge on the right bank where the Kathmandu *ghat* starts.
(12) M.S. SLUSSER, *Nepalmandala*, ibid.
(13) G. TOFFIN, *Pyangaon une étude du comunité newar*, Ed. du CNRS, Paris, 1977.



CHAPTER 6

adobe

Adobe house along Vishnumati river near Swayambhunath

From A. and H.A. Oldfield, 1880

Adobe

Earth is used in many different ways in the buildings of Valley. The principal and most characteristic use is for the construction of walls using sun dried bricks (adobe) where the two wall leaves are joined together using the same clay earth. Earth is also used for joints as a filling mortar and for the construction of traditional walls using fired bricks (1).

Adobe is not usually used as the main construction material for buildings in the historical centres with the odd exception. It is, however, very common in agricultural and rural contexts, particularly along the Bagmati River. The rammed earth (*pisé*) technique is never used in the Kathmandu Valley. Bricks are usually sun dried and made with earth found near the building site. The earth is left to season for a few days after which it is mixed and put in wooden brick shaped moulds and left to dry in the out doors. The same earth is used for making the mortar.

Adobe bricks are not usually laid directly on the ground, but on a foundation of stones found in nearby fields or along river beds (Plate 6.2). Two wall leaves make up the structure; the outer, visible leaf is usually built with good quality bricks or has a special finish, while the inner leaf has a simple rendered finish. The cavity between the leaves is filled with the same earth as that used to make the bricks and mortar. The total thickness is never less that 50 cm (Plate 6.1).

The two brick leaves are laid with one header followed by a stretcher, thus creating a strong cohesion with the filling material and a strong link between the two leaves. The outer leaf of many buildings is finished with a fine coloured earth plaster. Besides having an aesthetic role, especially when coloured, the plaster protects the bricks from the severe monsoon rains which erode the finest parts of the plaster leaving the bricks intact.

Clay earth is also used to model interiors: it is used for flooring, covering walls, modeling fireplaces and other fixed furniture, giving visual continuity to the interior space.

Earth has an important practical function in roof construction of both houses and temples. A stratum of clay is spread on the wooden boarding that forms the steep pitched plane supporting the tiles. This system, however useful in the short term, provokes damages to the roofs in the long term because of humidity, in particular rain, that infiltrates down the wood boarding resulting in the growth of plant matter and general decay. In order to resolve the problem, when roofs are restored, layers or bitumen are laid on the wood boarding before spreading the earth layer.

In some buildings the outer leaf is made using fired bricks while the inner leaf is made using adobe bricks. In other buildings only the parts visible from the street are made using fired bricks while the rest of the building is built using adobe. A stringcourse of bricks and decorations made using bricks of a particular shape make up the outer leaf. Floors and roofs are all made of wood and only two story buildings are usually built using this technique (Plate 6.2).

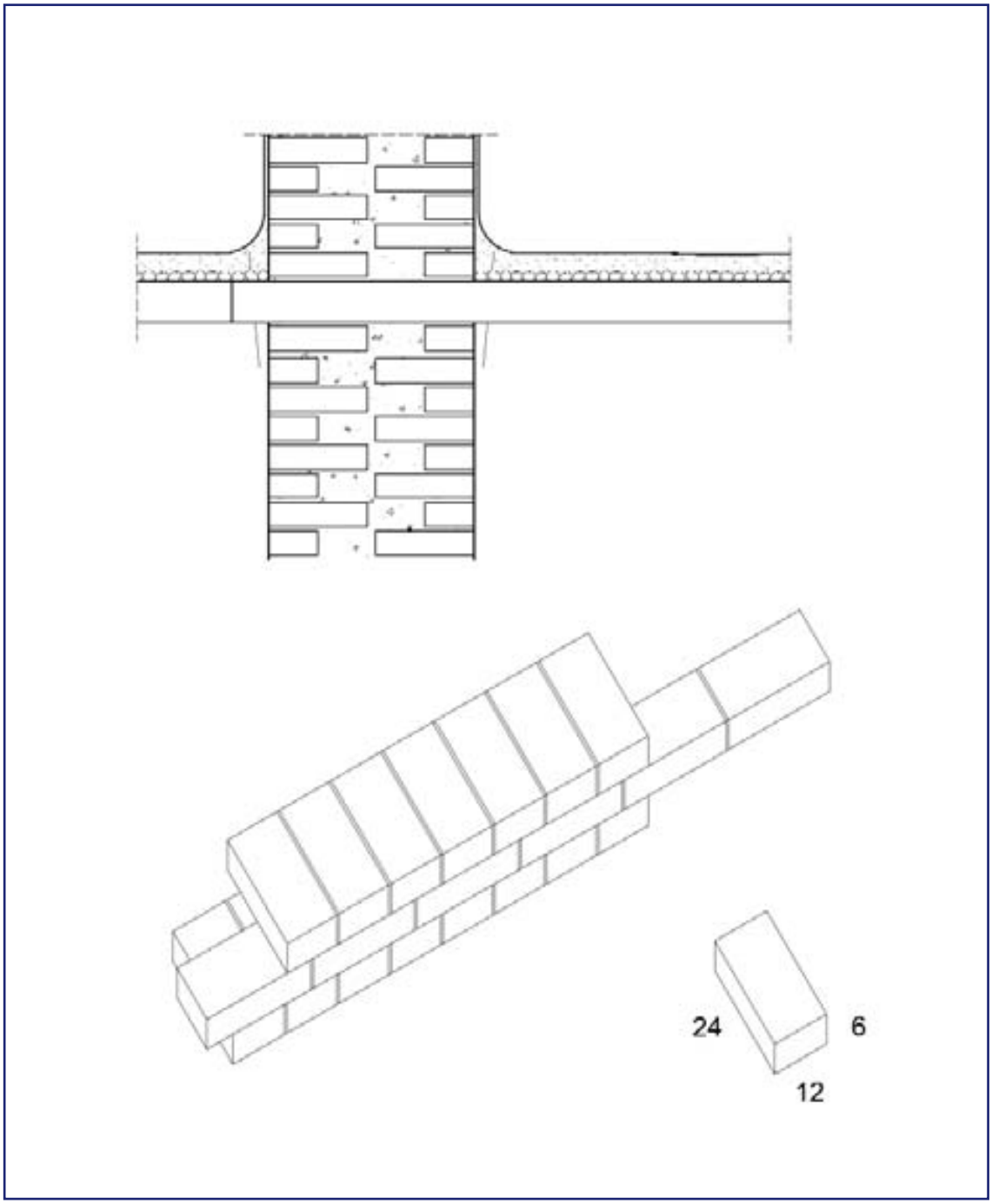


Plate 6.1 - Adobe wall, and typical dimensions of an adobe brick

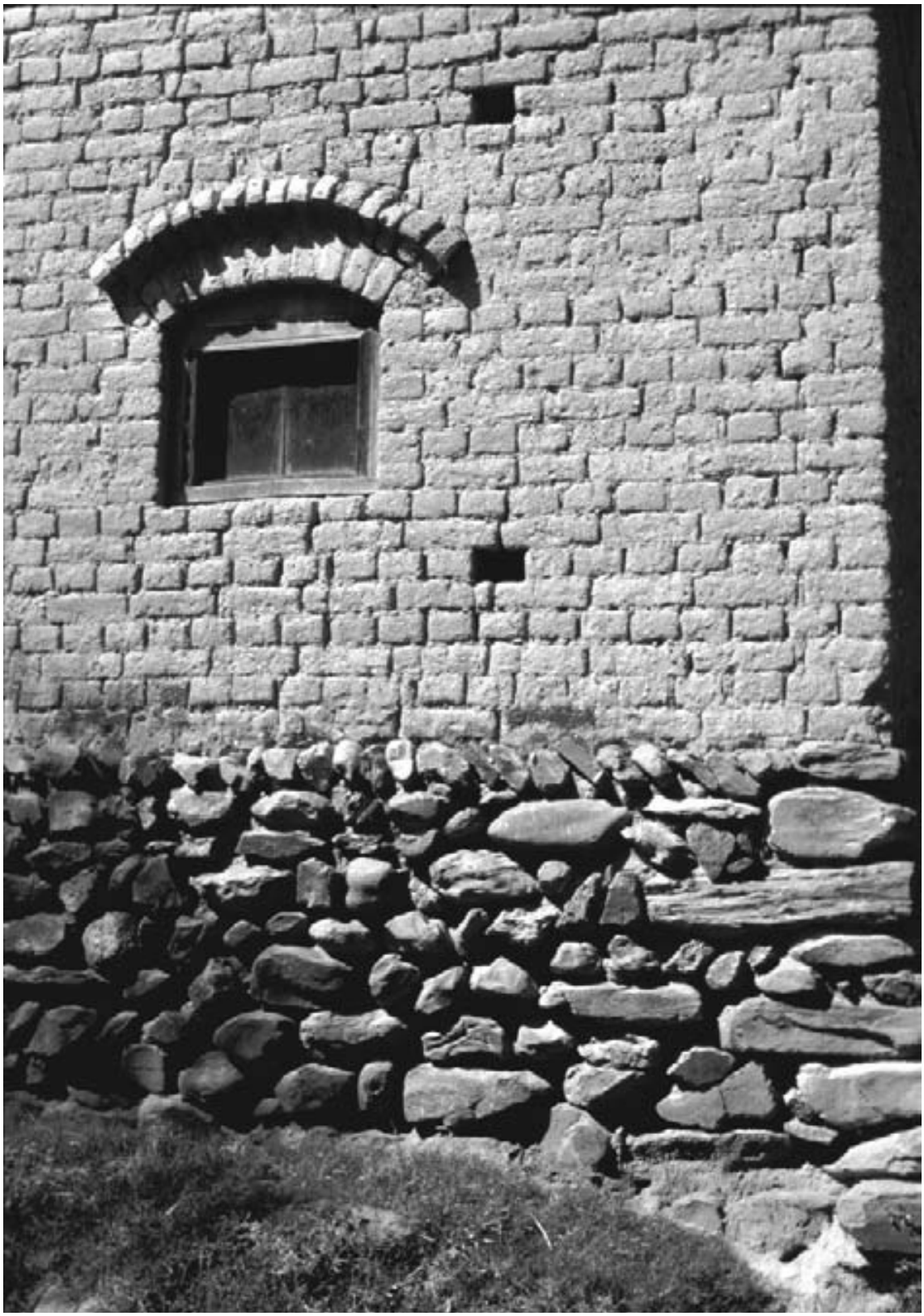


Plate 6.2 - Adobe house with stone foundations

Along the upper part of Bagmati River there are several villages with adobe houses and many isolated or small groups of buildings built along its banks (Plate 6.3). Among these villages is Gokarna, interesting for its urban fabric and location, where there are many adobe houses. Other adobe buildings are found on the southern stretch of the river, along towards Taudaha Lake near the Chobar gorge and similarly in many villages in the hills and neighbouring countryside.

Many of the surrounding villages of the Valley are built entirely using adobe, as it is less expensive than transporting bricks to be fired. Toffin observed that, when ever possible, a simple small kiln to fire the bricks was built nearby. For tile production, however, bigger kilns that are further away are generally used. In the rural context, as in the case of Pyangaon village studied by Toffin, the entire community was involved in the operation of building a house. The building process was most commonly carried out for three months during the winter when people had less work to do in the fields. One or several experts in building houses was normally called from other villages to undertake the site supervision (2).

Adobe architecture predominates along the Bagmati River and in rural areas in general. It blends in perfectly with the local environment, is ecological and is a part of the cultural patrimony of the Valley and should be conserved and protected in the same way as the monumental architecture.

Plate 6.3 - Adobe house along the Bagmati river, Uttarbahini

Research has been carried out on the *Newar* Gokarna village, with specific reference to the materials used, construction technologies, degradation, and seismic effects to which the entire Valley is subjected (Plate 6.4) (3).

A considerable amount of information has been obtained by looking at samples of clay earth used in the existing buildings, which reveal its mineralogical, granulometric and mechanical composition. The granulometric test, in particular, shows that the inert elements (sand particles), varied in size but all fell within acceptable limits. The mineralogical experiments demonstrated that the expansion of clay particles also fell within acceptable limits. Mechanical tests also showed that the crushing resistance of some samples remained within limits considered reasonable by experts in the field. Overall tests demonstrated the good qualities and potential of this earth as a viable building material.

In addition three research results showed that the resistance capacity of adobe buildings in Nepal to seismic movements is good providing the building has an adapted morphology, does not exceed two floors above the ground floor and has adequate links between the vertical and horizontal structural elements (4).

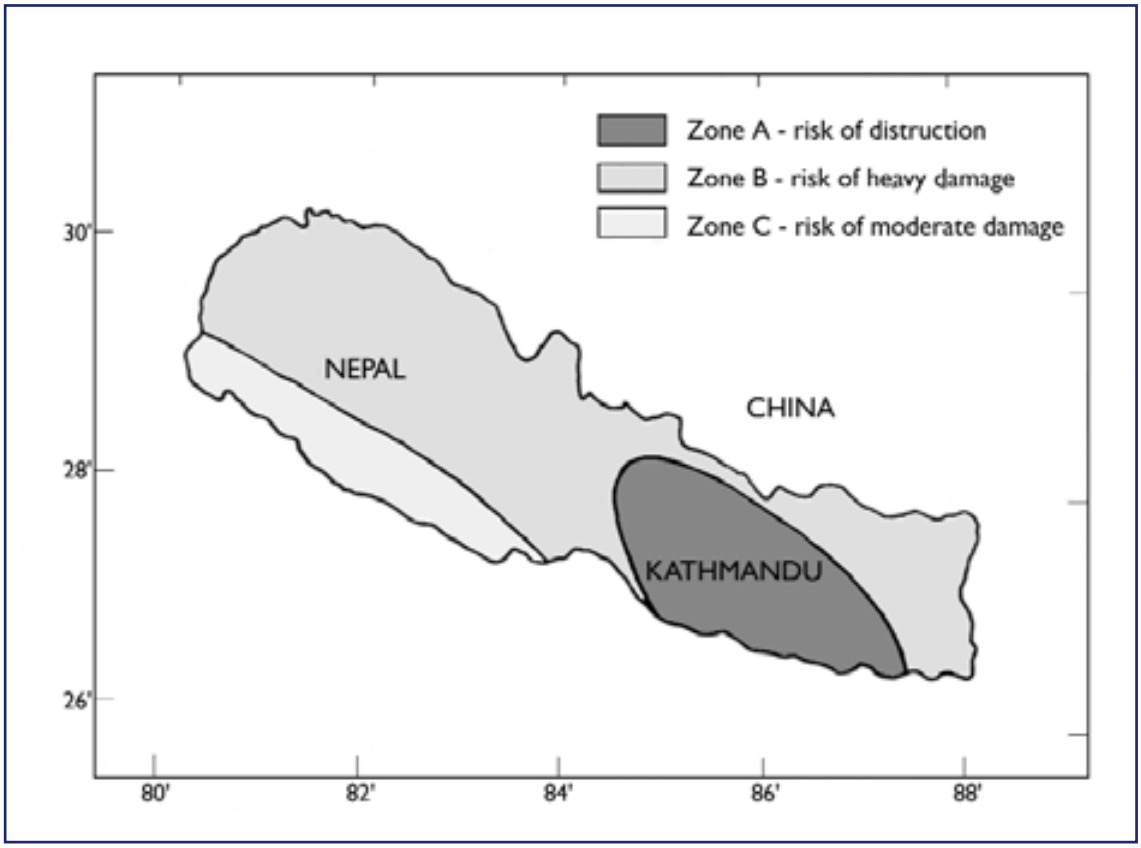


Plate 6.4 - Seismic zone map of Nepal (5)

Today the use of adobe as a construction material is still quite common in rural areas and people usually construct their houses themselves as they are used to using the locally available materials . Unfortunately the tendency is often to try and use new materials which are not necessarily better than the old ones.

Internationally, adobe has seen a strong revival, particularly in some developing countries where adobe has traditionally always been used. An important factor is that it is not expensive as there is no need for extra energy to fire the bricks or cement thus reducing costs and damage to the environment.

This international interest can be seen by looking at the wide range of literature available on the subject all over the world and by all the National or International Congresses held every year that discuss the subject.

There are many Institutions that research into the subject of adobe architecture like the Getty Conservation Institute in Los Angeles, USA; the International Centre for the study of the Preservation and the Restoration of Cultural Property (ICCROM) in Rome, Italy; and CRATerre in Grenoble, France. CRATerre has a UNESCO Chair in Earthen Architecture, Traditional Construction Methods and Sustainable Development (6). UNESCO has also included adobe architectures in the World Heritage List, the most famous of which are probably the cities of San'a and Shibban in Yemen as well as other examples found in other countries including Morocco. Architects like Wright and Le Corbusier were also interested in earth as a building material.

In the Himalayan context, the Kathmandu Valley is not an isolated example of adobe being used as a construction material. Earth constructions are also found in other Nepalese Himalayan valleys, as well as in Tibet and areas where Tibetan culture has become established (7).

By developing an awareness of traditional technologies of local building materials, notably earth, new and complementary building technologies that respect and take into account local traditions and the country's economic resources can evolve. In this context many of the living problems that have arisen because of the increase in population resulting from many people living on the borders and other parts of the country migrating to the Valley can also be addressed.

(1) Cfr. *Types of products and applications* (p.41) in Chapter 2 - Clay, bricks and tiles of this publication.

(2) G. TOFFIN, ibid., 1977.

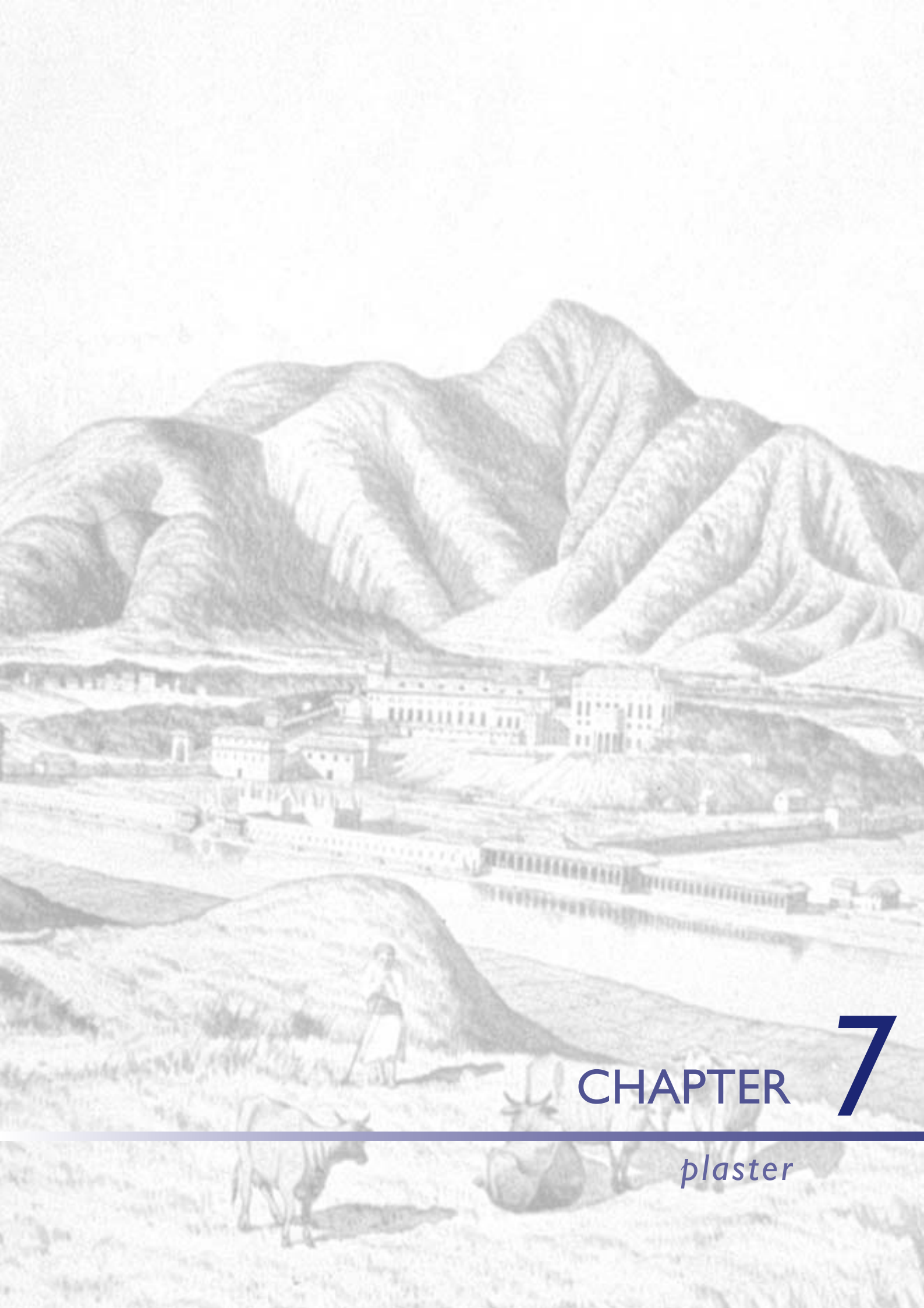
(3) Cfr. C. ALBERTINI, V. SESTINI, *La terra cruda nel patrimonio architettonico himalayano: L'architettura in crudo" della valle di Kathmandu (Nepal)*, memoria presentata al convegno "Festa della Terra, 2001/Architetture di terra e abitare sano", Casalincontrada (Chieti), 2001.

(4) C. ALBERTINI, *Tradizioni e tecniche innovative nell'architettura in "crudo" della valle di Kathmandu. Analisi e proposte per l'architettura in un insediamento newar*, tesi di laurea, Facoltà di Architettura, a.a. 2001-2002, relatore Prof. Valerio Sestini. For a summary of the research on the behaviour of a building in an earthquake, see the Appendix 2.

(5) Derived from map prepared by Pradhan of Tribhuvan University, Nepal.

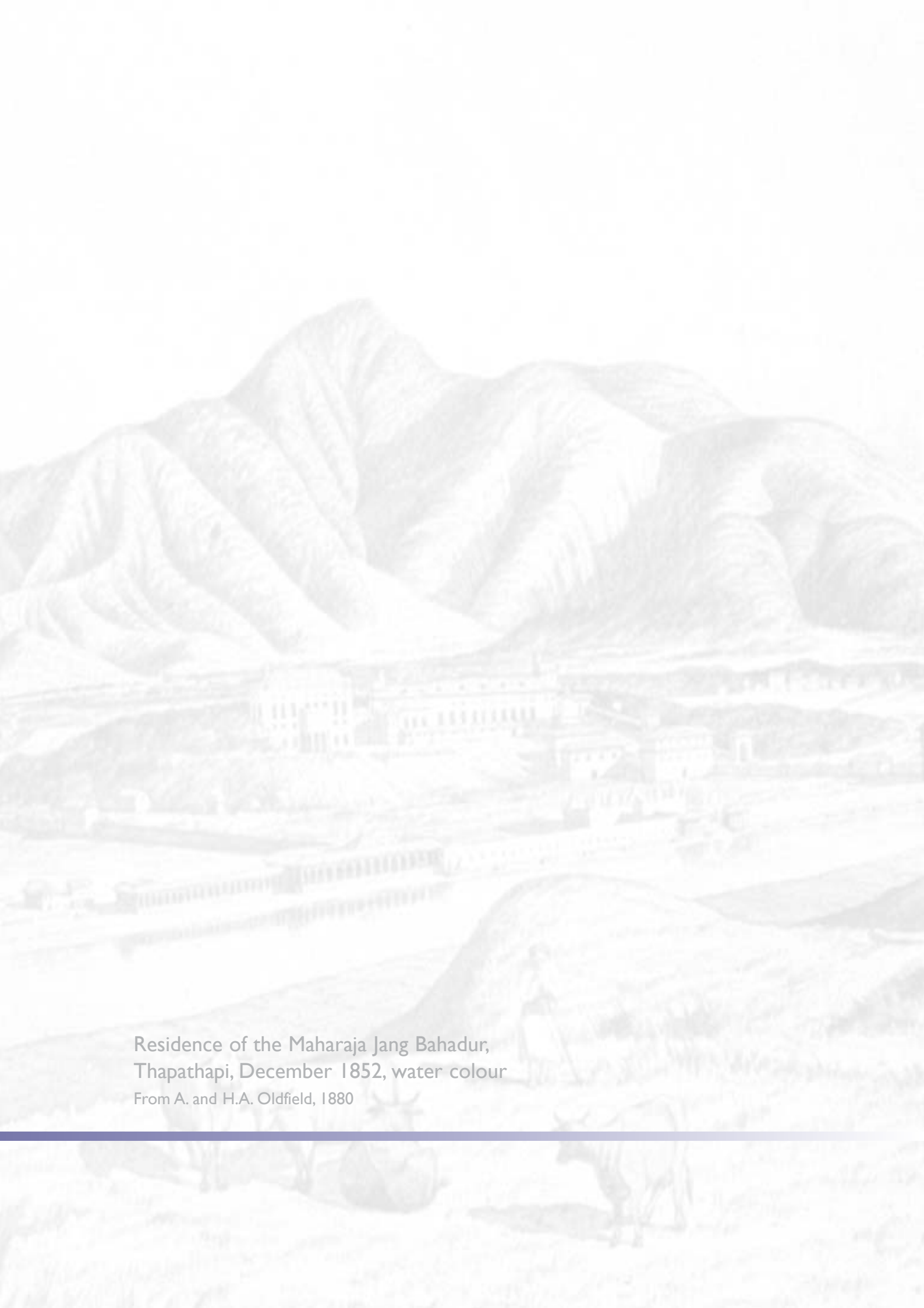
(6) CRATerre is the most important centre in the world for studies in earth architecture. Its activities started in 1979 and are oriented towards experimenting with the potential of earth as a modern construction material as well as to developing construction systems adaptable to the different cultures and societies in developing countries like Africa, India and South America. CRATerre have experimented widely with new technologies designed to improve the performance of earth as a building material.

(7) Cfr. V. SESTINI, *La terra cruda. Tradizioni e tecnologie nel patrimonio architettonico himalayano*, in "Costruire in laterizio", n° 64, Faenza, 1998.



CHAPTER 7

plaster



Residence of the Maharaja Jang Bahadur,
Thapathapi, December 1852, water colour
From A. and H.A. Oldfield, 1880

Plasters

As G. Nepali confirms: "*The walls of the house are plastered with a special kind of clay in which the Valley abounds and which serves the purpose of white-wash*" (1).

The use of plaster inside and outside common houses, particularly in the villages of the Kathmandu Valley has two main functions: to protect the house from water penetration due to heavy rains and to give the buildings their distinctive aesthetic character. G. Nepali describes how the plaster is made up using a special type of locally available clay, commonly found in the Valley, normally of a red or white colour. The houses are decorated externally by changing the colour of plaster between the first and second floors. Often the first floor is plastered using a lighter colour. The inner walls of these houses are traditionally also given a thin coating of red clay mixed up with cow dung and husk. This kind of plaster is damp-proof and the use of cow-dung in the plaster also acts as an insecticidal agent.

Beside the quarrying of clay, the variation of colours and mixing normally depends on the ethnic group (Tamang, Cheetri etc.) thus giving groups of villages their own well defined and distinct physiognomy.

In *Newar* tradition the special *daci appa* bricks, without the use of plaster, are used for the external facades of the temples and royal palaces. The *daci appa* provides protection against water penetration because of the special treatment administered before firing.

Recent research shows that the use of lime mortar must have been known to Nepalese artisans and builders for centuries. The ruins of some old masonry works found in Nepal where a lime mortar plaster was used, show a strong resistance against erosion.

With the rising power of the Rana family, around the middle of the 19th century, many neoclassical palaces were built. Additions and modifications were made to the Kathmandu Royal Palace in this neoclassical style, adding to previous changes that had been made in the late Moghul style. A completely new plastering technique was introduced at this time, based on the large use of air-hardening lime mortar (2).

Decorations in relief on frames, pilaster strips, columns and capitals, plastered surfaces, characteristic elements of neoclassical architecture, seen inside and outside many palaces, were made using this technique. Wright describes these buildings: "*the better class of buildings is elaborately ornamented with plaster and paintings*" (3) (Plates 7.1, 7.2 and 7.3).

Some of them are said to have been designed by three well known Nepali engineers: two brothers, Kishwor and Kumar Narshing Rana, and Dilly Jang Thapa, all of whom studied architecture in the former British founded Roorkee Institute of Engineering in India where they learnt about new European neoclassical forms and construction technologies. These palaces were built by workers from the Terai region, who under Indian influence became skilful in this particular technology. *Newar* craftsmen do not traditionally use the same method (Plate 7.4, 7.5 and 7.6).

Plate 7.1 - Detail of the late Moghul style, Hanuman Dhoka Royal Palace, Kathmandu

Plate 7.2 - Neoclassical style palace, Pashupatinath

Plate 7.3 - Window detail

Lime mortar

Data found in existing publications provide varying information on lime mortar. Among the authors who have touched on this subject are Sanday who, with reference to the Rana period, defines '*stucco*', without giving any detailed information about its composition, as the material used for exterior coverings and plaster for inside works (4).

In his manual, Gutshow, describes plaster as a "*brick dust plaster*", known as Bajra in Nepali. It is composed of molasses, 1 part black pulse, jute, 2 parts brick dust and 1 part lime (5).

According to Gajurel (Professor of Chemistry at the Tribhuvan University, Kathmandu), lime-mortar is a mixture of the following: coarse brick powder and lime, locally called *bajra* mortar. When large quantities of lime mortar are required this brick powder is mixed with black treacle - to make the mortar hard and quick drying, *saldhup* - a resinous oil from the *Sal* tree to make the mortar harder, jute fibre, *methi*, *mas* - otherwise called black gram. Black treacle is said to be used for the construction of big palatial buildings of the Valley, such as Singha Darbar, Singha Mahal. Even if the addition of black treacle was known to ancient builders, this material was expensive and therefore only used by more wealthy people. It was also said that the use of minced jute fibres along with black treacle made the lime mortar much stronger as a binding agent in masonry. *Saldhup*, with coarse brick powder, was said to be used as a paint for temples in the past. *Methi* and *mas* were boiled in water until a syrupy extract was obtained. It was then added to the lime mortar along with finely cut hemp fibres. This variety of mortar seemed to be of better quality than today's cement concrete mortar.

Gajurel says that the *bajra* was normally used as a lime plaster. B*ajra* sometimes referred to as *vajra* is a symbol of strength in the Nepalese tradition. It is composed of 2 parts brick powder, 1 part lime and 1 part sand.

Normally in the preparation of lime mortar the materials, coarse brick powder, sand and slaked lime were mixed and placed in a rectangular pit made of bricks to which was added the minimum quantity of water necessary for its workability. When large quantities of lime mortar were required for bigger building projects, a big circular pit was dug out and lined with bricks. A heavy grinding stone attached to the centre was rolled along the pit. White washing is commonly used as a finishing work (6).

In order to investigate 19th century plaster compositions Sestini and Bonapace analysed samples taken from buildings along the Shankhamul *ghat*. The laboratory results showed an heterogeneous composition of broken bricks and air-hardening lime, which is notable for its good resistance to humidity. It is similar to the plaster used in Roman times and called '*coccio pesto*' (7).

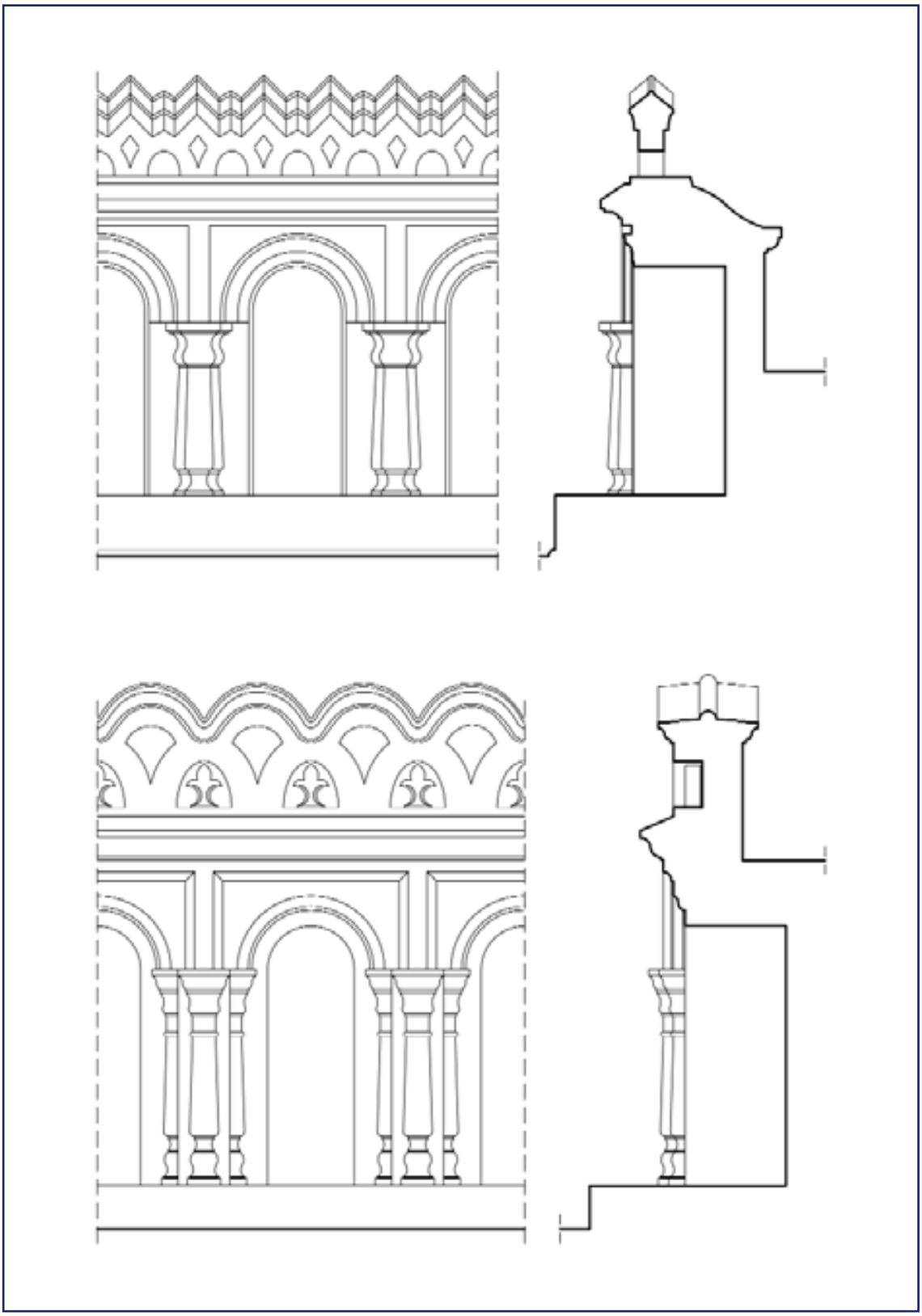


Plate 7.4 - Shankhamul *ghat* complex, Patan

Plate 7.5 - Singha Darbar, Kathmandu

Many traditional Nepalese works like *stupa* and *shikhara* temples, are totally or partially plastered. There is no documentation concerning the period when these temples were plastered. It can only be presumed that the most archaic *stupa* were initially hemispheric earthen tumuli, as three of the four Ashokhan *stupa* of Patan still are today. As regards the northern *stupa* of Patan, it is represented in a 1855 water colour painting published by A and H. Oldfield, It shows an earthen *anda* with with a spire finished in a different way (8). These changes took place in the last century as a photograph of the same earth *anda*, taken by Landon 1928, shows (9).

Plate 7.6 - Neoclassical part of the Hanuman Dhoka Royal Palace, Kathmandu

Other important examples of plastered *stupa* are the Bodhnath and the Carumati. Today both of them have a completely plastered basement, hemispheric *anda*, and a stepped pinnacle (Plate 7.7).

The construction of Bodhnath *stupa,* initially made of earth, was documented by many authors. There is one chalcography image from a photograph taken by Le Bon (10). It shows clearly that the high steps and pinnacle were made in stone, while the *anda* seems to be plastered already. Another of Le Bon's drawings shows that the *anda* of Swayambhunath *stupa* is plastered. The covering of these works with a total and uniform layer of white plaster gives them a plastic quality and a distinct visual presence. These works, according to tradition, are restored during special festivals where they are painted with a whitewash of lime.

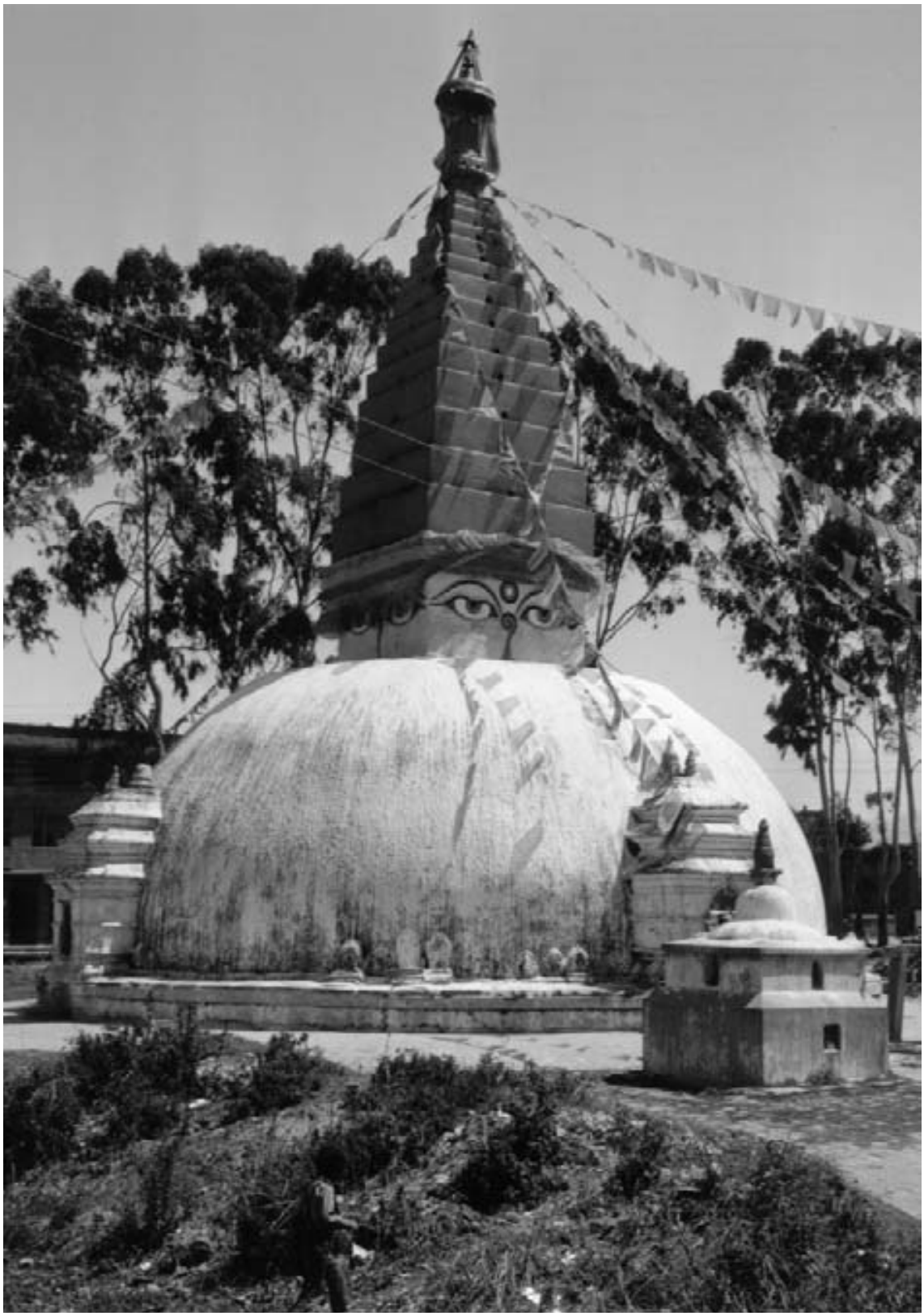


Plate 7.7 - Carumati *stupa*, Chabahil

Besides temples, *stupa* and statues, restoration works are also made on common houses on the first day of the long festival of Dasain, in September/October for 15 days, when the *Durga* goddess is worshiped. The houses are newly painted and cleaned for the celebration of one of the most important festivals of Nepal, the triumph of gods against demons.

Anderson explains: "*In preparation for Dasain every home is ceremonially cleansed with cowdung, decorated, painted and freshened for the visitation of Goddess Durga and the long-awaited return of distant and nearby family members.*" (11)

In most cases in the villages, it is the women who plaster and paint their house facades, in a simple way yet of a high quality. They work with cloths or long rags that allow them to pass from one window to the next without using a ladder, even for the higher parts of the facades. With straw brush like brooms, or a rag they paint the most accessible parts of the outer facade as well as the inside of the houses. They use their hands directly to plaster the trimmings, often ending up with both their hands and faces completely covered.

For the plastering and painting of Buddhist *stupa* and *chaitya,* monks do the work. They are organised in groups for the lime preparation. The higher part of the *stupa* is repainted by throwing big buckets of lime wash, hydrated lime diluted with plenty of water, directly onto the parts to be plastered (Plate 7.8). This operation is repeated many times a year on the occasion of important ceremonies. In the big courtyard that surrounds the Bodhnath *stupa* there was and still is a tank for mixing water and the air-hardening lime (often called alive, prior to being hydrated). Today the hydrated lime used for new painting is found ready made in powder form.

There are no special mines with stone for lime, only a deposit where air-hardening lime comes from in a kiln near a mine located in Joghi Mara, near Muglin, along the road to Terai. Gajurel says that deposits of limestones have been found in Bhainse and Bijaura (Karnali zone), where the limestone is fine-grained and compact but its chemical characteristics are rather variable.

With recent urban expansion and the spreading of new styles that do not have any direct link with the past, the Rana architecture (1846-1950) should be considered as a significant component of Nepali architecture that unfortunately, even today, is not considered to be very important and is therefore often not protected.

Plate 7.8 - Whitewashing Bodnath *stupa*

In the most recent architecture, cement is widely used for both walls and plasters as well as for the construction of reinforced cement concrete. A large scale cement production plant is located along the Bagmati river after the Chobar Gorge near the Jalbinayak temple complex. Limestone is quarried from a mine in the hills near the plant.

(1) G.S. NEPALI, *The newars*, Banaras Hindu University, Varanasi, 1964, p.57.
(2) C. BONAPACE, V. SESTINI, *L'architettura nepalese nel periodo Gurkhali*, in "bollettino ingegneri", n. 10, Firenze, 2000.
(3) D. WRIGHT, ibid. p.9.
(4) J. SANDAY, ibid., p. 19.
(5) GUTSCHOW, ibid., p. 189.
(6) The Romans understood that common lime mixed with an aggregate of broken bricks was very strong mechanically as well as being water resistant. These properties are due to the chemical reaction between the fired clay and common lime, similar to that of hydraulic limes. For research laboratory results see Appendix 1.
(7) C.L. GAJUREL, K.K. VAIDYA, *Traditional arts and crafts of Nepal*, S. Chand & Company Ltd., New Delhi, 1994.
(8) A. and H. A. OLDFIELD, *View from Nepal* 1851 - 1860, ristampa anastatica, Ratna Pustak Bandhar, Kathmandu, 1975.
(9) P. LANDON, *Nepal*, vol. I, London, 1928.
(10) G. LE BON, *Voyage to Nepal*, White Orchid Press, Bangkok, 1986 op. original in "*Voyage au Nepal! Le Tour du Monde*", Hachette, Paris, 1886.
(11) M.M. ANDERSON, *The festivals of Nepal*, Unwin Hyman Ltd., London, 1971.

conclusion

Painting of Bhairav god on Banepa Temple

Conclusions

Taking into consideration the enormous changes experienced by society in Nepal over the past 50 years and more, research undertaken for this publication has primarily aimed to establish if craftsmen today have the potential to produce construction and structural elements and materials that respect traditional methods for restoring and maintaining the large architectonic heritage of the country.

Newar craftsmen in the past as well as today have played an important role in passing down the Nepali architectural style to future generations thus helping to conserve the existing patrimony. These craftsmen, traditionally organised into groups according to their cast system, have passed on skills that have in some sectors excelled to such an extent as to become a recognised and respected art-form.

Although social structures and ways of living have changed in Nepal over the last century, research shows that craftsmen activities still remain relatively unchanged. Craftsmen still have many important skills in brick production, stone carving, metalwork and woodwork that are relevant to the present day. Woodcarvers, for example, still use traditional tools and technologies without the help of metals joints.

Craftsmen play an important role in the preservation of traditional technologies and skills, and by default the historical patrimony of Nepal. This specialised knowledge which in other countries has often almost disappeared helps to create a continuity with the past thus ensuring that past experiences never get lost.

For all these craft activities the presence of a responsible 'master' should not be forgotten. Traditionally, his 'master', the architect (*sthapati*), used religious and symbolic manuals of Indian origin, Vastu Sastra, and was guided by a Brahmin. For centuries, the Guthi association was responsible for the maintenance of religious or public works and organised the offerings of rich donators.

To better understand the role of craftsmen in the conservation of the Nepalese architectonic heritage, traditional methods and criteria used in restoration projects since the 1950s were analysed.

In Nepal, like in other Asian countries, the basis for intervention was demolition and reconstruction of the building in question, rather than restoration. These works were never preceded by rigorous graphic documentation in line with western methods. Each rehabilitation or reconstruction project was carried out by 'memory' and would vary depending on the particular craftsmen who was

carrying out the work, and their individual skills. The rehabilitated or reconstructed building was only required to function as it had always been designed to do so, and the methodology and process of work was not so important.

The Indian researcher Banerjee observes: "*The principles of repairs or restoration with a view to preserving the form, the shape and style of the structures as objects of legacy of the past and examples of the achievement of the olden days, was clearly not known or recognised or followed.*" He also wrote about the different interpretations of the Indian term jiranoddhara "*The omnibus ward used to describe the process of repairs or restoration, which included total reconstruction, was jiranoddhara, which literally means reclamation from the ruins*" (1). In other words, according to Indian and Buddhist ways of thinking, a re-birth and purification of the building from its state of decay can be achieved by using new materials.

After 1950, when access to Nepal opened out towards the western world, traditional concepts and rehabilitation methods were partially changed. There was an initial period where the different interventions undertaken by both local authorities and foreign experts were not homogeneous, resulting in a methodological confusion. More recently, however, there has been a convergence of ideas and criteria for intervention.

From traditional methods of demolition and reconstruction, a tendency to follow western criteria has gradually developed where international parameters and conventions are followed. Notably the "Convention for the Protection of the World Cultural and Natural Heritage", adopted at the UNESCO General Conference in the 1972, and accepted by Nepalese Government in 1978. Restoration works on the Pujari Math, a historically significant building in Bhaktapur city, were undertaken between 1971 and 1972 according to the terms of what became the World Heritage Convention (2).

In 1994, a Meeting was organised in Japan on the Authenticity in Relation to the World Convention. The subject matter was very relevant to Nepal and results of discussions reflected what others, like the director of the DOA of Nepal, Amatya in 1984 (3) and Larsen in 1992, supported (4). The results confirmed that: "*All judgement about values attributed to heritage as well as the credibility of related information sources may differ from culture to culture, and even within the same culture. It is thus not possible to base judgement of value and authenticity on fixed criteria. On the contrary, the respect due to all cultures requires that cultural heritage must be considered and judged within the cultural contexts to which it belongs.*" (point 11) (5).

CONCLUSION

From what can be seen in different building sites where recent interventions have been made or are being made, most of the works involve substituting the damaged parts only, in particular the wooden components. This approach is not generally considered to be in line with standard international conservation and restoration practices. According to some western conservationists, the methods adopted in Nepal and in other Asian countries are derived from a combination between local traditions and what is often referred to as the different '*Charts*' of restoration. The local traditional culture itself should also be taken into consideration, as it is part of the historic patrimony of the country and creates continuity with past and present.

Research undertaken for the preparation of this publication aimed to document the different materials and basic products used in Nepali architecture in order to consolidate and understand the commonly used construction methods with their inherent elements and morphology. The two most important construction materials used are bricks and wood. Fired clay bricks are almost always used for the construction of fair-faced walls, and wood is primarily used for structural elements. Bricks are also widely used in the construction street pavements, wide courtyards of *Newar* houses and monasteries and fired clay tiles are used for roofs. Because of their colour they give a visual uniformity to the urban and private spaces of Nepal's towns and cities.

Wood has helped Nepalese builders to create architectonic spaces that respect canonical forms and symbolism, indispensable to the religious cult where the *mandala* is the symbolic basis for the design of many works. Wood is also used for making the elaborately carved, almost sculptural frames, that beside their symbolism and beauty, hide a complex and elaborate method of construction not found in other cultures.

Stone and metal also have had an important role in the evolution of Nepalese architecture and are used in the making of sculptures and simple decoration or coverings which are important for giving symbolic and religious value to Nepalese architecture.

Even adobe, once used for the construction of urban buildings and nowadays found mainly in rural areas, constitutes an important part of the Nepalese cultural patrimony. The use of adobe provides an immediate and spontaneous ecological relationship between man and his environment. Adobe's qualities as a suitable building material can be demonstrated scientifically by carrying out laboratory experiments and analyses on soil samples. The positive findings that result confirm the intuition of Nepali people who have used this material for construction throughout history.

CONCLUSION

Construction technologies adopted during the Rana period, saw the use of new materials, in particular the wide use of lime plasters, which were and still are used to produce architectural elements typically found in neoclassical architecture.

Graphic documentation of important typologies, derived from a large campaign to record and archive research findings, gives future conservation experts immediate and valuable visual information, indispensable for the understanding of Nepalese architecture and its implicit technology and how best to intervene on future projects.

In conclusion, new management systems today have modified some of the production processes of these activities, in particular in the domain of brick production. For example the large scale production of bricks for new constructions in the urban context means that workers are not required to have specialised craftsmen skills and only the owner has a real in depth understanding of technical details and traditional methods. As a result the quality of the product is restricted because of trade demands. In contrast, however, bricks used for restoration work where a certain autonomy and continuity inside the historical family context is maintained, results in the maintenance of, and specialised technical skills required, to produce products of a certain quality, similar to those used for the historically famous constructions from the Malla period. The same can be said for restoration projects where wood, stone and metal are used. Where there is a lack of big orders at an industrial level, the possibility of a subdivision of individual roles is limited, thus maintaining a high quality product.

Even in the general management of the entire cultural patrimony, many changes have taken place in recent years. Where originally the Guthi and religious men had an important role in decision-making based on the offerings and donations of believers, today the Government has partially substituted this tradition through the establishment of institutions like the Department of Archaeology and through the Municipalities at a local level. Fundamental to progress is the collaboration with other countries that have organised projects that aim to restore many of the most important works which are very often located within the Nepalese World Heritage zones.

In this context the role of craftsmen assumes an important role from both a practical point of view as well as in conserving a living human patrimony by safeguarding skills and techniques that have been used throughout history and are indispensable for preserving the cultural heritage of the country.

(1) N.R. BANERJEE, op. cit., p. 156.
(2) N. GUTSCHOW, The Pujhari Math: a Survey of *Newar* Building Technique and Restoration Methods in the Valley of Kathmandu, in "East and West", vol. 26, nuova serie, Roma, 1976.
(3) S. AMATYA, A Brief Note on strategy of His Majesty's Government Conservation, in "Ancient Nepal", n. 79, Kathmandu, 1984.
(4) K. LARSEN, The Authenticity of the historic Building with particular reference to Japan, in "Icomos International Wood Committee, 8th International Symposium", Tapir Forlag, 1994.
(5) R. LEMAIRE, H. STOVEL, Nara Document on Authenticity, extract from the Nara Conference on Authenticity in Relation to the World Heritage Convention, 1-6 November 1994, Nara, Japan.

appendixes

Krishna Temple, Darbar Square, Patan

From G. Le Bon, 1886

Laboratory analysis

During research, samples of various materials were taken and analysed in the laboratory of the '*Study Centre for the causes of deterioration and conservation methods of art works*', of the CNR in Florence as well as in the laboratory for testing materials in the '*Department of Construction*' at Florence University. The analysis made on the samples gave some interesting preliminary results to be used as a basis for future research, which will be carried out on wider range of samples.

Earth

Samples of clay earth used to make different products were taken. Their mineralogical and clay composition were investigated.

Sample 1: Earth for fired bricks taken from a kiln near Thimi.
Sample 2: Black earth used for the fabrication of ceramic in Bhaktapur.
Sample 3: Earth for the fabrication of trapezoidal-cut bricks (*daci appa*) used in the construction of fair-face brick wall leaves.
Sample 4: Red earth used for colouring trapezoidal-cut bricks and ceramics.
Sample 5: Earth used to make the best quality ceramics, mixed together with a small quantity of white earth taken from a modern fabric (see sample 6).
Sample 6: Earth used to perfect the composition of the mix described in sample 5.

Results:

Table I.1 - Principal components

Sample	Qz Quartz	F Feldspar	Clay minerals
1	29	5	66
2	27	17	56
3	37	6	57
4	21	2	77
5	21	4	75
6	21	5	74

Table I.2 - Clay elements

Sample	K Kaolinite	I Illite	I-S Illite Smectite	S Smectite	Cl Chlorite	Cl-V Chlorite Vermiculite	V Vermiculite
1	15	35		50			
2	5	55			20	20	
3	10	25	35		10	20	
4	25	75					
5*	5	10	20				20
6	10	20	20	25	10	15	

* 45 % of this sample is talc.

Stone

Samples of stone were taken for analysis from a workshop in Patan.

Results:

Dark stone: this stone sample was found to have a very pronounced foliation with a lepidoplastic texture (oriented weave of mica blades) / nematoplastic (oriented weave of prisms o acicular). Micas and calcite-rich layers and quartz-rich layers were observed. Many cartonatici porphiroblasts and minor oxides from 10µm to 300µm in size were also found to be present. This stone is a medium grade metamorphic calcshist derived from the metamorphism of marly rock.

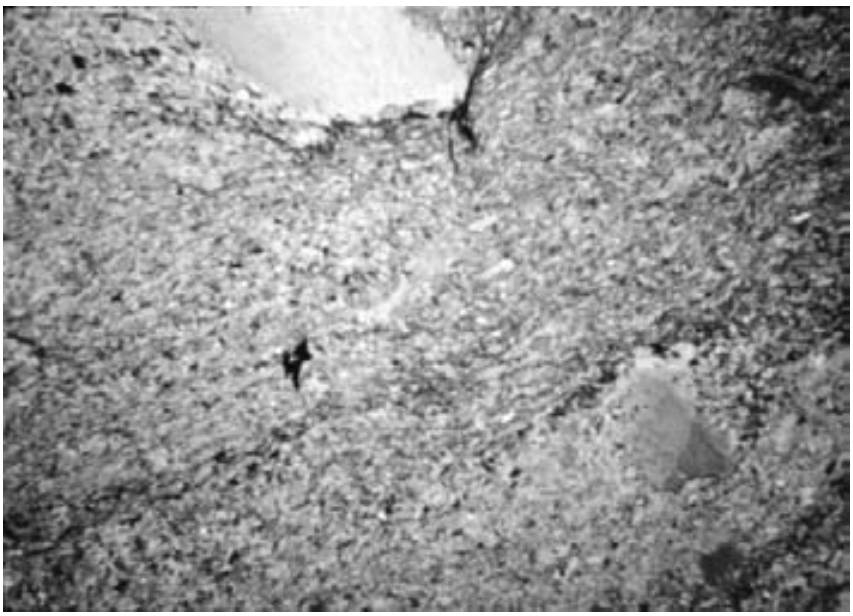


Plate I.1 - Dark stone (sample enlarged x 6)

Clear stone: this rock has a lepidoplastic texture. The smallest grains have a dimension no bigger than 30µm Many opaque minerals, about 10µm in size, were also found to be present. This stone is a phyllite, a low-grade metamorphic rock derived from a metamorphism of siltstone.

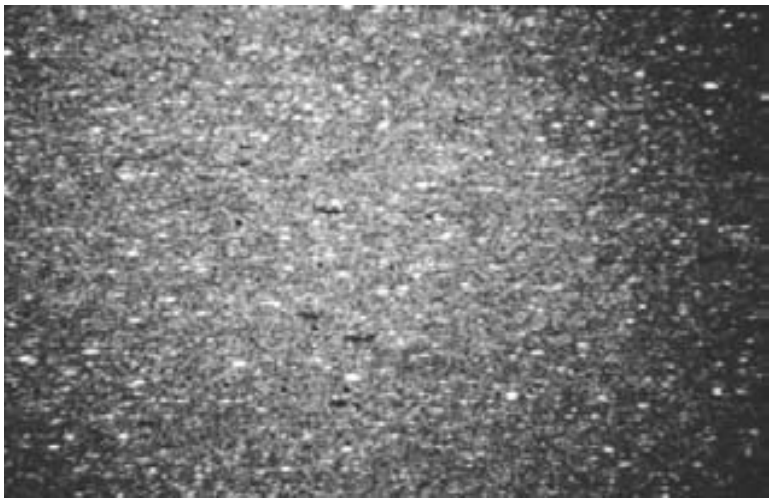


Plate I.2 - Clear stone (sample enlarged x 6)

Plaster

Samples were taken from the 18th century wall leaves of Sankhamul *ghat*.

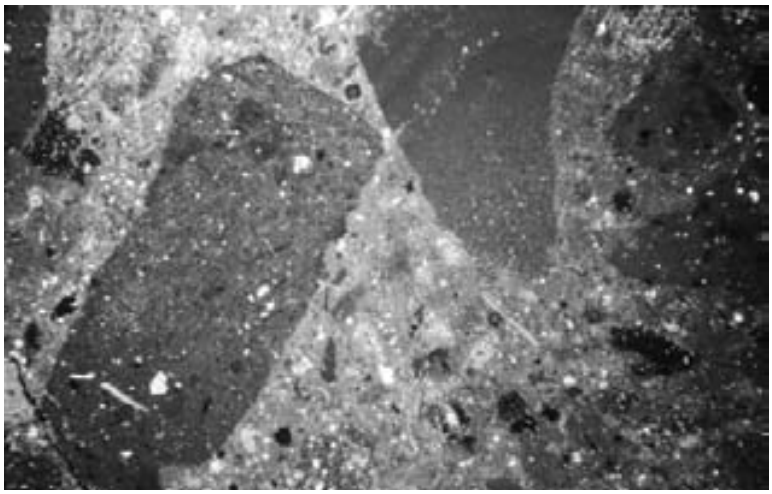


Plate I.3 - Plaster stone (sample enlarged x 6)

Results:

The mortar is composed of a scarce binder, made from lime and clay and an abundant aggregate, characterized by an unimodal granulometry, distributed in a non- homogeneous manner. This aggregate is mainly composed of brick fragments of different nature with millimetric dimensions (mm) and fine-grained sandstone fragments. The porosity is high with pores with an irregular shape and pores of cracks caused by shrinkage. Lime lumps are also observed. In the surface a film of lime wash is present partly detached from the substrate; its thickness is about 800µm.

How adobe constructions respond to earthquakes (V. Sestini and C. Albertini)

Construction material - earth: In the earth samples taken and analysed, two came from adobe houses in Gokarna village. The laboratory tests were designed to establish the appropriateness of this material as a construction material. Like for the other earths samples, a mineralogical analysis was carried out to find out the principal components and the composition of the clay minerals,

Results:

Table II.1 - Mineralogical analysis: principal components

Sample	Qz Quartz	F Feldspar	Clay minerals
1	37	21	42
2	36	16	48

Table II.2 - Mineralogical analysis: composition of the clay materials

Sample	K Kaolinite	I Illite	I-S Illite Smectite	S Smectite	Cl Chlorite	Cl-V Chlorite Vermiculite	V Vermiculite	I-C Illite Chlorite
1	15	50	30		5			
2	20	50			10		10	10

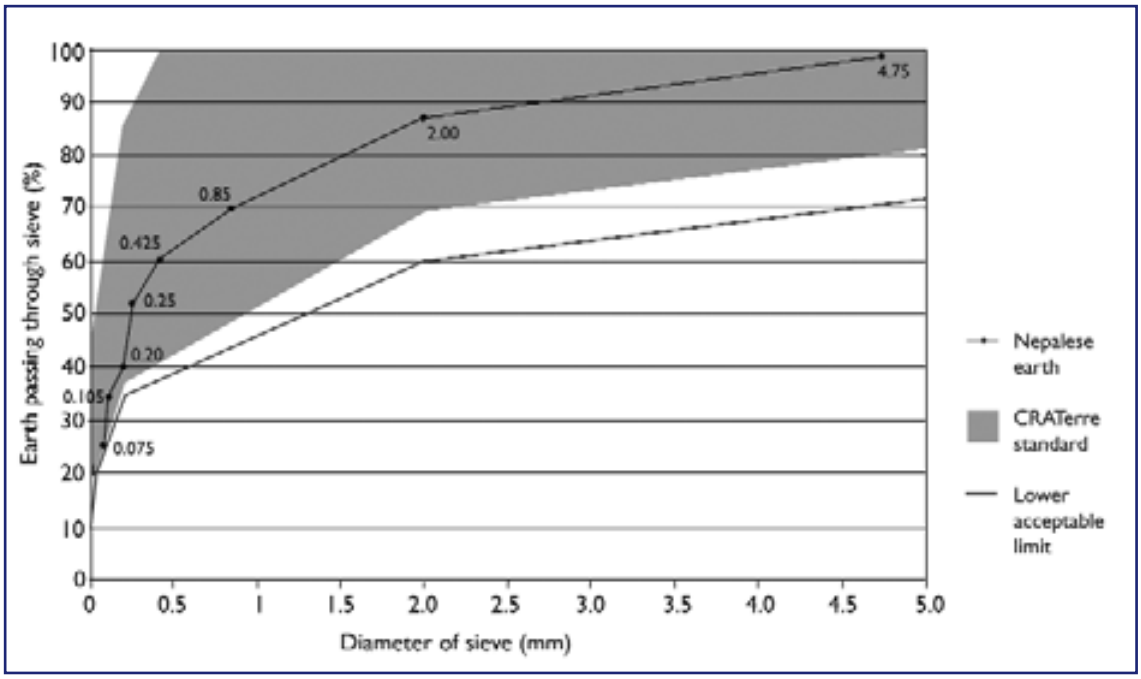
A comparison was made between the optimal values of the principal components as found in various documents on the subject and the results found in the laboratory. Findings show that the earth samples tested fall within acceptable limits.

Table II.3 - Comparison between the optimal values for earth and the values of the samples analysed

Sample	Sand (Qz+F)	Silt + Clay
Optimal Composition	55-75%	25-48%
1	58%	42%
2	52%	48%

Further analysis of the granulometry of the samples was made. The granulometric curve produced from the results clearly fall within the acceptable and even ideal limits as identified by CRATerre (Y axis = percentage of earth passing through; X axis = diameter of the sieve).

Table II.4 - Granulometric curve of earth taken as a sample



The monotonic (ever increasing load) and cyclic uniaxial compression tests were made on cubic samples of 6 x 6 x 6 cm. These tests were carried out on three samples and gave as results σ_k = 30 Kg/cm^2. This parameter has been obtained from the ratio between the peak load and the area of the single face (36 cm^2).

The results obtained with these tests constitute an initial attempt to pick out some of the mechanical properties useful for evaluating the load bearing capacity of structures made of adobe. Even though adobe is generally a poor construction material, the identified properties show that adobe is a suitable construction material if used in the right context.

Results imply that if the construction is not too big and if it is well protected against water penetration, the earth structure itself does not, in principal, present any structural problems. It is certain that appropriate construction methods will enhance the characteristics of earth construction and prove that this low cost and ecologically sound material is a suitable construction material in a large number of cases.

Seismic movements

The Himalayan range, including Kathmandu Valley, experiences frequent earthquakes. These are caused by orogenetic movements that originally gave rise to the Himalayan Mountains according to the recent theory of the drift of continents. Damage, by earthquakes, to the architectonic patrimony of the Valley has been considerable. The last big earthquake was in 1934 and the damage it caused can still be seen today in some cities. There was another violent earthquake about a hundred years before this that was documented by A. Campbell in '*The Journal of the Asiatic Society of Bengal*' published in Calcutta in 1833. Other negative effects of previous earthquakes are documented in inscriptions carved on tablets and commemorative steles. These 'open-air, historical accounts', are often found next to the restored or reconstructed works. Research into the availability of documentation on earthquakes in Nepal reveals that there have been no major studies carried out as to the seismic effects on the constructions of the Valley.

Structural seismic resistant design

Research on this subject looked at a building, housing two families, in Gokarna village. The plan and dimensions were surveyed and recorded so as to be able analyse the seismic action on the building (1). The building consist of two identical stories, all walls are made with adobe. The floors and roofs are made of wood.

A first goal of the research was to verify the capacity of the walls to absorb the seismic actions.

It is important to note that one of the immediate results of an earthquake is a sudden acceleration of the ground that is transmitted to the building. Depending on the mass of the building and the extent of the dynamic movements, inertial forces develop. These forces are transferred from wall to wall across the floor and subsequently transferred down the vertical structures. The floors should therefore be able to absorb part of the shock because of their rigidity (2). Increased rigidity implies increased absorption of the seismic forces. The seismic forces is transmitted from one element to another through the floors that should be sufficiently rigid in their horizontal plane and suitably linked to the different vertical elements. The resistance of the building is dependent on the efficiency of the connections between the walls, and between walls and floors, by creating rigid un-deformable plans.

The hypothesis indicated above could not be verified on the sample building due to a lack of rigid horizontal un-deformable plans. The distribution of the seismic forces should be proportionally divided to each cross walls and to each shear wall (3) making up the building, because horizontal forces are proportional to the vertical loads imposed on it, independent from its rigidity.

Computer simulated structural tests undertaken show that in absence of a static connection between the wall leaves and the horizontal structures only four wall leaves out of five were verified, thus implying that the building would not be resistant to an earthquake.

Structural improvements for existing buildings

On the basis of the results the idea was to hypothesize some interventions that could strengthen the rigidity of floors and introduce construction devices that could allow the building to act as a structural entity. In this way, the building could respond to the horizontal forces as a unified box structure of great rigidity reducing to a minimum the possibility of the walls or other construction elements breaking under the pressure of the forces imposed by the earthquake. The proposed interventions took into consideration the traditional technological systems used in existing constructions, using locally available materials that have empirically and intuitively been adopted by the local population. The hypothesized interventions can be summarised as follows:

- The substitution of wood elements both for floors and coverings which do not respect the construction concept of 'rigid plan', made by using double boarding laid at 45° to the joists;
- The making of wooden structures along the perimeter of all wall leaves, corresponding to the floors in such a way as to distribute the loads transmitted by the floors to the walls, to create an efficient link between the wall leaves, to join floor and wall by introducing wooden wedges inserted in the joists, also connecting the internal and external wall leaves;
- A link between the roof structures and the walls on the last floor to share part of the thrust generated by the strut on the walls with a link similar to the one described for the floors;
- The disposition of a couple of tie bars between the two struts, to reduce the outward thrust of them against the walls;
- The stiffening of the inclined plan of the roof by incorporating a double layers of wooden planks placed at 45°.

After having identified and represented the function of the single leaves through diagrams showing the load-movement, a second seismic verification was done in relation to the proposed new building in its entirety. The verification has been carried out using the same computer software and gave positive results.

Technological innovations

Beside the 'box system' intervention described above there is the technique of stabilisation, a way of permanently consolidating the earth. Stabilisation acts on earth in two ways: on the structure and on the texture. As far as structural stabilisation is concerned a chemical stabilisation can be adopted by adding natural, mineral or synthetic additives that modify the properties of the earth. Concerning

stabilisation of the texture as system of mechanical stabilisation is used whereby the earth is compressed so as to become denser. Mechanical stabilisation is achieved by mixing together grain fractions of different granulometry.

In the case of chemical stabilisation, the biggest impact will be on the mechanical resistance, reinforcing the molecular links and the permeability, filling the holes between the particles, thus limiting the absorption of water or humidity. Traditional natural additives used are vegetal fibres like straw, rice husks, ash, bitumen, elephant dung, and prickly pear mucilage.

Mechanical stabilisation and the physical act of compressing the earth has an impact on the porosity by reducing the volume of the spaces between the particles. In this way, both density and impermeability of the material is increased.

In the specific case of Nepal, the chemical stabilisation will be done by incorporating low cost additives found in-situ and of, in particular with prickly pear mucilage or a very small quantity of cement, a material readily found in Valley,

(1) It is important to underline that the shape of the building (the symmetric form) and the good construction technique, combine to increase its seismic resistance. These factors make the building develop a resistant behaviour also called 'box system' to counteract the seismic force.
(2) The concept of rigidity is exactly the opposite to that of flexibility or inflection. The more rigid the element is, the more it can absorb the seismic force. It can consequently lighten the most flexible elements. The structural resistance of the building is strictly linked to the rigidity if the single elements that compose it and that interact with each other.
(3) The cross wall leaf is the leaf that resists the earthquake. It lies in the same direction as the seism. As this direction cannot be foreseen, each cross wall is considered. It is composed of plane bands and shear walls. The first are portions of wall between two vertical openings (windows) belonging to superimposed stories. The second are portions of wall between two horizontal openings that are next to each other.

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GLOSSARY

Adobe Sun-dried earth brick.

Anda or Andakar Skr. Literal translation - 'egg'. In the context of Nepali architecture it is a hemispheric cupola that is built on the circular base of a *stupa*. Ancient Indian *stupa* had a stone wall around the base, delimiting the sacred space. Four entrance doors are situated according to the cardinal points around which a walking ritual can start.

Ashoka Ancient Indian emperor of the Maurya dynasty (273-232 B.C.) who converted to Buddhism and went to Nepal where he built the four Patan *stupa*.

Ashta dhatu Skr. Literal translation - 'eight metals'. An alloy used for crafting bells and metal Nepalese statues.

Awal New. *Newar* cast of bricks workers.

Bahal New. Buddhist monastery.

Bajra o Vajra Skr. Literal translation - 'thunderbolt'. Ritual object used by worshippers and priests.

Bhakhari Nep. Circular stone platform found along the Nepalese *ghats* that provides an interruption to the descent of the stairs leading down to the river.

Bhimsen Thapa Nepalese Prime Minister between 1800-1850.

Bhuiyo o kairo dunga Nep. Literal translation - 'white stone'. One of the principal stones found in the Kathmandu Valley.

Brahmanalas or Brahmma nalas Skr. Stone plate found along the *ghats* that facilitates contact of the river waters with the dead body.

Brahmin rope Symbol of the second rebirth, worn across the Brahmin's back.

Chaitya Skr. Derives from *chita* - funeral pyre. It originally referred to the ashes remaining from cremation and funerary mounds. It is a Buddhist funeral or commerative monument, sometimes housing sacred relics.

Chetri Skr. Cast of warriors in Hindu cast system.

Chuchundra Nep. The mouse, 'vehicle' of the god Ganesh.

Daci appa New. Trapezoidal-cut brick used for the external leaf of *Newar* houses and temples, commonly found in most urban contexts.

Dasain Nep. Nepalese and Indian festival where the victory of the goddess Durga over the demons is celebrated. Festivities last for 15 days and usually take place in September- October, according to the lunar calendar.

Dega New. Literal translation is temple. Commonly used to define the 'pagoda style' of temple, typical of *Newar* architecture with its many tiers.

GLOSSARY

Dhara	Nep. Fountain. Its main feature is that waterspouts are located below ground level. Access to water is through a descending staircase, which leads to one or more stone makara (waterspout) where water flows continuously.
Durga	Skr. One of the most important Hindu goddesses who has numerous forms, all of which are worshiped all over India and Nepal.
Gaju or Gajur	Nep. Gold gilded copper pinnacle found on the top of temples.
Ganesh	Elephant god, son of Shiva and Parvati, particularly worshiped in Nepal
Garuda	Man-bird, 'vehicle' of Vishnu.
Ghat	Skr. Public, social and religious space formed by stairs built along river banks that lead down to the water, often used for ritual purposes.
Guthi	Old social and religious association that has many functions, like the safeguarding and maintenance of public and religious works and buildings.
Gwaisasi	Nep. Type of tree commonly found in southern Nepal.
Haldup or Haldu	Nep. Type of tree commonly found in Nepal.
Hanuman	Hindu monkey god found in the epic poem Ramayana, often found fighting next to Rama. Hanuman is often found on or near thoroughfares like gates, gorges and rivers.
Jhigati or djigati	New. Typical Nepalese tile.
Jiranoddhara	Skr. Indian word that means 'redemption from ruins', to give life to.
Kalo dunga	Nep. Black stone. Together with the *bhuiyo dunga* it is the most common stone of the Kathmandu Valley.
Kami	Nep. Cast of iron workers.
Kansakar	New. *Newar* cast of metal workers.
Krishna	Hindu god, eighth Vishnu incarnation.
Kuldeuta	Nep. Literal translation - 'Cast god'. Tutelary god of a particular family or cast.
Lamaism	Particular evolution of Buddhism in Tibet.
Mahabharata	Indian epic, sacred book.
Manasara	Medieval Nepalese book of architecture, belonging to the Vastu Sastra.
Mandala	Skr. Painted representation of the universe in its creation. Basis for the construction of cities, temples and sacred images.
Mandapa	Skr. Nepalese evolution of the *Dharmasala*. Typical construction used for social activities like public meetings and trade exchanges. It is similar to the *sattal*, but it has a square base. It is said that the mandapa was situated in the centre of Kathmandu and became the Kastamandapa.
Mandir	Nep. Temple.
Manjusree	Nepalese Buddhist god linked to the legend that recounts the origins of the Kathmandu Valley.

GLOSSARY

Math	Skr. Social and religious Hindu institutions, Hindu priest house.
Moghul	Skr. Architectonic style that got its name from the muslim dynasty that reigned in India during the 19th century.
Nandi	Bull, 'vehicle' of Shiva.
Newar	Ethnic group of Kathmandu Valley. The term is used also for the style of architecture typical of the Kathmandu Valley.
Ograth or Agrakh	Nep. Type of tree. Common name for the *sal* tree.
Panch dhatu	Skr. Literal translation - 'five metals'. Alloy used in Nepal for the fabrication of objects including bells and statues.
Pemsakar	New. *Newar* cast of metal workers.
Pisé	A technique used in the construction of earth walls.
Prajapati	New. Cast of *terracotta* workers.
Puja	Nep. Offering ritual to a divinity.
Sal dhoop	Nep. *Sal* tree resin.
Salla	Nep. Type of tree commonly found in Nepal.
Shakya	Skr. Cast of stone workers in Patan.
Shikhara	Skr. Architectonic works of Hindu origin. Typically the *shikhara* is built with a cell with an image of one of the gods which is covered with a curvilinear tower.
Sikarmi	Nep. Carpenters.
Silapakar	New. *Newar* cast of wood workers.
Silay	New. Particular mixture made with oil, vegetal resin and red clay mixed to form a putty which is used to join the *daci appa* bricks.
Sisau	Nep. Type of tree commonly found in Nepal
Sthapati	Skr. Architect and priest.
Stupa	Skr. Literal translation - 'guide for man's enlightenment'. Originally a Buddhist reliquary mound. However, many stupas do not contain actual relics, and so the term has come to be applied to any Buddhist shrine or monument with a similar form or connotation.
Taleju	Nep. Nepalese goddess who protected his majesty's royal family
Tamang	Ethnic Nepalese group.
Tamrakar	New. *Newar* cast of metal workers.
Torana	New. Ornamental decoration found above temple doors, often made in gilded copper.
Utis	New. Type of tree commonly found in Nepal.