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Stepwells as Heritage Sites: Exploring Their Roles for Sustainable Communities

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Abstract: *Water is a vital element of nature and all life on earth and since historical times, human settlements have thrived around it. All sources of water and rivers are considered sacred across cultures. Many pilgrimage traditions involve rituals that include a holy dip and immersion in rivers. In India, temple complexes often feature structures like puṣkariṇi, kalyāṇi, kuṇḍa, sarovara, tālāba, and pukhuri, collectively known as temple tanks and stepwells, which reflect the societal and spiritual significance of water.*

This paper provides a comprehensive examination of stepwells in the Nagpur district along with their architectural details. The study analyzes the structural intricacies of these stepwells, including their organization, orientation, dimensions, ratios of length, width, and depth, along with morphological characteristics. The author aims to highlight the aesthetic and functional appeal of these wells.

The paper proposes a methodical approach to emphasize the importance of preserving these architectural marvels. It's about their dual role for heritage value or potential as tourist attractions, and even their crucial role in water conservation efforts as covered in UN sustainable development goals. The study emphasizes the pressing need to advocatefor their protection in contemporary contexts while recognizing the heritage significance of traditional stepwells which will ensure that future generationswill appreciate and celebrate these cultural treasures.

Keywords: *Bahuli vihirs, Architectural Heritage, Sustainable Water Management, Morphological Characteristics of Stepwells, Community Water Resources, Traditional Water Systems.*

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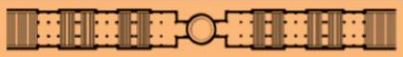
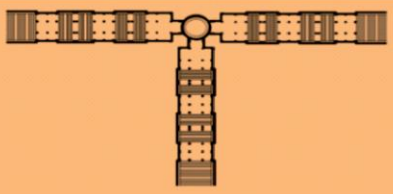
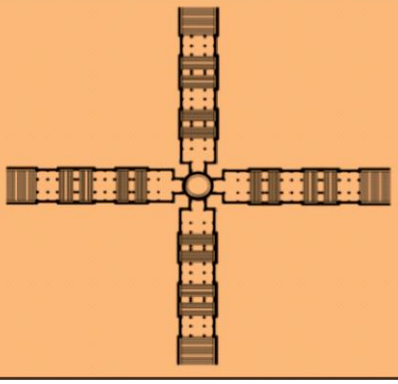
Introduction

Water holds a special and sacred place in Indian culture, as seen in ancient texts like the Vedas and the Nadīsūkta ("the hymn in praise of rivers",is 75th hymn/sukta of the 10th Mandala of Rigveda), which honor the concept of Sapta Sindhu. In India, the rivers and water bodies are considered

essential to the spiritual and practical aspects of life. A ritualistic immersion in these waters during pilgrimages is a common practice, while temple tanks, known as puṣkariṇi, kalyāṇi, kunḍa, sarovara, tālāba, and pukhuri, are worshipped as architectural symbols of this reverence. The ancient Indian wisdom, as recorded in the Chāndogyopaniṣad (a Sanskrit text embedded in the Chandogya Brahamana of the Samveda of Hinduism) and works attributed to the great sages like Vishwamitra and Kashyap, elucidates the profound significance of water. The sacred text of Bṛahatsaṃhitā by Varahamihira (a Sanskrit language encyclopedia),dating back to 550 CE, even describes methods for obtaining potable water from contaminated sources,indicating advanced knowledge along with a practical understanding of water management.

Furthermore, ancient texts like Parmāra King Bhoj's 'Samarāṅgansūtradhāra' (an 11th century poetic treatise on classical Indian architecture/vastu Shastra) and Shri Bhuvan Dev's Aparājitpṛchā (a 12th century sanskrit text notable for its sections on temple architecture/vastu, sculpture/shilpa,painting/chitra and classical music/sangita and dance/nritya) detail the classification and construction methodologies of stepwells, wells, and tanks. The Samarāṅgansūtradhāra emphasizes the utility, sustainability, and aesthetic appeal of stepwells, while the Aparājitpṛchā categorizes the stepwells into different types based on their structural characteristics. The two texts of Mayamata and Mānasāra (an ancient Sanskrit treatise on Indian architecture and design organized into 70 adhyayas/chapters and 10,000 shlokas/verses) serve as early repositories of knowledge onwater monuments, detailing features of structures like kūpa and vāpi. Aparājitpṛchā further refines this classification, categorizing stepwells into four different types based on their layout and design intricacies, namely Nanda, Bhadra, Jaya, and Vijaya, each characterized by different configurations of steps leading to the water source within the well as is seen in Table 1 below.

Table 1: Types of Stepwells in India

Sr. No.	Diameter of well	No. of exits	Cultural name	Place of provenance	Sketch
i)	0.75 m	1	*Nanda*	Bhavani Vav, Matar, Ahmedabad	
ii)	1.5 m	2	*Bhadra*	Dada hari ni Vav, Ahmedabad	
iii)	2.75 m	3	*Jaya*	Adalaj Vav, Gandhinagar	
iv)	3.5 m	4	*Vijaya*		

(*Source:* doi:10.16943/ijhs/2020/v55i2/154675)

The Bṛhatśilpaśāstra (Book 3, verse 532) and the Rāja vallabha (Chapter 4, verse 28) describe about the four types of step wells. These concise verses encapsulate essential information. Bunce (2013) conducted a comprehensive study of various wells and tanks across the Indian subcontinent and then categorized them based on their morphological characteristics such as form, size, and shape. With the help of meticulously documented measured drawings and precise dimensions, Bunce's work unveils the intricate elements of these water structures in India. Carneiro (2012) has identified heritage values associated with the Chakla bavdi of Chanderi, in Madhya Pradesh and then formulated indicators for heritage value assessment based on these values. His study provides a framework for evaluating the architectural value of these structures. It emphasizes the importance of building materials and construction types in defining their architectural character. Alonso and Meurs (2012) have advocated for the evaluation of indicators linked to cultural heritage. They emphasized the urge to assess the performance of conservation works. Their research reviews the various theoretical perspectives and indicators used to measure the positive and negative impacts of conservation activities. They bring forth the utility of indicators in guiding, planning, and policy-making processes. Thus, mentioning that the indicators should align with the aims of conservation and the values associated with cultural heritage. Carneiro (2012) through his study concluded that an essential prerequisite for effective conservation is the development of an inventory and indicators to monitor the progress of conservation efforts.

Research Problems

The studies carried out in the Indian context and the status of stepwells points towards some of the research problems that can be addressed to enhance the depth and breadth of the works on stepwells:

1. Historical Context and Evolution - From ancient to contemporary times, investigatingthe chronological progression of stepwell construction can unfold the shifts in design, functionality, and societal attitudes towards water management. A deeper exploration of the evolution of stepwells over time and the socio-cultural factors influencing their development is the need of the hour.
2. Technological and Engineering Aspects - Examining the materials, tools, and construction methods used across different historical periods can shed light on the innovative approaches adopted by ancient civilizations to harness water resources. Studying the technological advancements and engineering techniques employed in the construction of stepwells can reveal valuable insights into their structural integrity and sustainability adding to its relevance with the sustainable development goals (SDG's).
3. Hydrological Considerations – An integration of hydrological modeling, groundwater monitoring data, and environmental assessments can elucidate the hydrogeological significance of stepwells within their respective landscapes in India. The comprehensive analysis of the hydrological conditions surrounding stepwells, including groundwater dynamics, aquifer recharge mechanisms, and water quality management, can help in providing a holistic understanding of their ecological impact.
4. Cultural and Socio-economic Implications - Research works documenting the rituals, folklore, and community practices associated with stepwells can reveal deeper insights into their symbolic significance and communal identity. Further expanding the scope of work to encompass the cultural, religious, and socio-economic dimensions of stepwells can bring out their multifaceted roles within local communities. Additionally, explorations on the economic contributions of stepwells to livelihoods and tourism can highlight their socio-economic relevance in contemporary contexts.

5. Conservation and Management Strategies - A more nuanced examination of conservation challenges and management strategies is required in the present times. Assessing the threats posed by urbanization, climate change, and neglect of step-well heritage sites would inform the development of effective conservation policies and interventions.

Research Objectives (RO)

This paper tries to bring forth a study carried out in accordance with the understanding of stepwells as integral components of India's cultural heritage and hydraulic engineering legacy. It aims for an informed decision-making process to safeguard these invaluable historical assets.

The following research objectives help in formulating the study further -

RO1 - To detail the various stepwells in the study area, along with their historical backgrounds and architectural features, offering valuable insights into their evolution over time.

RO2 - To provide intricate details about the architectural designs, materials used, and decorative elements found in stepwells.

RO3 - To explore the spatial layout and typology of stepwells and examine the influence of various architectural traditions on these structures.

RO4 - To assess the heritage value of stepwells through expert evaluations and community engagement.

RO5 - To ensure the involvement of local communities, including school children, in understanding and preserving these heritage sites and understanding community aspirations.

The Study Area

The research objectives framed help in the study of water harvesting structures in Nagpur, situated in the Vidarbha region of Maharashtra, providing a focal point for examining these concepts. Maharashtra is India's second most populous state and third largest by area. It encompasses diverse cultural and urban landscapes. Nagpur, known for hosting the winter session of the state legislature, exemplifies the region's historical and contemporary significance. Meanwhile, Pune, acclaimed as the "Oxford of the East" due to its prestigious educational institutions, serves as the cultural capital of Maharashtra, enriching the state's intellectual landscape.

(1a)

(1b)

Figure 1a Map showing India. (Figure 1a Map showing India. (Source: https://www.vecteezy.com/detailed-country-map-of India)

Figure 1b Maharashtra state. (Source: www.financialexpress.com/maharashtra-samruddhi-mahamarg/1444512/)

Located at the geographical center of India as shown in Figure 1a and 1b, Nagpur holds a significant position in the country's history and heritage. The Zero Milestone monument, which signifies its central location, is a notable landmark here. The city was founded in the early 18th century by Bakht Buland, a Gond raja and later emerged as a vital political and economic center under the Bhonsles of the Maratha confederacy. However, the British influence started to shape Nagpur's trajectory in 1817, which led to its complete annexation in 1853 and its designation as the capital of the Central Provinces in 1861. Nagpur's evolution into a bustling trade hub began after the introduction of the Great Indian Peninsula Railway in 1867. This set the stage for its continued growth and development. After independence in 1947, Nagpur was the capital of Madhya Pradesh state until 1956 when it became part of the newly formed Bombay state. Eventually, in 1960, it became part of Maharashtra state.

Nagpur's urban landscape is characterized by a mixture of low and medium-rise buildings, particularly prevalent in the older inner-city areas popularly known as Mahal, and vast expanses of open agricultural land in the outer regions. Step wells, also known as bavadis, bahuli or the pairyachi vihir, are unique features of Nagpur's architectural heritage. These baolis are wells with steps leading down to the water and represent a unique architectural innovation indigenous to India. The design of these step wells utilizes the properties of earth and water. The earth's natural temperature along with the cooling effect of evaporative winds over water, create underground cool havens of respite during scorching summer months. The water management systems of Nagpur, dating back to the Gond and Bhonsla periods, were planned meticulously, incorporating extensive layouts of talaos, pushakarnis, bahuli vihir, and vihir. The water distribution was facilitated through properly engineered and sophisticated networks of earthenware and stoneware pipes. These pipes were laid according to the natural contours of Nagpur's landscape, highlighting the city's advanced hydro-engineering prowess and strategic urban planning.

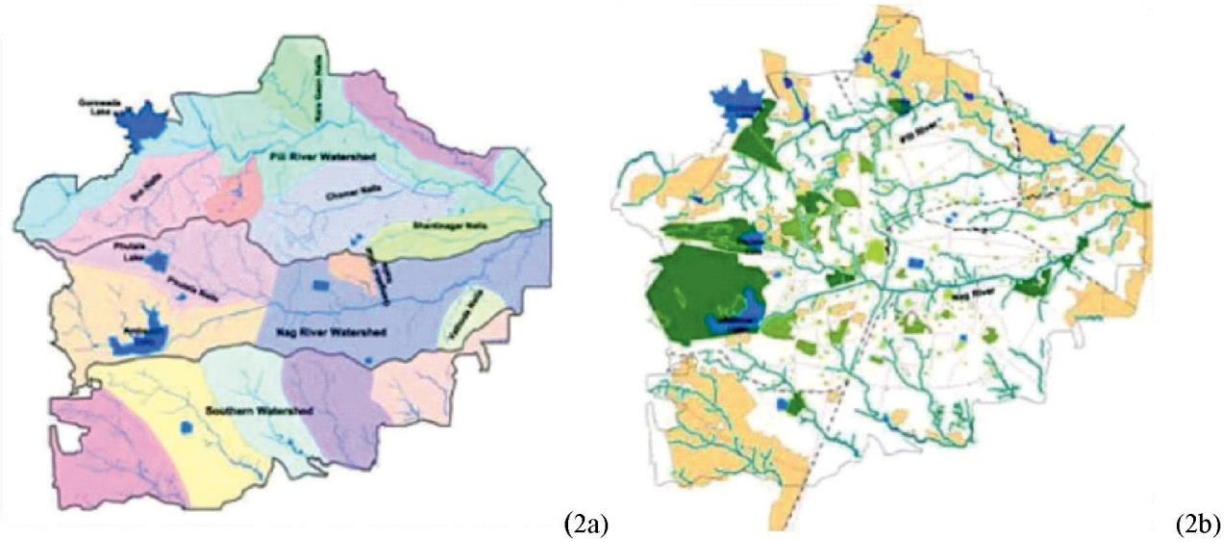


Figure 2a: Watershed Map of Nagpur, Vidarbha, Maharashtra. (Source: https://www.ijser.org/researchpaper/)
Figure 2b: Drainage Map of Nagpur. (Source: https://www.ijser.org/researchpaper/)

The Ambazari Lake is a well-designed manmade reservoir situated in Nagpur that showcases human ingenuity. With its strategic location and adjoining natural features, there is minimum human intervention in its construction, and it serves as the primary source of water for the Nag River. Its overflow during the monsoons ensures a consistent supply of water for the city's inhabitants. The Gonds (1542-1743) and Bhonslas (1743-1853) developed advanced water management practices

over three centuries, which continues to support the city's water supply network even today. Their visionary approach to resource utilization is evident in Nagpur's watershed and drainage map as shown in Figure 2a and 2b, which reflects a strategic understanding of natural topography and slopes, preserving vegetation, ecology along with groundwater levels. Baolis, or stepwells, are another architectural concept demonstrating the rulers' vision and foresight in preserving water resources. They are constructed by excavating the ground deeply until the water table is reached, then carefully calibrating steps for efficient and safe traversal back towards the ground level. Baolis served as sources of domestic water and irrigation, but they also offered peaceful retreats from the summer heat, with shady platforms, pavilions and galleries providing a welcoming respite.

In addition to their practical functions, baolis also hold religious and cultural significance, as evidenced by their elaborate entrances, pavilions, decorative columns, and sculptural niches. These architectural embellishments enhance the architectural beauty of the baolis while reflecting the aesthetic and spiritual reverence accorded to these structures. Furthermore, strategically located along highways and roads, baolis have historically served as essential rest stops or retreats for weary travellers, replenishing their stamina amidst long trade, militaristic or migration journeys from one place to another. The construction shows that to withstand the immense pressure exerted by the surrounding earth and the water within, the walls of baolis require robust reinforcement, often supplemented by horizontal beams and additional retaining walls. Thus, the enduring legacy of baolis extends beyond their utilitarian function, encompassing a rich tapestry of cultural heritage and architectural ingenuity.

Methodology

The survey team conducted a comprehensive reconnaissance survey to assess several stepwells in and around Nagpur. In line with the detailed documentation study, site visits were conducted, along with direct observations, and delved into a plethora of secondary sources such as archival records, vintage photographs, maps, manuscripts, and iconographic depictions. This enriched the research with the relevant historical context.

To generate detailed measured drawings capturing the intricate plan forms of the stepwells, the study utilized state-of-the-art tools such as measuring tapes, total stations, mobile GPS devices, and a 3D scanner. This meticulous process facilitated the creation of a database comprising photographs, sketches, field notes, and survey maps, providing invaluable insights into the fundamental characteristics of these water-retaining structures.

A survey was conducted with a cohort of twenty-five experts shortlisted by the survey team, encompassing eminent archaeologists, municipal councillors, and members of organizations like INTACH, Nagpur Chapter. With the help of a five-point Likert scale to gauge the heritage value of Nagpur's stepwells, the experts evaluated the heritage values and historical significance of those stepwells under study while, identifying the indicators which are cherished by both the present and future generations.

Field studies and documentation

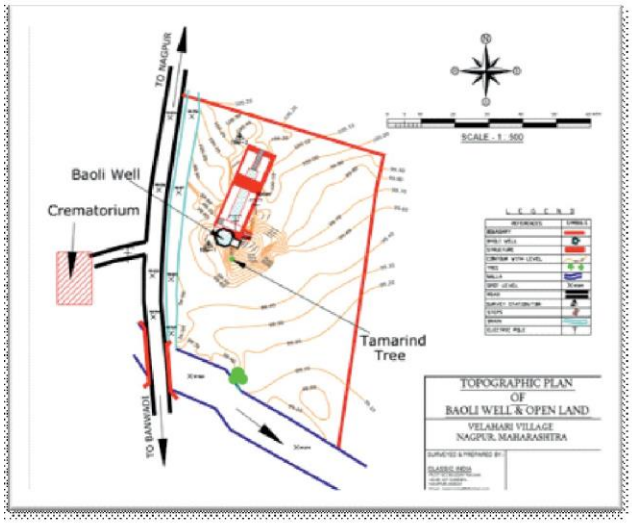
Hariweda stepwell

The investigation began with an examination of the Hariwedagaon stepwell near outer ring road, Nagpur as is seen in Figure 3. This stepwell is constructed using a blend of yellow sandstone, lime mortar, powdered stone, and dressed stone, along with bricks, exemplifying meticulous craftsmanship. Notably, the vihir's robust exterior walls boast of a composite construction, featuring a filling of

random rubble masonry, with brick facing. Meticulously dressed cut sandstones with carvings and sculptures, epitomize the rich architectural beauty of this stepwell. The black cotton soil in the site is suitable for agriculture with high moisture retaining property. Its geological composition is attributed to the cooling of magma and subsequent deformation of igneous rocks. The lime mortar, characterized by its porous properties, proves advantageous when working with softer materials like natural stone and terracotta.

(3)

(P1)



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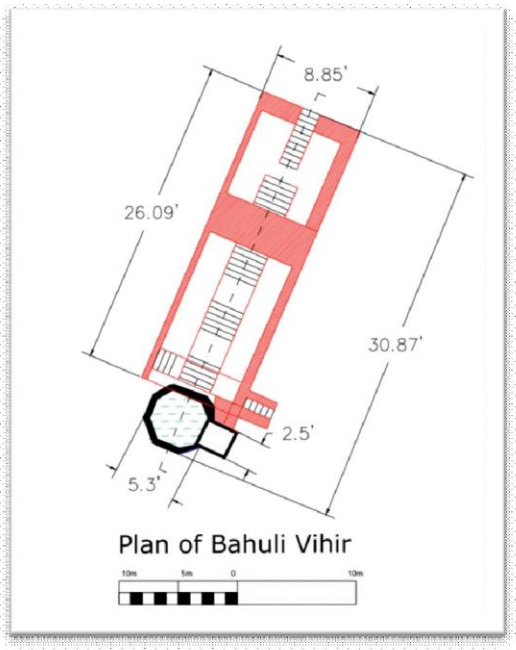


(5)

Figure 3: Google map showing location of Hariwedagaon and vihir. (Source: www.mapsgoogle.com)
Figure 4: The topographic plan of the Bahuli vihir (Source – Author)
Figure 5: The existing plan of the Hariweda vihir. (Source – Author)
Photograph P1 Dwarpal at Hariweda vihir (Source – Author)

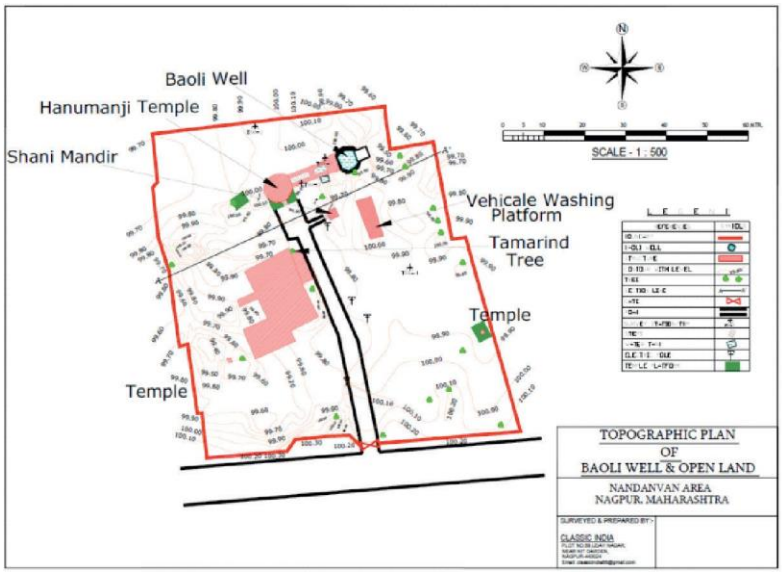
The vihir is an impressive structure made of natural stone and terracotta. As seen in the figure 4 and 5, it is about 31.1 meters long and 9.4 meters wide. The centerpiece is an ashtakoni vihir or octagonal well with a diameter of 4.5 meters and a depth of about 8.6 meters. Two flanking tanks on

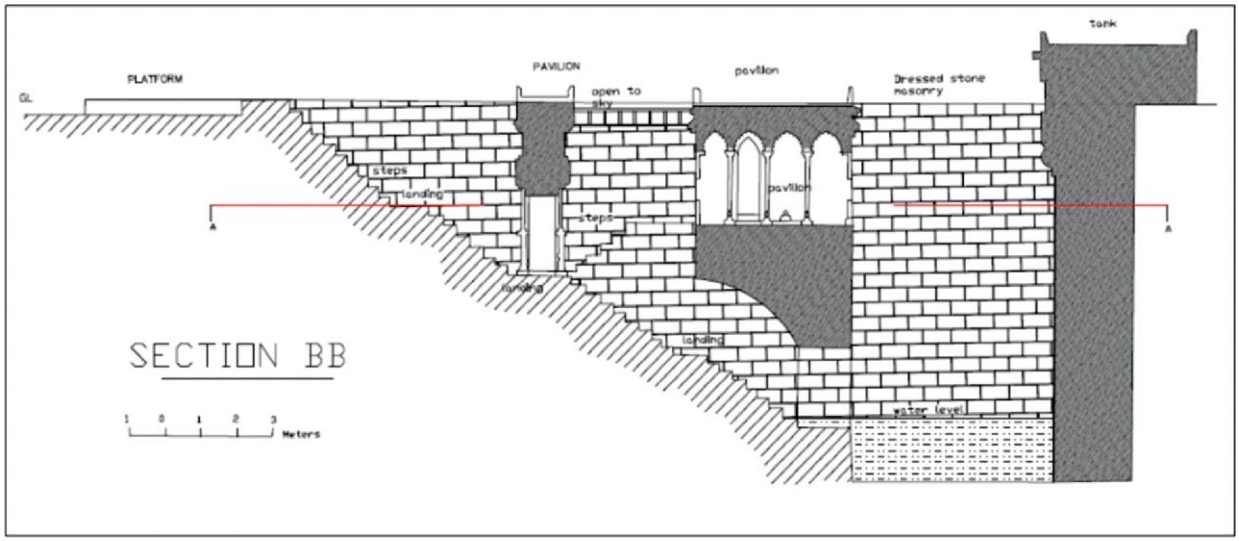
either side of the well, measure 2.0 meters by 2.2 meters each. The steps that lead to the well have aisles or passages that are about 2.0 meters wide. There are smaller pavilions that measure 1.8 meters by 1.8 meters, and the side entries are adorned with 0.8-meter-wide arches. The vihir is a two-storey structure with an average floor height of about 2.4 meters.

The vihir is elaborately decorated with intricate carvings that feature a variety of motifs, such as floral patterns, leaves, animal forms, depictions of Ganesha, birds, and human figures as is seen in photograph (P1). The architectural embellishments include blind lattices, chattris, stone corbel crude arches, domes, niches, platforms, and steps leading to the well. All these features demonstrate the exceptional craftsmanship and artistic accomplishment of the past.

Nandanvan Bahuli vihir

Nandanvan Bahuli Vihir is located near the Ubha Mahadeo Shiva temple as shown in figure 6. It has a linear planform with overall dimension of 28x7 m approximately, with a temple on one end at ground level and a straight flight of steps leading down to the Shiv dwar and the well at the other end as is seen in photograph (P2). At the end of the steps, there is a circular well that people can use to extract water using traditional methods or pulleys with buckets and ropes.





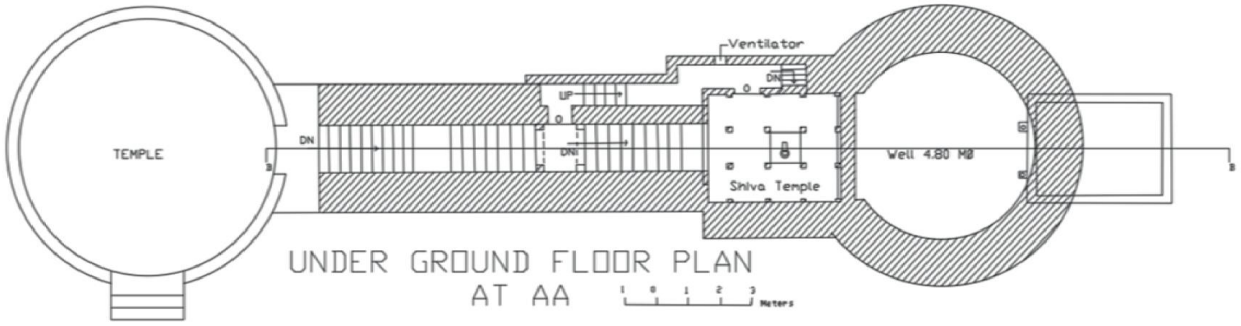


Figure 6: The topographic plan of the Nandanvan Bahuli vihir (Source – Author)

Figure 7: Section of the Nandanvan Bahuli vihir. (Source: Author)

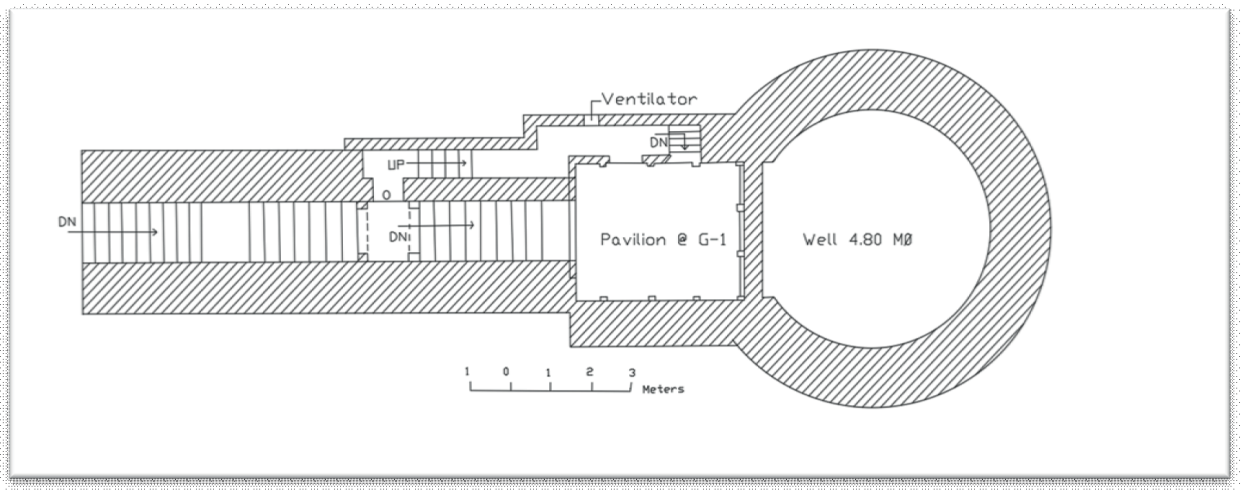
Figure 8: Plan of the Nandanvan Bahuli vihir. (Source: Author)

Photograph P2 Nandanvan vihir. (Source – Author)

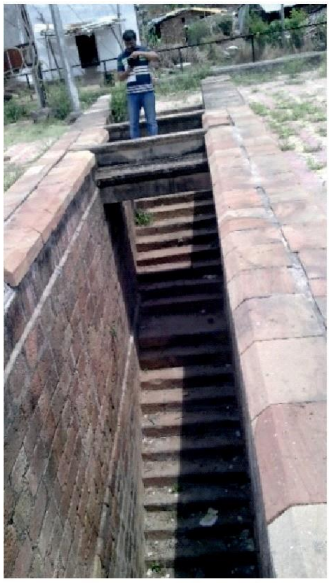
In all the vihir has three floors as seen in figure 7. The first floor features a pavilion that measures around 3.5 meters by 3.5 meters. It has multifoil arches on all the four sides and is home to the sacred Shiva Linga and Nandi at its centre. There is another flight of steps located on one side, which allows people to access the shrine. Figure 8 shows the subsequent floors leading downwards towards the water level, with habitable floor heights ranging from approximately 2.5 to 2.7 meters. This provides a conducive environment for various activities and rituals in small group of 4 to 5 people during the annual festive celebrations of Shivratri every year.

Adasa bahuli vihir

The Adasa Bahuli Vihir is a well-maintained structure that provides water to the residents within the temple complex. The vihir is enclosed within a protective boundary wall and fence ensuring its longevity and structural stability. It is built entirely of sandstone and lime mortar as the primary building materials. The vihir is located at the foothills of the famous Adasa Ganapati temple, known as one of the Ashtavinayak temples of Vidarbha. It is characterized by narrow steps and arches at two distinct floor levels.



(9)



(P3)

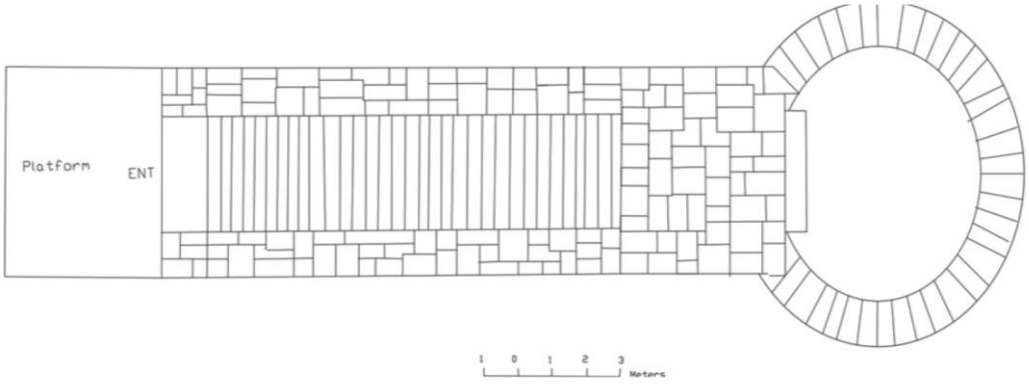
(P4)

Figure 9 Plan of the Bahuli vihir at Adasa devasthan, Near Nagpur. (Source – Author)
Photograph P3 & P4 Adasa vihir. (Source – Author)

The plan of the vihir as seen in Figure 9 clearly shows the chambers and level platforms in its design with the dimensions of 24x8 meters approximately. The vihirs location away from residential areas, makes it free from encroachment while preserving its historical and architectural significance. The vihir's aesthetic appeal and accessibility are enhanced by its pristine condition, which obviates the need for iron grills atop the steps for safety reasons. Although the vihir's architectural style primarily serves utilitarian purposes, it is characterized by minimal ornamentation as seen in photographs (P3) and (P4), with only a few mouldings adorning the arches and parapet walls. This exemplifies the pragmatic approach of our ancestors towards design and construction, which focuses on functionality rather than decoration.

Pauni bahuli vihir

Located in Paunigaon near Hinganghat, the Pauni Bahuli Vihir is a stepwell made of black basalt stone, bricks, and mortar. Despite its simple and utilitarian design as seen in Figure 10, the vihir remains in excellent condition, showcasing the durability of its construction with the dimension of 24x4 m approximately.



(10)

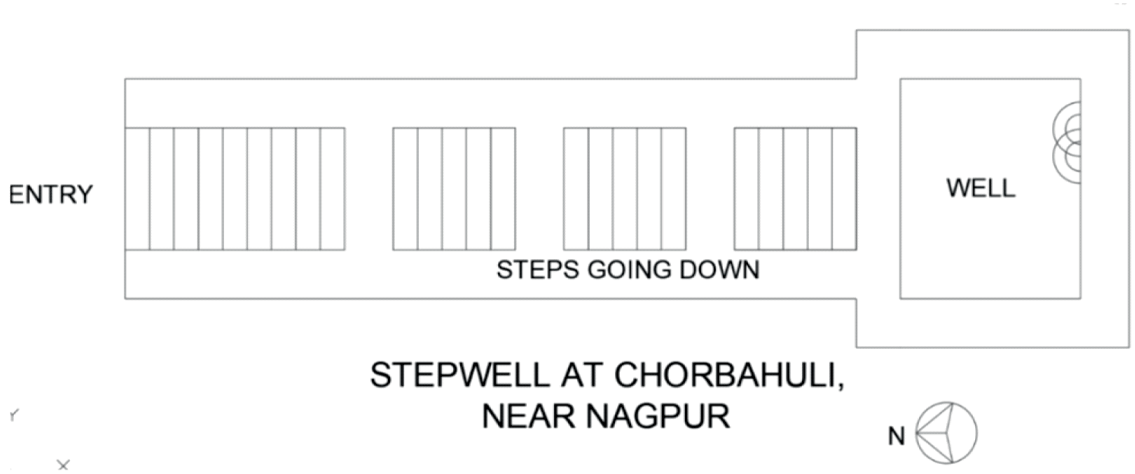
(P5) (P6)

Figure 10: Plan of Vihir at Pauni. (Source: Author)
Photograph P5 & P6 Pauni bahuli vihir, Hinganghat, Nagpur. (Source: Author)

The well has an oblong shape and is protected by iron grills. However, the surrounding residential structures pose potential hazards for children and animals. Although the water is not actively used, the gram panchayat takes measures to maintain the cleanliness of the well as is seen in the photographs (P5) and (P6). They occasionally allow for recreational activities such as swimming, especially during periods when the water levels are high in the vihir.

Chorbahuli, near Nagpur

Chorbahuli is a small village located in the Ramtek Block of Nagpur district, Maharashtra. The village is surrounded by lush forests and water bodies, making it a serene and peaceful place. The village's economy is primarily driven by agriculture, which sustains the livelihood of 75 families residing there even today.



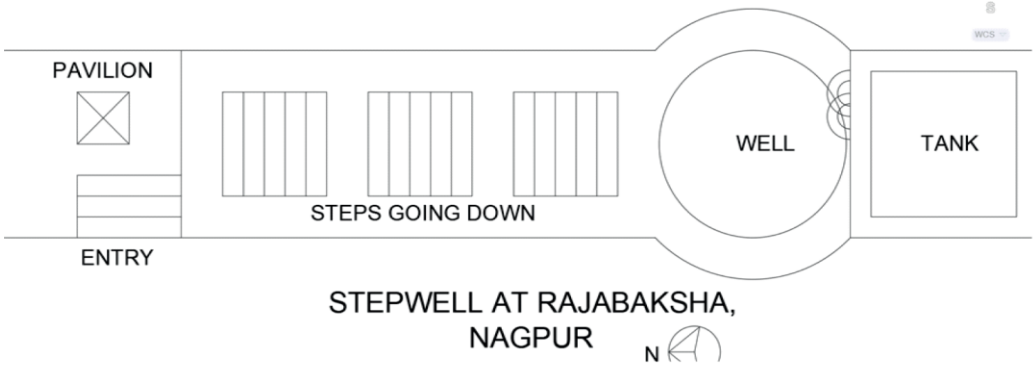
(7) (8)

Figure 11 Plan of Chorbahuli vihir. (Source: Author)
Photograph 7 & 8 Chorbahuli, near Nagpur. (Source: Author)

The planform of the vihir having dimensions of 28x7 m approximately, as seen in Figure 11, shows the flight of steps leading to a rectangular well with achors for ropes to draw water with the help of bullocks. The village is located near a beautiful lake that is home to two bahuli vihirs. The location of the vihirs near the existing lake help in maintaining the overflow of the lake during the monsoon months. Unfortunately, one of the vihirs had to be closed due to the ongoing highway construction, while the other has been neglected and is now hidden behind dense bamboo vegetation as seen in the photographs (P7) and (P8).

Rajabaksha bahuli vihir

The Bahuli Vihir is made using both stones and bricks and has a rectangular shape. The well inside is square and has two passages at its ground level. Although there are no visible entrance arches, the presence of stone anchors on one of the Vihir walls indicates its historical use in agricultural activities for drawing water using the bullocks.



(12)

(9)

(10)

Figure 12 Plan of vihir at Rajabaksha, Medical Square, Nagpur. (Source: Author)
Photograph 9 & 10 Chattri at vihir. (Source: Author)

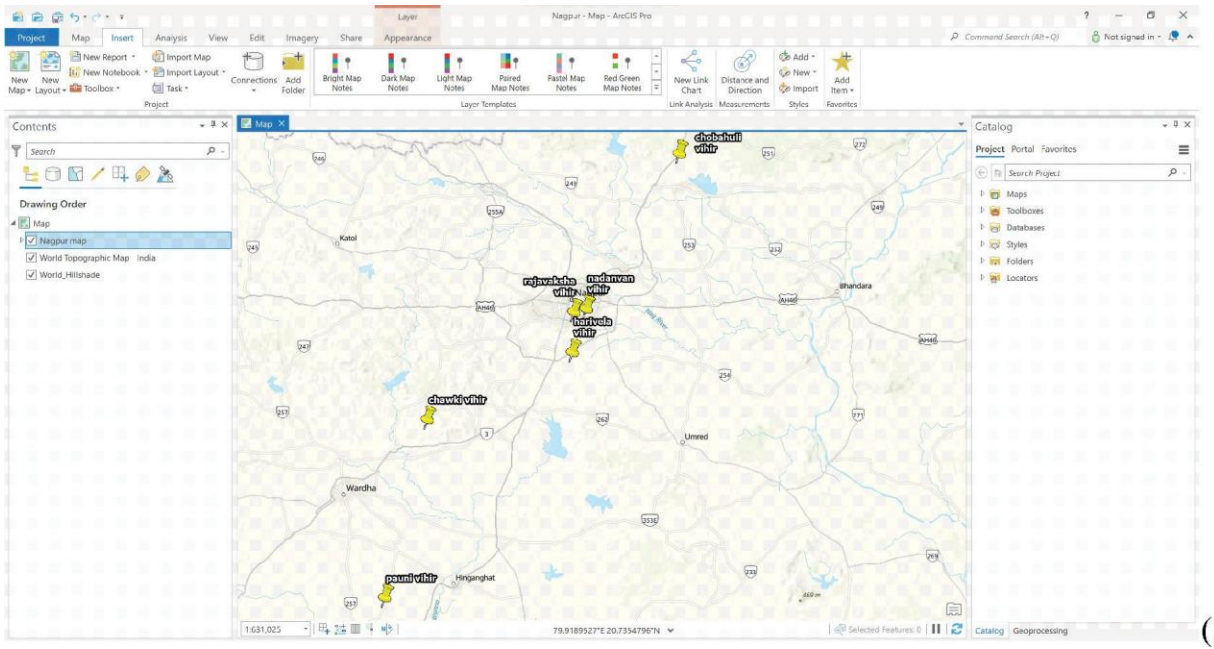
The Rajabaksha Bahuli Vihir is presently located next to the Government Medical College campus in Nagpur. The Hanuman temple at Rajabaksha is significant because it was founded byone of the esteemed Saints of Maharashtra, Samarth Ramdas Swamiji. Devotees visit the temple every Tuesday and Saturday, as well as during the auspicious occasions of Hanuman Jayanti andthe festival of Dussehra. The Bahuli Vihir is located at the southwest corner of the temple premises, having a north-south orientation. It measures approximately 20 m by 5 m as is seen in Figure 12. A storage tank is located at the southern end of the vihir to enhance its functionality. The entrance ofthe vihir as seen in photograph (P9) and (P10) has a small chattri and semi-circular arches made of bricks, decorated with intricate floral carvings which are a testament to the architectural excellenceof the historic times.

Typical Characteristics of Stepwells in Nagpur

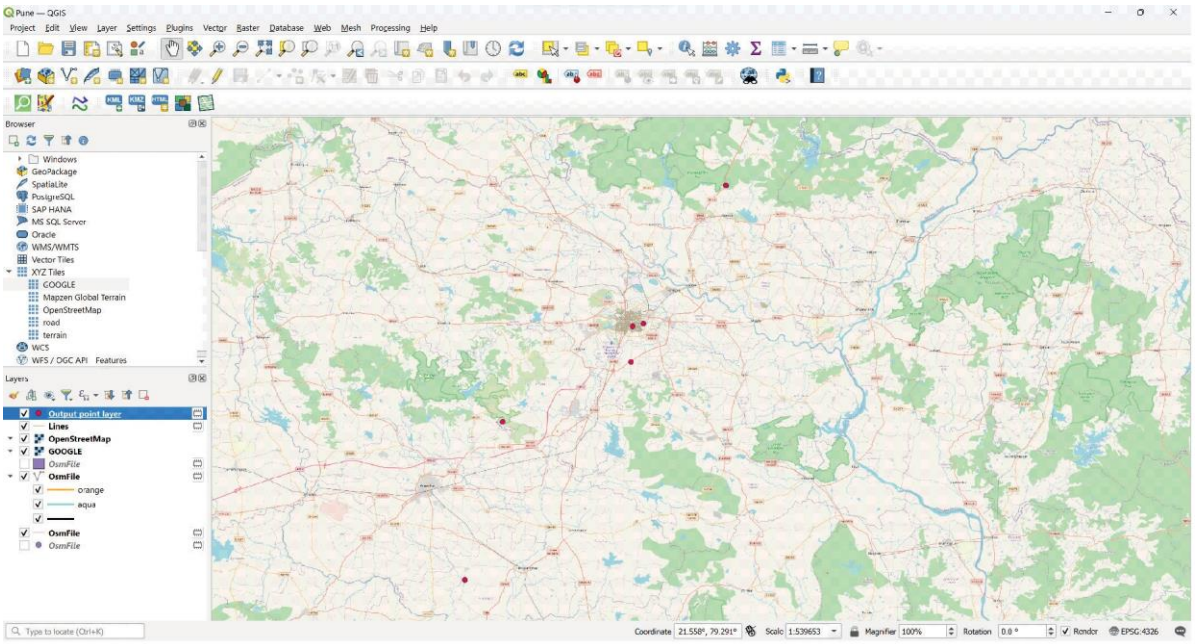
The Table 2 below shows the GPS location of the vihirs with their present status of being protected or in use on their premises. Figure 13a and 13b show the use of the softwares of ARCgis pro to mark the location of the above stepwells which was further substantiated by the Qgis pro maps software.

Table 2: The geographical location of the stepwells. (Source: Author)

S. no	*Name of Stepwell*	*Location*	*Latitude N*	*Longitude E*	*Status*	*Protected/Notified*
1	Stepwell at Hariwela gaon	Nagpur	21.0442	79.0919	Not in use	Unprotected & Not Modified
2	Stepwell at Nandanvan zone	Nagpur	21.1372	79.1215	In use	Unprotected & Not Modified
3	Stepwell at Pauni village, Hinganghat	Nagpur	20.5185	78.6898	In use	Protected & Not Modified
4	Stepwell at Chauki gaon	Nagpur	20.9001	78.7810	In use	Protected & Not Modified
5	Stepwell at Chorbahuli Mogra village, Nagpur	Ramtek	21.4699	79.3209	Not in use	Unprotected
6	Stepwell at Rajabaksha, Nagpur	Nagpur	21.1306	79.0951	In use	Protected and not modified



(13a)



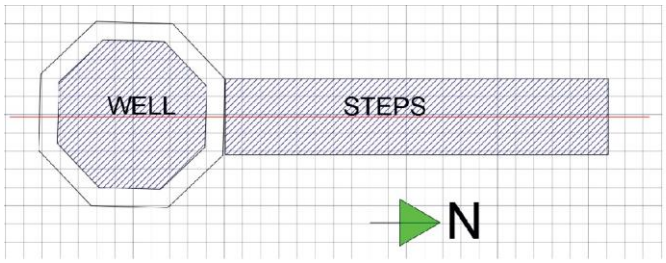
(13b)

Figure 13a: ARCgis pro maps marking the location of the above stepwells. (Source: Author)
Figure 13b: Qgis pro maps marking the location of the above stepwells. (Source: Author)

The examination of stepwells in Nagpur reveals several characteristic features, which can be outlined as follows:

Orientation and Location

Stepwells in the Nagpur district are typically aligned along the North-South axis, with the well positioned on the southern side and the steps on the northern side as seen in template (T1). This placement is likely to minimize exposure to sunlight while mitigating the effects of heat, providing shade for most hours of the day and reducing evaporation rate of the water. These stepwells are usually found in clusters of 2 to 3, located at the base of large tanks or reservoirs. They serve the dual purpose of preventing overflow and maintaining groundwater levels in the surrounding areas.



(T1)

Template 1: Orientation of stepwells. (Source: Author)

Ratio of length to width

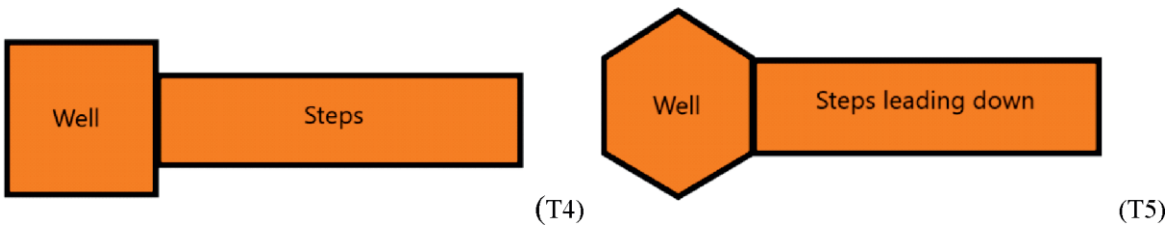
The Nagpur district experiences fluctuations in the water table, which can range from depths of 10 to 60 feet. In this region, Nanda stepwells are a common sight. These stepwells feature a single flight of steps that descend to G-2 levels, and some may also have an intermediate pavilion at the G-1 level. Interestingly, the length to width ratio of many of these stepwells ranges from 1:3 to 1:5 as seen in template (T2) and (T3), which indicates that their architectural proportions are well-balanced and harmonious.

1:3 planform (T2) 1:5 planform (T3)

Template 2 & 3: Showing ratio of length to width. (Source: Author)

Organization of steps and the well

A flight of steps, which runs from north to south, makes it easy to descend to the water in the well. The width of these flights is usually enough for only one person at a time, or two people crossing together. This narrowness is likely to discipline the movement of people, keep things orderly and prevent accidents due to overcrowding on slippery surfaces on steps submerged in the water. It gives us a perfect example of how design can transform people's behaviour in the built forms. The width of these flights varies from 0.9 meters to 1.8 meters across most stepwells as is seen in the template (T4) and (T5).



(T4) (T5)

Template 4 & 5 Organization of well and steps. (Source: Author)

On the other hand, wells at the opposite end have different shapes, such as the octagonal or Ashtakoni, the hexagonal or Shashtakoni, the square or the Choukoni, and the circular or Golakar vihirs. These shapes showcase unique architectural designs and functions.

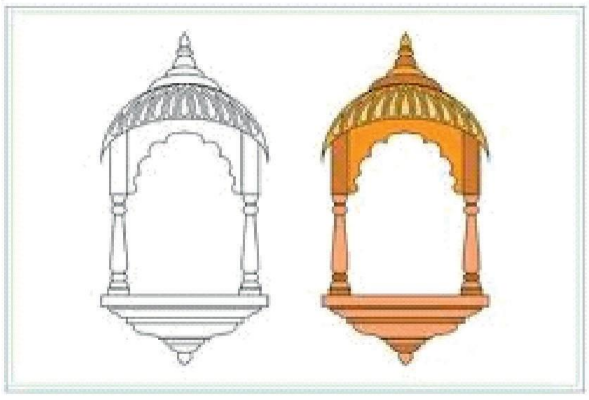
Typical elements of the Vihir

Chhatris

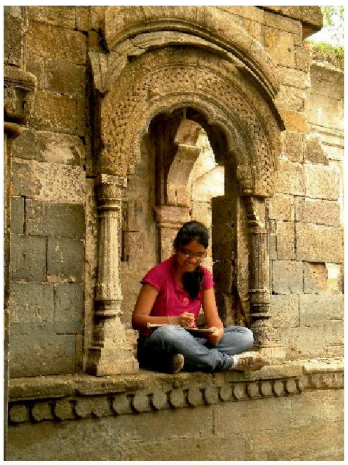
Simple chhatris and part elevations of the chhatri are seen adorning the stepwells of Nagpur. A chhatri is a dome-shaped pavilion that is elevated and serves as a hallmark element in both Indo-Islamic and Indian architectural traditions. It was created as a canopy to adorn tombs but later became a decorative feature added to various structures. Chhatris are particularly noticeable in Mughal architecture and have been used extensively in Rajasthan, demonstrating a unique fusion with their prevalence across both Muslim and Hindu architectural realms throughout the Indian Subcontinent. Although its roots lie in Indo-Islamic design, Shekhawati Chhatris are characterized by a simple structure comprising a single dome supported by four pillars. Some chhatris feature interior paintings reminiscent of the intricate artwork.

Jharokhas

Small imitation of the jharokha is seen in the Hariweda vihir at Nagpur. A jharokha is a stone window that protrudes from the facade of a building, usually on an upper floor, and provides views of streets, markets, courts, or other open spaces. It is supported by two or more brackets or corbels and has two pillars or pilasters, a balustrade, and a cupola or pyramidal roof as is shown in the photograph (P11). The jharokha is partially enclosed by intricate jali work, but it allows the inhabitants to peep out and observe passing processions. The jharokha is known for its formal elegance and decorative embellishments and is one of the most distinctive features of medieval Indian architectural facades as is shown in template (T6).



(T6)



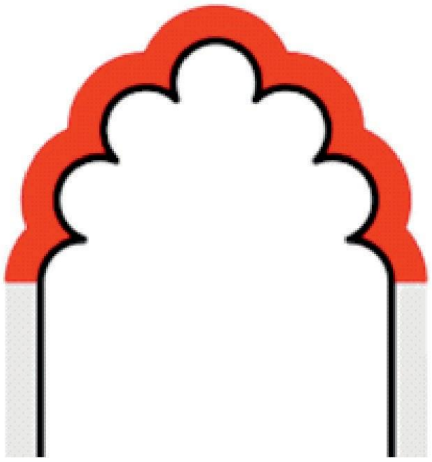
(P11)

Template 6 Proportionate Drawing of Jharoka. (Source: https://www.shutterstock.com/image)
Photograph 11 Broken jharokha at vihir. (Source: Author)

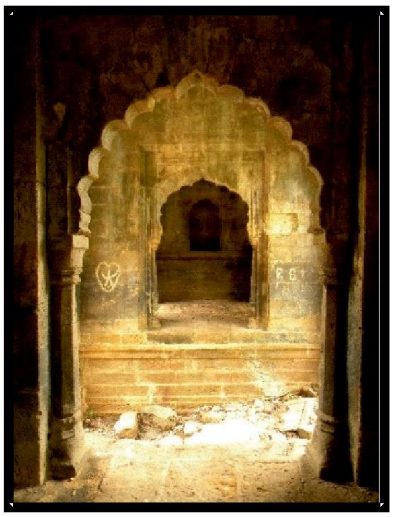
Multifoil Arches

One of the most typical features of Nagpur's architecture is the multifoil arch, also known as the Polyfoil arch or Polylobed arch as shown in photograph (P12). It is a unique architectural feature characterized by a series of symmetrical leaf-shaped segments. These segments are usually created by overlapping circular forms. The term "foil" comes from the Old French word meaning "leaf or foliage," which perfectly captures the organic essence of these architectural motifs. The number of leaf-shaped elements in an arch is denoted by a prefix, such as "trifoil" (three), "quatrefoil" (four),

"cinquefoil" (five), "sexfoil" (six), "octofoil" (eight), and "multifoil" or "polyfoil," which typically refer to configurations of more than eight leaf-shaped elements as seen in the template (T7).



(T7)



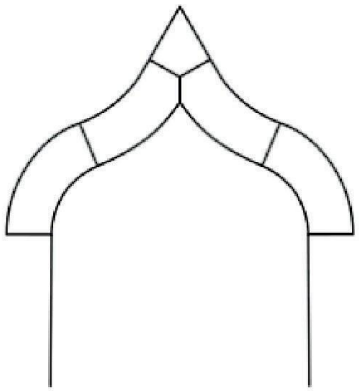
(P12)

Template 7: Proportionate Drawing of pointed multi-foil arch. (Source: https://www.homestratosphere.com)
Photograph 12: Multifoil arch. (Source: Author)

Ogee arches

Some of the stepwells in Nagpur display the simplicity of the ogee arch as seen in template (T8), which is a unique decorative design that is easily recognizable. It is made up of two curves that are connected to each other. The top curve is concave, while the bottom curve is convex, giving the arch an elegant S-shaped appearance. This type of arch is made by combining two pointed arches at the top, which creates a single pointed end as evident in photograph (P13). The ogee arch is not only aesthetically pleasing but also structurally sound.

(P13)



(T8)

Photograph 13: Ogee arch. (Source: Author)
Template 8: Proportionate Drawing of Simple Ogee arch.
(Source:https://en.m.wikipedia.org/wiki/File:Ogee-shaped_arch.svg)

Pulleys, parapets

The parapet walls are a feature that line the periphery of stepwells making them visible at the ground level and slightly raised by about 0.45 meters above ground. A parapet is a small wall-like structure

that serves a dual purpose in the built environment. Firstly, it acts as a protective barrier, preventing accidental or falls by marking the edges of stepwells.

(P14)

(P15)

Photograph 14: Stone rings for pulleys. (Source: Author)
Photograph 15: Stone lintel with carving on openings. (Source: Author)

Secondly, it functions as a defensive measure, providing cover and concealment against external threats. This versatile architectural feature minimizes the risk of potential accidents and enhances a sense of security and fortification as seen in the photograph (P14) of the Nandanvan vihir. The photograph (P15) shows stone lintel with carving on openings. It highlights the practicality and strategic foresight inherent in their architectural design.

Brackets

Some stepwells in Nagpur are beautifully decorated with a series of bracket designs in plant, fruits or animal forms as is seen in photograph (P16) and (P17). These brackets are carved in stone and are a fundamental component in architectural design. They even act as structural supports and may be crafted from materials such as wood, stone, or metal. Their primary function is to extend from or project over a wall to bear weight, providing essential reinforcement.

(P16)

(P17)

Photograph 16 &17 Brackets at Vihir. (Source: Author)

Brackets also serve as platforms for various elements, including statues, arch springs, beams, or shelves, offering crucial support and stability. Brackets are designed in diverse forms such as volutes

or scrolls, and can be intricately carved, cast, or moulded, accentuating their ornamental appeal. Among the recognized types, corbels and consoles stand out prominently, each exhibiting distinct characteristics and applications. However, various other bracket variations exist, often lacking specific nomenclature yet retaining their indispensable role in architectural composition.

Toranas

Some stepwells in Nagpur like the one at Hariweda and Rajabaksha have an entrance gateway or a Torana dwar with multifoil arches which is clearly seen in the photograph (P18) and (P19). A torana is a ceremonial gateway that holds great symbolic and cultural significance. It consists of a unique design featuring a cantilevered cross-piece supported by two uprights or posts, typically made of materials such as wood or stone. The horizontal beam or the cross-piece itself consists of three horizontal bars intricately arranged atop one another and is adorned with sculptural embellishments that reflect the cultural and spiritual ethos of the communities it serves. We can find variations in the design of the same at the stepwells within some of the temple precincts in Nagpur.

(P18)

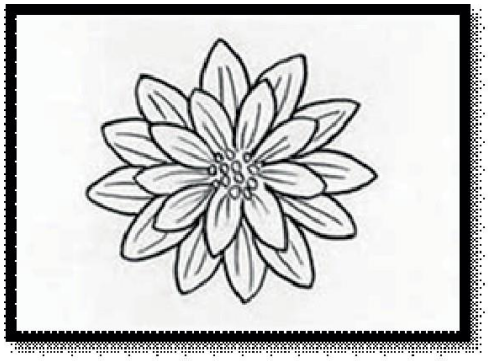
(P19)

Photograph 18: Entrance to vihir. (Source: Author)
Photograph 19: Carvings at the entrance. (Source: Author)

Toranas are not only functional structures but also hold profound associations across diverse religious and secular contexts. They are a prominent feature in Buddhist, Jain, and Hindu architecture, as well as secular edifices. Beyond their architectural utility, toranas serve as conduits for spiritual significance and are often adorned with symbolic motifs such as flowers, leaves and dwarpalas carved as safeguarders believed to bestow blessings and auspiciousness upon those who pass beneaththeir arches. Thus, the torana as a manifestation of cultural identity, spiritual devotion, and aesthetic expression transcending its physical form in stepwells and temple complexes.

Stone Carvings

In the stepwells at Nagpur made in yellow sandstone, a few carving details are seen. These carving details and sculptures on stone have been a venerable artistic tradition that involves meticulously shaping raw natural stone through controlled removal of the unwanted in order to achieve expressive forms and motifs as seen in template (T9). This ancient craft due to the permanence and durability of stone as a material helps in bridging the gap between past and present through its timeless beauty and allure.



(T9)

(P20)

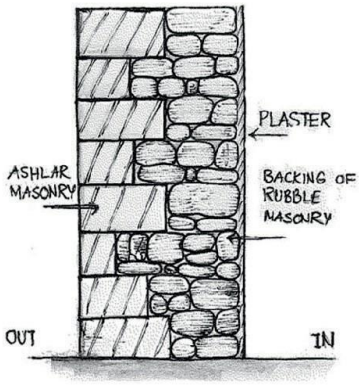
Template 9: Proportionate Drawing of a flower motif. (Source: https://www.pinterest.com/)
Photograph 20: Carvings on parts of stepwell. (Source: Author)

Stone carving is a profound means of artistic expression that produces sculptures and architectural embellishments as is seen in the photographs (P18), (P19) and (P20), with a sense of timelessness and grandeur. The carved statues gracing these stepwells make us aware of the art of stone carving transcending cultures, reflecting the ingenuity and creativity of human endeavor through the ages.

Material and Structural Details

The stepwells at Nagpur show the use of composite masonry. It is a technique that involves the integration of two different masonry styles: ashlar masonry and rubble masonry. In this technique, rubble masonry is primarily used as a backing for the wall due to its cost-effectiveness, while ashlar masonry is reserved for facing the wall to give an aesthetically pleasing facade.

(P21)



(T10)

Photograph 21: The masonry styles used in the stepwell. (Source: Author)
Photograph 22: Sketch of the masonry styles used in the stepwell. (Source: https://www.researchgate.net/profile/)

By combining these two masonry styles as seen in photograph (P21) and the sketch in template (T10), the resulting stepwell and its structure boasts both structural integrity and visual appeal. However, achieving a seamless integration of these styles requires careful attention to detail throughout the construction process. Precise alignment, jointing, and material composition are essential to ensuring that both the facing and backing components function cohesively as a single unit in the stepwell. Composite masonry exemplifies the artistry and engineering skills integral to architectural design. By balancing cost considerations with aesthetic and structural requirements, composite masonry structures stand as a good blend of form and function in the built environment. Due to the thoughtful execution and craftsmanship, composite masonry used in the water structures last longer.

Results and Discussions

Stepwells, which are architectural feats with an inverted design, are fascinating structures that feature certain typical characteristics. The ground-level entrance and surrounding walls serve as focal points, guiding the descent through the well's various levels. The study and close examination of stepwells has provided enlightening insights into the intricate nuances of inverted architecture in Nagpur.

In line with the technical architectural documentation of the stepwells, efforts to bring the vihirs in the main lifestyle of today's generation, certain initiatives were taken up at the community level like -

1. Drawing workshop for the students of the government school at Hariwela village near Nagpur.
2. Heritage awareness workshop at the village of Hariweda, near Nagpur.
3. Cleaning drive with the students of Navodaya Vidyalaya at Nandanvan stepwell premises, Nagpur.

1. A workshop was conducted with the local school children of Hariweda gaon to better understand their perspectives on these historical marvels. Through the interpretive lens of children's drawings, rich expressions surfaced, providing insights into their proximity to and envisioning of these structures within contemporary contexts. The drawings revealed aspirations for the integration of lush gardens adjacent to the stepwells, envisaging increased public engagement and revenue generation to sustain their upkeep in the present times. The figure 14 shows the workshop in progress and some drawings by school kids as outcomes of the same.

Figure 14: School children's drawing workshop at Hariwedagaon and its outcomes. (Source: Author)

2. Heritage awareness workshop at Buddha Vihar, Hariweda gaon near Nagpur was taken up by organizing Nukkad Natak with architecture college students of RTM Nagpur university in the local language of marathi as seen in Figure 15. The event was graced with the presence of eminent Professor in history of RTM Nagpur University, experienced technical staff member of Archaeological Survey of India, (A.S.I.), and village heads of Grampanchayat at Hariwedagaon like Vice Chairperson(Upasarpanch), Chairperson(Adhyaksha), and Secretary (Sachiv). At the end of the workshop certain designs of village haat bazar for rejuvenating the vihir and its premises were proposed by the participants with some of the outcomes of workshop as is seen in the figure 15 below.

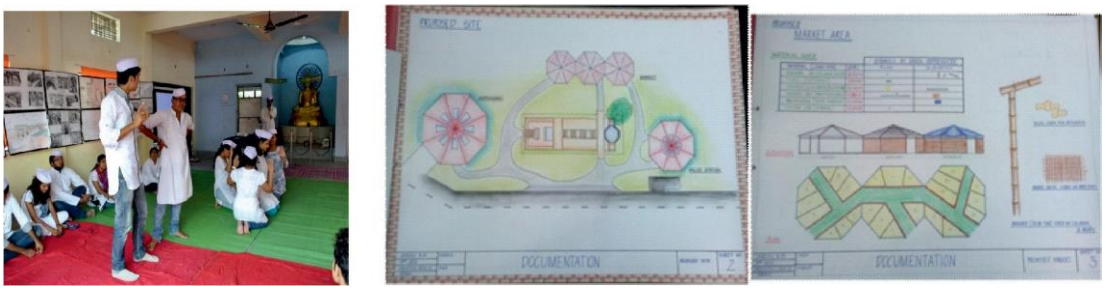
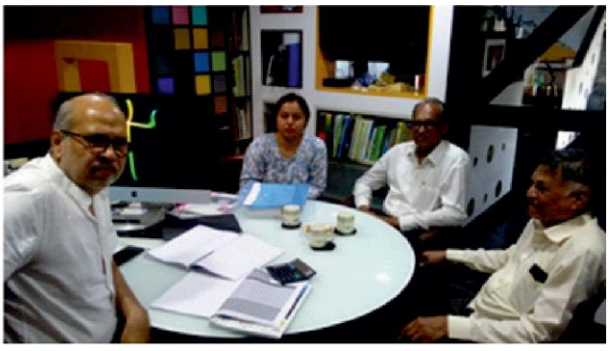


Figure 15: Heritage awareness workshop at Hariwedagaon and its outcomes. (Source: Author)

3. Cleanliness drive with the students of Navodaya Vidyalaya at Nandanvan stepwell premises, Nagpur – Awareness programmes on water conservation and cleanliness was organized with the school students, orange city water works and INTACH Nagpur chapter members as the community initiatives seen in photograph (P22) below.

Photograph 22a and 22b: Cleanliness drive with the students of Navodaya Vidyalaya at Nandanvan stepwell premises (Source: Author)

Evaluating the above stepwells on their heritage values were carried out based on the literature studies on heritage value assessments, which incorporated aesthetic, historical, scientific, and social indicators. With the survey of twenty-five experts from Nagpur, literature studies, the sub-heritage values for application towards heritage value assessments were carried out during the study as is seen in the photograph (P23a) and (P23b) below.


(P23a)

(P23b)

Photograph 23a: Meeting with expert from the field for stepwell evaluations. (Source: Author) Photograph 23b: Meeting with expert Chairman of the Heritage division of Nagpur Municipal Corporation.(Source: Author)

The discussions with experts on Design and mapping of stepwells in India and meeting with the Chairman of the Heritage division of Nagpur Municipal Corporation, along with INTACH members helped in deriving the indicators for stepwell evaluation. The values and the sub-heritage values helped the experts to evaluate the stepwells on an ordinal scale of excellent, very good, good, fair, and poor as is evident in the Table 3 below. It was interesting to note that the values varied fromsample to sample based on their perceptions. As these stepwells were made in agricultural fields and near villages in the outskirts of Nagpur, it created a sense of belonging for the community and was valued high on their function. The assessments revealed noteworthy findings, indicating variations

in perceived values among the sampled experts. Remarkably, stepwells situated amidst agricultural landscapes and rural settlements on the outskirts of Nagpur evoked profound communal attachment, garnering high acclaim for their utility.

Around 22 experts recognized the tourism and archaeological potential inherent in these sites, underscoring their scientific and cultural values. The aesthetic and architectural assessments underscored the distinctive regional characteristics and exemplary craftsmanship embodied by these structures, earning commendation for their intrinsic beauty and historical significance.

Table 3: Indicates variations in perceived values among the sampled experts. (Source: Author)

	Values	Sub values	Excellent	Very good	Good	Fair	Poor
1	Emotional	Aesthetic	20	0	5	0	0
		Architectural	23	1	1	0	0
		Identity	18	3	2	2	0
2	Cultural	Historic	20	4	1	0	0
		Scientific	22	1	1	1	0
		Social	15	6	2	2	0
3	Functional	Bequest	11	8	5	1	0
		Utility	24	1	0	0	0
		Community	21	2	1	1	0

The interpretation of the data in the text underscores the multifaceted significance of water structures like stepwells, from their cultural and historical importance to their practical utility and architectural beauty. The need for comprehensive preservation efforts may include the following aspects like -

1. Establishing the Cultural and Historical Significance of Water Structures:
    - Water is depicted as a vital element for life and has deep cultural and spiritual significance across different civilizations, particularly in Indian culture.
    - Ritualistic practices involving water immersion and the presence of sacred rivers and water bodies highlight the spiritual importance of water.
    - The historical context of water management, as depicted in ancient texts and historical records, emphasizes the significance of water.
    - Architectural texts and historical accounts provide insights into the construction and need of water structures like stepwells, temple tanks, and reservoirs.
2. Exploring the Architectural Details and Characteristics of Stepwells:
    - The architectural intricacies of stepwells, including their dimensions, orientation, layout, and morphological characteristics.
    - Different types of stepwells, such as Nanda, Bhadra, Jaya, and Vijaya, are mentioned, each with unique features and designs.
    - Detailed measurements and descriptions of specific stepwells in Nagpur illustrate the diversity and complexity of these structures.
3. Awareness about the Importance of Preserving Architectural Heritage:
    - The importance of preserving stepwells not only for their heritage value but also for their role in water conservation efforts is to be realized by all.

- Advocating for the recognition of stepwells as cultural treasures emphasizes the need for their protection and conservation in contemporary contexts with technological advancements in the changing times.

4. Methodological Approach towards study and preservation:
   - A methodical approach to preserving stepwells, including heritage value assessments, empirical surveys, and collaborative efforts involving experts and local communities may be incorporated.
5. Community Engagement and Future Directions:
   - The involvement of local communities, including children, in heritage assessments and preservation efforts is emphasized, reflecting a commitment to inclusive conservation practices.
   - Aspirations for integrating stepwells into contemporary contexts, such as through tourism development and adaptive reuse, are discussed, highlighting the importance of balancing preservation with adaptation to changing societal needs.

Conclusions

This study aims to provide a comprehensive understanding of the spatial configuration of stepwells in Nagpur district. These stepwells are predominantly characterized by the Nanda architectural typology, which consists of a centrally located well with descending steps leading to the water source. The study also delves deeper into the unique architectural motifs that are prevalent in these structures, which are indicative of their historical provenance primarily from the Gond and Bhonsla epochs.

In addition, the study examines the discernible influences from Rajput and Mughal architectural traditions that underscore the diverse cultural amalgamation embodied by these architectural marvels. This analysis provides a better understanding of the historical significance of these structures and their cultural context.

Furthermore, the study emphasizes the importance of preserving these edifices for future generations. This imperative is underscored not only from a heritage and tourism perspective but also from the perspective of water conservation. The heritage value assessments conducted in the study reveal the significance of these stepwells, emphasizing the urgent need to safeguard them.

The study also highlights the pressing need to safeguard traditional stepwells in their original state or adapt them to contemporary contexts. This imperative is echoed in the aspirations articulated through the drawings of children from Hariwedagaon's Bahuli Vihir, reflecting the community's desire to preserve these cultural landmarks for posterity. The explorations in the community-based approaches to heritage stewardship and participatory conservation initiatives helped foster greater community engagement and ownership. The paper encapsulates the themes of water conservation, sustainable management, and the preservation of cultural heritage, aligning with the Sustainable Development Goals, particularly SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 15 (Life on Land). In conclusion, the study emphasizes the importance of safeguarding these architectural marvels. By fostering a legacy that future generations can cherish and celebrate, we can ensure that these cultural landmarks are preserved for posterity.

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