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Research Article

Comparative Analysis of Treated Openings and Comprehensive Study of its Building Physics in Context with Sustainability in Nagpur (India).

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Abstract

Today India is witnessing a paradigm shift. After Industrial revolution, urban development was flourished. This transaction led to the development of concept called sustainability. Nagpur being geographically centrally located has generated a major impact on history of Architecture. This architecture comprises of various building elements in a structure where treated openings are critical components of any building's envelope. Treated openings (doors and windows) are considered main elements of buildings that on first glance establishes the Character of the Structure. This research revolves around identification, spotting and understanding the functional language of treated openings with comparative analysis of its building physics with respect to its function, style, use, technique used in construction, change in scale and materials used for over the period of 100 years in Nagpur region.

Introduction

A building envelope is that which defines a boundary between in and out. Whereas the envelope has an opening, which acts, in the form of regulatory and protective functions and provide light, ventilation and climate control for rooms. Treated openings can also be defined as a space or void allowing access or vision to a space or surface, such spaces or surfaces act as openings or open spaces. At the same time, they are essential functional and design elements of facades, enabling communication between indoor and outdoor spaces as transparent or translucent structural components. Openings are broadly classified into two major types A) Vertical openings ie (Doors, windows) and B) Horizontal openings ie (Skylights and courtyards).While looking for the aspect of sustainability, habitat able spaces should be taken into consideration, which are utilized for throughout the year, where the concept of sustainability starts working. Thus this study mainly focuses on the comparative analysis of such type of vertical treated openings and its building physics, in Central part of India (Nagpur region), where it mainly deals with the function of the different types of treated openings at different locations within a structure, the style and its use, different materials and techniques used in construction an lastly change in scale of the openings for over a period of 100 years.

Importance of Building Physics

Building Physics is a science that deals in hydrothermal, acoustical and light related properties, and the performance of building materials, building assemblies such as (roofs, facades, openings, walls, spaces, building as a whole and the overall built environment. Building Physics has to operate within an architectural framework, floors, facades, openings and roof form, aesthetics and choice of materials are all elements which shape the building and whose design is based on among others, the performance requirements which building physics imposes. The need to build a comfortable indoor environment that protects humans against vagaries of the outside climate, defines the role of building physics. it deals with variety of criteria- on one hand, requirements related to human comfort, health and wellbeing, and on the other hand restrictions because of architecture, material use, economic and sustainability demands. The building, which has been designed and constructed according to requirements, that reflects a correct understanding of building physics could generate a better sustainable habitat. Of overall building envelope, a single element of treated Openings is considered for analysis and comparative study with respect to its building physics in the following cases studies.

Case study 1 (Year 1921-30)

Location: Model Mills chawl

Nilay Murarka Marg, Near Ganeshpeth Bus stop Ganeshpeth, Nagpur

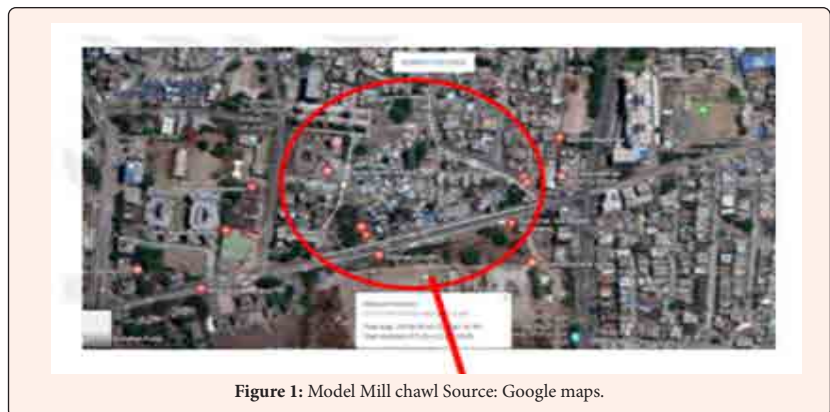


Figure 1: Model Mill chawl Source: Google maps.

The Model mill chawl at Nagpur is the oldest settlement consisting of total 416 units, which is spread over 3.16 acres of land in the heart of the city. The site is situated exactly opposite to Godrej Anandam Township, Model Mill Compound on Nilay Murarka Marg, which lies in the centre of the city. The chawl came into existence on 4th July 1921 for the workers of the Model mill which was closed down in the year 2003. The condition of chawl is down at heel, looks old and no longer in good condition. Each unit consists of approximately 30-32sq.mts in area with 2no of doors and a small window with roof projected outside acting as shading device with toilet facilities in public toilets Figure 1-4.



Figure 2: Model Mill chawl Source: Google maps.



Figure 3: Actual pic at Model Mill Chawl.

Sr No.	TYPE OF OPENING	MATERIAL	SOURCE	BUILDING TECHNIQUE	SKILL	IMAGES
1	Without frame Door in (Drd class clay bricks wall) Door(0.60m x 1.5m)	1 Hardware of MS steel 2 Timber planks 3 Hinges	Local	Wooden lintel supported on wooden post on each side of the span of double shutter battened and ledged door, where the shutter is directly attached to the frame in the walls by hinges on both the sides	skilled	
2	With frame Window in (cob wall plastered with lime mortar) window(0.60m x 0.75m)	1 Hardware of MS steel 2 Timber frame 3 Hinges	Local	Wooden lintel supported on wooden post on each side of the span of single shutter MS sheet door, where the shutter is directly attached to the post attached to the wooden planks by hinges on one side.	semi-skilled	
3	Without frame MS sheet Toilet Door is fixed and hinged wooden plank and wooden mesh Door(0.60m x 1.5m)	1 Hardware of MS steel 2 Timber planks 3 Hinges 4 wooden mesh	Local	Wooden lintel supported on wooden post on each side of the span of single shutter MS sheet door, where the shutter is directly attached to the post attached to the wooden planks by hinges on one side.	semi-skilled	
4	no opening or ventilator toilet facilities in public toilets.					

Figure 4: Represents treated opening details at Model mill Chawl.

The image (Figure 5) below represents brick arch openings for doors and windows with wooden lintel low height opening size of 0.60mX1.50m. Vertical bars are used as grill and the panels are fixed inside the grill. The unfinished arched openings with key stone (brick) in the centre gives the effect of colonial style of architecture.

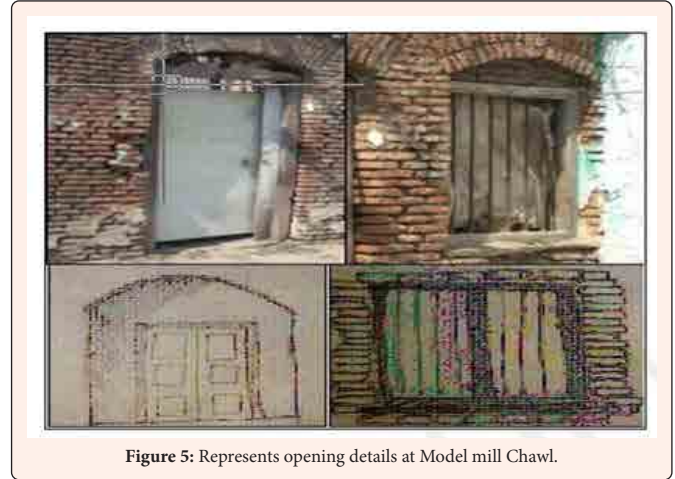


Figure 5: Represents opening details at Model mill Chawl.

Case study 2 (Year 1941-50)

Location: Kumbharpura, Lalganj, Residence of OP Devikar Dahi bazaar road, Nagpur

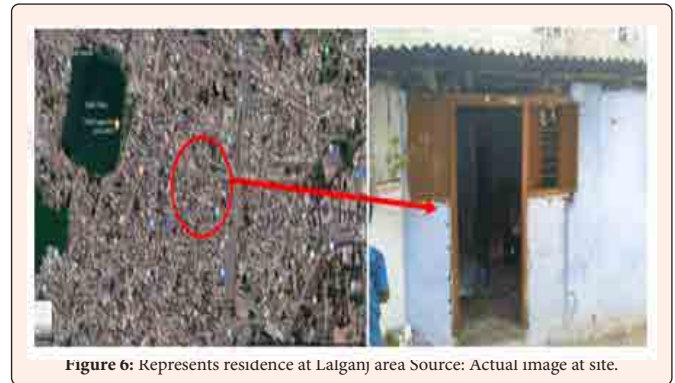


Figure 6: Represents residence at Lalganj area Source: Actual image at site.

Sr No.	TYPE OF OPENING	MATERIAL	SOURCE	BUILDING TECHNIQUE	SKILL	IMAGES
1	With treatment With framed double shutter Door in 1/2'attle and daub wall plastered with lime mortar door size (0.75m x 0.60m)	1 Hardware of MS steel 2 Timber planks 3 Hinges	Local	With frame, the shutters are directly attached to the frame by hinges on both the sides	semi-skilled	
2	Without shutter Window in 1/2'attle and daub wall plastered with lime mortar window size (0.60m x 0.45m)	1 MS bars 2 wooden lintel	Local	Without shutter window where wooden lintel supported on wattle and daub wall with MS horizontal bars	skilled	
3	With treatment An opening in 1/2'attle and daub wall plastered with lime mortar opening size (0.60m x 0.60m)	1curtain 2 m.s bar 3 nut/bolts	Local	An opening at times closed with curtains	semi-skilled	
5	With framed double shutter window in 1/2'attle and daub wall plastered with lime mortar window size (0.60m x 0.75m)	1 Hardware of MS steel 2 Timber planks 3 Hinges	Local	With frame, the shutters are directly attached to the frame by hinges on both the sides in wattle and daub wall	skilled	

Figure 7: Represents treated opening details at Kumbharpura Lalganj.

The residence of OP Devkar, tailor by profession and a Resident of Lalganj Kumbharpura chowk, Nagpur residing in the dwelling of 400sq.ft area for more than 75 years. Its old and construction of three rooms with no front or backyard. The condition of the residence looks old and no longer in good condition. The temperature inside is cooler as the wattle and daub wall thickness varies from 1'-1'6". The low height openings were 3 in no with double shuttered ledge and battened door and 3 window supported on wooden lintel in wattle and daub wall with MS horizontal bars acting as grill, and roof projected outwards acts as shading device for the openings Figure 6,7.

Case study 3 (Year 1961-70)
Location: At Mahal, opposite Kalayaneswar Mandir Residence of Yashwant Wardilwar Nagpur

The study and analysis of treated openings at residence of Y Wardilwar's, who runs a newspaper agency from Mahal area was built around 50-55 years ago was built in colonial style of architecture. The low height openings were 9 in no with double shuttered framed and panelled door and 4 windows supported on Brick lintel brick wall with MS horizontal bars acting as grill Figure 8.



Figure 8: Shows the entry of the residence that is fixed up with teak wood double panelled framed door below brick lintel with low height opening size of 0.90m X 1.80m. The style of doors and windows used were those as used in wadas with raised plinth, brick lintel with very less or no ornamentation.

Sr.No	TYPE OF OPENING	MATERIAL	SOURCE	BUILDING TECHNIQUE	SKILL	IMAGES
1	With treatment With frame Door in clay bricks wall door size (0.90mX1.80m)	1 Hardware of MS steel 2 Timber Frame/Panels 3 Hinges	Local	Double shutter framed and Panelled door is directly attached to frame in the walls by hinges on both the sides	semi-skilled	
2	With frame Window in clay bricks wall window size (0.90mX1.20m)	1 Hardware of MS steel 2 Timber frame 3 glass	Local	Double shutter ledged and battened door, directly attached to frame in the walls by hinges on both the sides	semi-skilled	
3	With treatment With frame ledge and battened Door in clay bricks wall door size (0.80mX1.50m)	1 Hardware of MS steel 2 Timber battens/ledges 3 Hinges	Local	Double shutter ledged and battened door, directly attached to frame in the walls by hinges on both the sides	semi-skilled	

Figure 9: Represents treated opening details at Mahal Area.

Further to carry, the comparative analysis of treated openings at Aakar nagar, Katol road, were the resident is a Retired Government Employee, where the structure is G+1 was built around 30 years ago. The residence is a duplex row house is located on rectangular

plot with its longer sides facing north-south axis (which are attached to common walls of neighbours) Figure 9,10.

Case study 4 (Year 1981-90)
Location: B-69 Aakar Nagar, Katol road, Nagpur
Residence of RC Sonkusare

Sr.No	TYPE OF OPENING	MATERIAL	SOURCE	BUILDING TECHNIQUE	SKILL	IMAGES
1	With treatment With MS steel frame panelled Door in (1st class brick wall) door size (0.90mX2.10m)	1 Hardware of MS steel 2 panelled timber door 3 MS Frame	Local	RCC lintel supported on MS steel frame on each side of the span of single shutter framed and panelled door which is directly attached to the metal frame in the walls by Holdfast on both the sides with attached metal door for security is fixed	skilled	
2	With MS steel frame glass window in (1st class brick wall) window size (0.90mX1.20m)	1 Hardware of MS steel 2 MS frame 3 panelled glass window	Local	RCC lintel supported on MS steel frame on each side of the span of single shutter plywood door which is directly attached to the metal frame in the walls by Holdfast on both the sides	semi-skilled	
3	With treatment With MS steel frame single shutter plywood Door in (1st class brick wall) door size (0.75mX2.10m)	1 Hardware of MS steel 2 panelled plywood door 3 MS Frame	Local	RCC lintel supported on MS steel frame on each side of the span of single shutter plywood door which is directly attached to the metal frame in the walls by Holdfast on both the sides	semi-skilled	

Figure 10: Represents treated opening details at Katol road area.

In total, it has 11 no of panelled doors with height of the opening as 2.10 mts, 6 double glazed aluminium framed windows are provided treated glass are used. Double glazed reflective glass with cavity (air gap) insulation in between is used for window panels, which ceases 20 % of heat coming inside, with rcc 0.60m chajja as an shading device Figure 11.

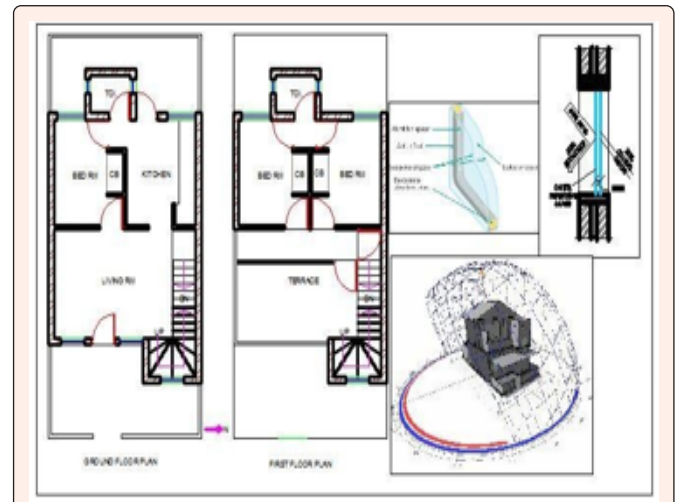


Figure 11: Schematic representation of floor plan and window detail.

Case study 5 (Year 2001-2010)
Location: KT Nagar, Katol road, Nagpur
Residence of Ashok Nanwani

The last example to analyse was at KT nagar, Katol road, were the resident is a Businessman and deals in Electrical equipments and the structure is semidetached G+1, where the plot size measures about 1891sq.ft was built during the period of 2003-2007. The building is equipped with all the latest techniques of construction and materials and is installed with solar power generation. The total no. of openings in the structure consists of 12 Teak wood framed and panelled doors with 7no of double glazed large glass windows. Maximum no. of openings are covered with porch, which acts as shading device Figure 12.

Sr.No.	TYPE OF OPENING	MATERIAL	SOURCE	BUILDING TECHNIQUE	SKILL	IMAGES
1	With Teak wood frame Teakwood single panelled Door in (1st class brick wall) door size (1.0mX2.10m)	1.Hardware of MS steel 2. panelled teakwood door 3. wooden Frame	Local	RCC lintel supported on teakwood frame on each side of the span of single shutter framed and panelled door which is directly attached to the wooden frame in the walls by Holdfast on both the sides with attached metal door for security is fixed.	skilled	
2	With MS steel frame metal (gill) door in 1st class brick wall door size (1.0mX2.10m)	1.hardware of MS steel 2. metal frame 3. metal door		RCC lintel supported on MS steel frame on each side of the span of single shutter MS grill door which is directly attached to the metal frame in the walls by Holdfast on both the sides for security is fixed.		
3	With teakwood frame double glazed window in (1st class brick wall) window size (1.50mX1.20m)	1.Hardware of MS steel 2. wooden frame 3. panelled double glazed window		RCC lintel with 0.60m roof projected chajja supported on teakwood frame on each side of the span of 4 shutter framed and panelled window which is directly attached to the wooden frame in the walls by Holdfast on both the sides with attached metal grill for security which is fixed from inside.		
4	With treatment With MS steel frame single shutter PVC Door in (1st class brick wall) door size (0.75mX2.10m)	1.Hardware of MS steel 2. PVC door 3. MS Frame		RCC lintel supported on MS steel frame on each side of the span of single shutter PVC door which is directly attached to the metal frame in the walls by Holdfast on both the sides		semi-skilled

Figure-12: Represents treated opening details at KT Nagar area.

Conclusions

Over the period of 100 years, the study displays the following change in building physics. In older times, storage spaces were maximum in all activities, flexibility of activities or performing activities in different manner ensured multiple use of same space, creating multiutility spaces. Thus minimizing the requirement of exclusive spaces. As the size of the structure increased over the years, this building envelope changed.

With this change in envelope, the need of exclusive spaces increased which resulted into increase in no of treated openings and its accessories. In recent times, carbon neutral building concept has become a popular catchphrase to describe the synergy between energy-efficient building and renewable energy utilisation to achieve a balanced energy. Energy is one of the most important factors in economic growth and social development in all countries. A building consumes energy at different levels in every stage of the life cycle, whereas building materials occupy a great share of this consumption. The choice of building materials can have multiple effects on a building's energy consumption. Therefore, the amount of embodied energy consumed by materials used for treated openings in buildings plays important parameter in determining the energy efficiency of the buildings. The timber doors required for no. of door and windows are obtained from forests whereas steel and glass are altered in form with the help of human and machine skill and manufactured with mine ore with heavy industrial process involving external use of fuel/electricity and energy. Over the years, the materials used for openings in buildings have higher environmental impacts than those used in traditional buildings Figure 13.

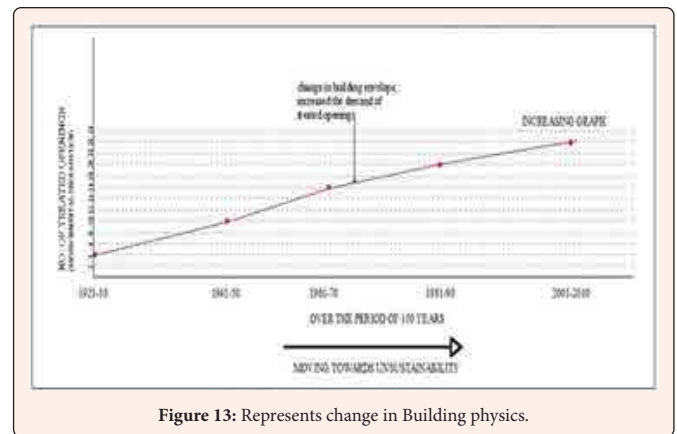


Figure 13: Represents change in Building physics.

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