HIGH RISE MIX USE BUILDING

EAST AVENUE MALL

Project - Academic 7th semester, 2023 .
Typology - MIX USE HIGH RISE BUILDING .
Area - 39041 Sqm
Location - Jabalpur , Madhya Pradesh 482003 .
Involvement - Individual Academic Work .

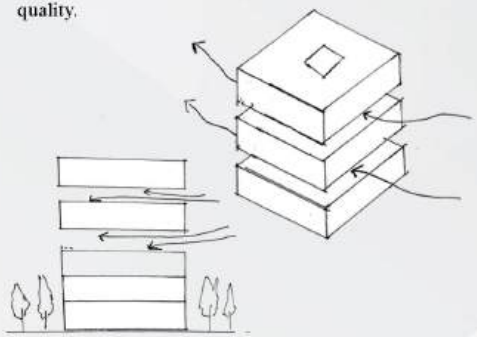
A mix of Mall/Retail Spaces (30%), Business hotels (30%), offices, and Public access zones (20%), topped with an X-Factor (20%), integrated with a single footprint building.

Ground Coverage: 40%.
Max. Permissible Height: 70 meters

CONCEPT

{BREATHING ARCHITECTURE}

IT is a principle that employs structural and aesthetic strategies to maximise the flow of natural air and improve mechanical ventilation for better indoor air quality.



The breathing mask concept focus on incorporating green infrastructure such as green roof, sustainable development practices such as energy efficient building ,renewable energy sources, and low impact development techniques.

Providing FREE FLOORS such that it help in providing CROSS VENTILATION throughout building.

Free Floors act as Multi.funtionIng spaces (yoga ,garden ,walking, gym, park Meetings, open cafes etc.)

Help to reduce a building's HVAC costs.

this concept aimed to reduce the ecological footprint of the community.

SITE CONTEXT

NEIGHBORHOOD CONTEXT

D-MART
AN RETAIL STORE

GANGA FULES
PETROL PUMP

VIJAN MAHAL
5 STAR HOTEL

INDIAN PUBLIC
HIR.SEC. SCHOOL

ANANTARA
(URBAN SETTING)

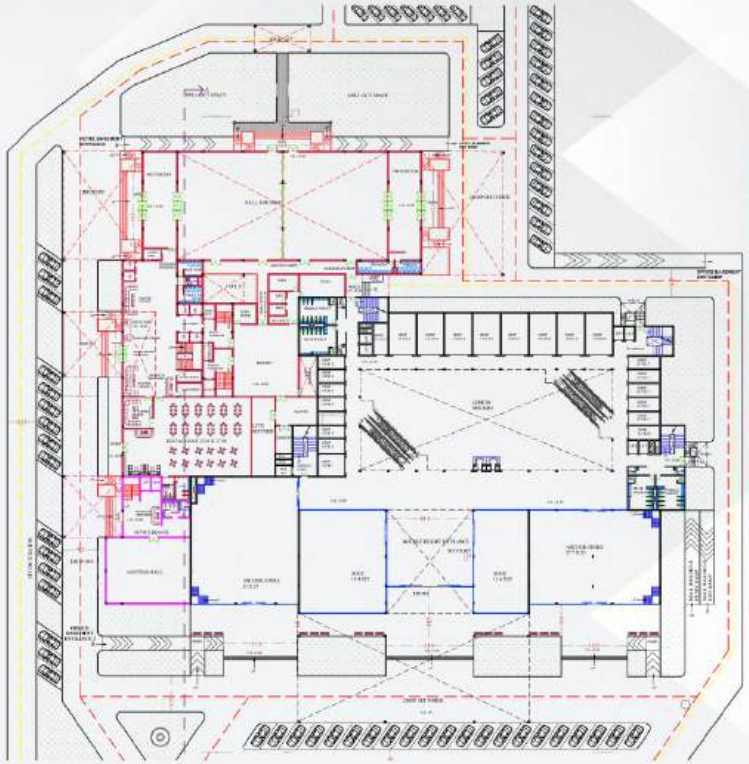
ANANTARA ENTRANCE

SITE PLAN

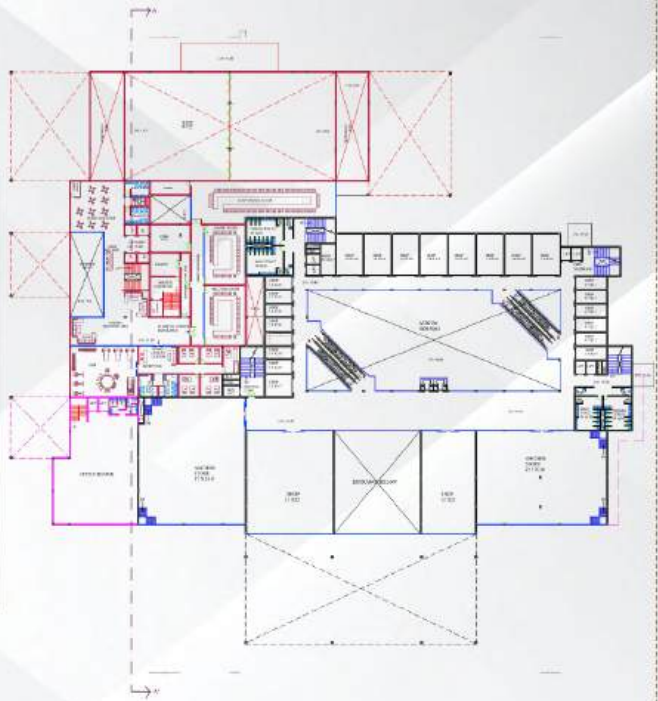
SITE PLAN

PLANS

BASEMENT FLOOR PLAN

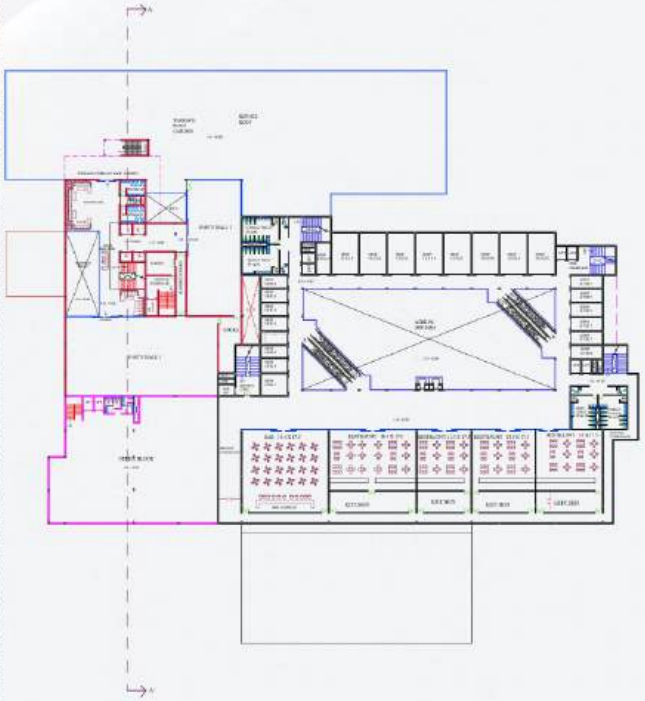


GROUND FLOOR PLAN

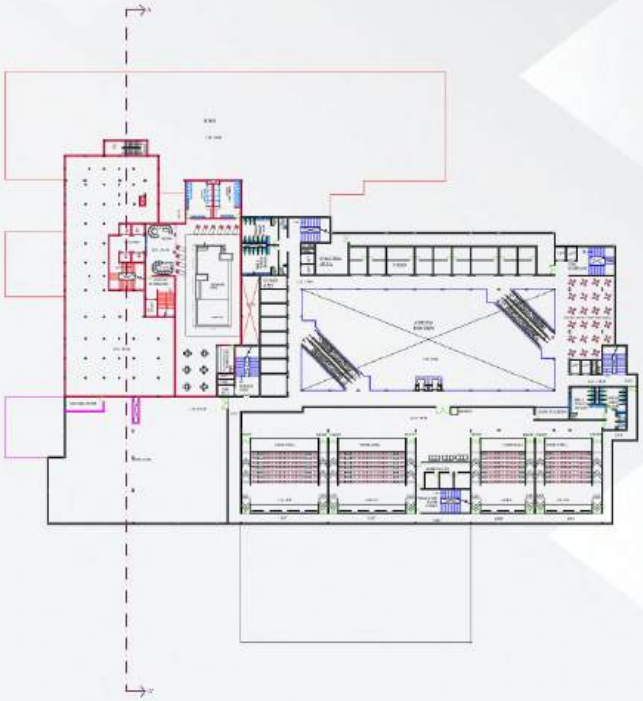


FIRST FLOOR PLAN

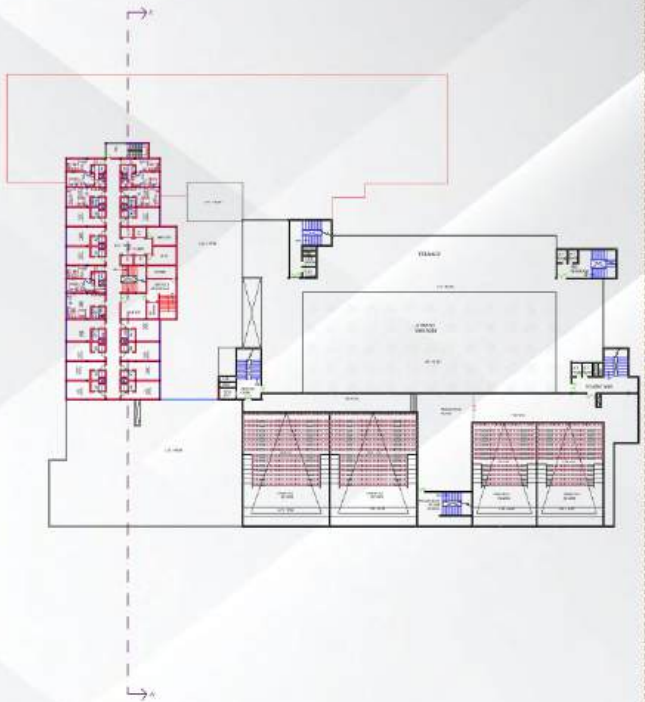
PLANS



SECOND FLOOR PLAN



THIRD FLOOR PLAN



FORTH FLOOR PLAN

ELEVATIONS & VIEWS

FRONT (SOUTH) SIDE ELEVATION

EAST SIDE ELEVATION

WEST SIDE ELEVATION VIEW

NORTH SIDE ELEVATION VIEW

SECTIONS AND VIEWS

SECTION A-A'

SPILL OUT AREA VIEW

MAIN ENTERANCE VIEW

VIEW FROM PARKING

OFFICE AND HOTEL ENTRY VIEW

LAWN VIEW

A dissertation report on

STUDY OF COGNITIVE LEARNING APPROACH-FOCUSING AUTISTIC CHILDREN

Synopsis of dissertation to be submitted for the award of the degree of

Bachelor's of Architecture

[redacted]

[redacted]

HITKARINI COLLEGE OF ARCHITECTURE AND TOWN PLANNING

Rajiv Gandhi Proudyogiki Vishwavidyalaya(RGPV)

DECEMBER 2023

CERTIFICATE

This is to certify that the synopsis entitled *STUDY OF COGNITIVE LEARNING APPROACH-FOCUSING AUTISTIC CHILDREN* submitted by [redacted] to *Hitkarini college of architecture and town planning* for the award of the degree of Bachelor of Architecture, is a bonafide record of the research work which will be carried out by her under my supervision and guidance.

This B.Arch. Dissertation synopsis along with recommendation is being forwarded to the Director.

Under the guidance of

Ar. Priyanka Virha

Dissertation guide

Date:

Place: Jabalpur

Ar. Neeraj Agrawal

Director

Date:

Place: Jabalpur

ACKNOWLEDGEMENT

I am grateful to Hitkarini College of Architecture and Town planning, for providing me with the opportunity to research and write this dissertation report. For her critical comments on the drafts, I would like to thank my guide Ar. Priyanka Virha for her guidance and supervision. Their willingness to provide feedback and constant push to strive for better, made the completion of this dissertation a productive experience. I devote my special thanks to other faculties too who have added more meaning to my research with their guidance and knowledge. I am also very thankful to my fellow classmates who have read through the drafts and provided valuable opinions.

LIST OF FIGURES.

LIST OF TABLES.

1. SYNOPSIS.

1.1 INTRODUCTION:

Autism spectrum disorder (ASD) is an umbrella term used for a range of heterogeneous neurodevelopmental conditions, characterized by:

1. Difficulties in social communication and social interaction across multiple contexts.
2. Restricted and repetitive patterns of behavior, interests, and activities.
3. The incidence of the disorder has increased significantly in recent years. The estimated global incidence is of 1 in 160 people.
4. A monitoring study carried out in eleven states (Arizona, Arkansas, Colorado, Georgia, Maryland, Minnesota, Missouri, New Jersey, North Carolina, Tennessee, and Wisconsin) of the United States in 2016 reported an incidence of 1 in 54 among 8-year-old children, showing an increase compared with the previous editions conducted in 2014 and in 2012 (incidence of 1 child in 59, and 1 child in 69, respectively).
5. INCLEN study suggests that ASD prevalence across five States in north and west India was as high as one in 125 children between 2-6 years age group and one in 80 among children in 6-9 years age; overall the prevalence in India is estimated to be 1in 89.
6. The prevalence of ASD as per 2020 CDC report is 1 in 44.
7. Built environment design can be considered as an influential factor in the quality of life of people with autism spectrum disorder.

1.2. NEED FOR THE STUDY:

- Centers for disease control and prevention (CDC) estimates that approximately 1 in every 88children are diagnosed with some level of autism, (one in 54 boys) a sharp jump from the previous numbers in India is1 in 250 (figure may vary as many cases are not diagnosed and currently 10 million people are suffering in India.

---

https://doi.org/10.53553/JCH.v09i02.002

asd: 18 million Indians have autism: Learn more about 3rd most common developmental disorder; know the basics of parenting children with ASD - The Economic Times (indiatimes.com)

1.3. AIM:

To study cognitive learning approach focusing Autistic children.

1.4. OBJECTIVE:

To understand enabling built environments for children with autism for learning spaces.

1). Establishing co-relation between built environment and the needs of children with autism.

2). To understand cognitive learning spaces.

3). To discuss the aspect of design consideration required for autistic children.

1.5. LIMITATION:

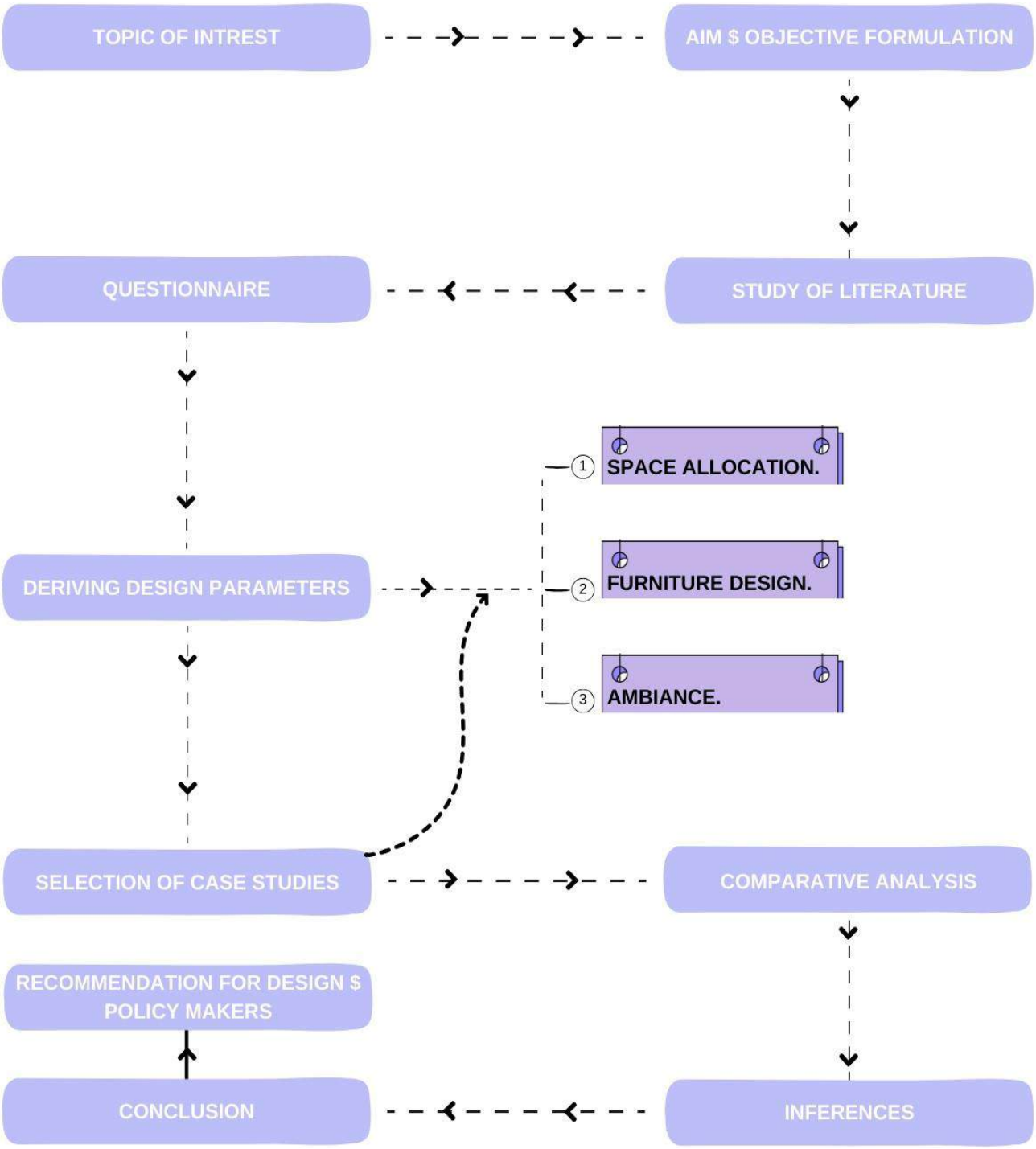
To study on learning spaces for autistic child.

Focusing on the age group of 4-9 years.

1.6. METHODOLOGY:

- The process will begin with identification of environmental issues of importance for children with autism based on an extensive literature survey and study of environmental traces in the classrooms for children with autism.
- For this I will do an extensive literature survey, to understand the educational needs of children with autism.
- The literature review allowed the identification of three main factors to be considered when designing for people with ASD—the sensory quality, the intelligibility, and the predictability of the built environment.

1.7. STUDY STRUCTURE:



2. LITERATURE STUDY:

2.1. Research Tools to Study Vulnerable Populations; A Case of Designing Inclusive Spaces for Autism.

IMPACT OF AUTISM.

1. An extensive survey is cited out in the research and data is collected from sixteen educational spaces in USA and six in India.
2. The overall rating of identified design parameters is done by eighteen autism experts and from fourteen regular education experts.
3. The research samples represent all age groups, elementary, middle and primary; different type of educations settings, inclusive and specialized; different education experts, autism and regular education, and different cultural context in the countries- developed and developing.
4. With the escalating incidence of autism and advent of inclusive education, it has become vital to explore the scope of environmental design for autism.
5. The present research is a sequential progression that stands on existing body of knowledge, to produce environmental design guidelines those are enabling for children with autism.
6. Using a research process, with pre-established foundations, it generates new evidence-based knowledge, to design supportive, accessible and inclusive learning environment for all children with and without autism.

2.2. OBSERVATION OF PHYSICAL TRACES.

Drawings, annotated diagrams and photographs were used to observe the traces in the classrooms with children with autism (on walls, ceilings, furniture layout, and floor, please refer table 1). Different types of schools were observed during field visits, like early childhood program, autism school, inclusive school, vocational unit and school with residential facility.

The environmental interventions by the teachers in existing classrooms with children with autism reflected the teaching methods adopted to combat autism conditions. Structured teaching, behavioral modification, one to one teaching, were the most visible amongst all.

Classroom layout	The classroom is well structured. It has individual work areas, group work areas and a withdrawal space partitioned using cabinet. Classroom has wash basin for learning self-help, computer, space for hanging bags and ample storage space, spaces are clearly labeled using pictures. Separate rooms for vocational activities are also provided for children.
Walls	The light colored walls have a lot picture schedules and visual instructions for students. Pictures are photographs, line drawing or computer generated. Lot of wall shelves are provided in the classroom for storage.
Floor	Plain dark colored tile flooring, free of patterns and easy to clean is provided in the classroom area. Not many activities are performed on the floor.
Ceiling	Light colored false ceiling with lighting fixtures
Furniture	Furniture is provided for small group teaching and individualized teaching. A bean bag is provided in the withdrawal space.
Doors and Windows	The classrooms are air-conditioned and there is ample light through windows. The windows have venation blinds and curtains. Every classroom door has a small window; the children are monitored from outside using these windows.
Security	The building is fenced with gates. The children are not allowed to leave the building on their own; they are always accompanied by a staff. The building follows fire regulations guidelines and has visual symbols to demarcate evacuation paths.
Accessibility	Accessible with lifts and ramps
Toilets	Accessible toilets are provided near classrooms
Additional services	The other facilities that are available to the children are speech and occupational therapy, sensory room or sno ezelum room, dining hall, swimming pool, gymnasium, playground, vocational training center

TABLE 1. Observation of physical traces in an autism classroom in special school.

2.3. COMMUNICATION INTERVENTION FOR CHILDREN WITH AUTISM.

Author: - Benedict, Christine S.

Title: - Communication Intervention for children with Autism: A literature Review.

Masters: - Master of science in education with a major in school psychology.

Research adviser: Kelly Lamon.

Year: May 2007

Number of Pages: 45

Style Manual Used: - American Psychological Association, 5th edition.

This Chapter will review the literature relevant to the different behavioral and interactive language-based interventions currently in the literature. It will also purport the efficiency of these interventions based on empirical studies. Continued research has provided a clearer understanding of the disorder of autism and has led to better treatments and therapies.

- The most effective programs share an emphasis on early, appropriate, and intensive intervention.
- To accommodate the diverse needs of individuals with autism, effective approaches should be flexible, revaluated regularly, and provide the child with opportunities for generalization.
- Parents should investigate all treatments thoroughly and use caution before committing to any particular treatment.
- The differences range from behavioral approaches, which shape and modify behaviors, to developmental-interactive approaches, which aim to develop social and communicative processes through naturalistic interaction and cognitive approaches.
- There are different communication interventions and approaches that come from traditional Applied Behavior Analysis (ABA) procedures that combine behavioral and developmental principles to increase social and communication skills in children with autism.

Behavioral Approaches: -

- Behavioral approaches are based on the theory of skinner who believed learning is development, and all behavior is learned.
- Using associative learning and operant conditioning, behavioral responses can be modified by positive and negative reinforcement.

- This approach was developed on the theoretical basis that individuals with autism were thought to be incapable of responding to the typical environment, because they had not learned the behaviors of typically developing children.
- Applied behavior analysis has proven to be successful in establishing and implementing language intervention programs and teaching a variety of other skills.

Picture Exchange Communication System: -

- The Picture Exchange Communication System (PECS) devised by bondy and frost (1994) is an augmented alternative communication (AAC) system designed to teach functional communication to children with limited speech.
- The purpose of PECS is a functional non-verbal communication system based on initiation of communicative interactions.
- PECS includes a structured program that involves a child exchanging a symbol, such as a picture for a desired item.
- It can be expanded to using multiple words for labelling and commenting.
- The intervention is based on behavioral teaching methods with an emphasis on encouraging the child to communicate spontaneously (Bondy & Frost, 1994).
- Some children using PECS later develop speech, and it has been a promising practice for enhancing communication.
- A number of studies show increased communication skills after two years of PECS usage (Bondy & Frost 1994; Ganz & Simpson, 2004; Charlop-Christy et al. 2002).
- Studies of the effectiveness of PECS report that children with limited communicative ability can be trained to use the system, and that independent speech also occurs for many of these children.

Developmental and Interactive Approaches: -

- The developmental interactive approach differs from a behaviorist approach.
- The developmental interactive approach emphasizes how both genetic and environmental factors play a role in language development, and the approach focuses particularly on the role of early caretakers in a child's acquisition of language.
- The developmental-interactive approach encourages interpersonal processes and opportunities thought to underpin social, communicative and cognitive outcomes in children with autism.
- These approaches aim to motivate a child to engage in social settings required in typical development (Trevarthen 2001).
- Complementary to the role of socializing agents, such as parents, is a child's own active role in developing normal speech.
- The interactive model of language development may include a developmental approach to teaching which generally refers to a child centered approach, where the child leads, and adult follows.
- Materials and tasks may be used that fit a child's developmental level.

Incidental Teaching and Pivotal Response Training: -

- Incidental teaching consists of a chain of pre-specified, child-tutor interactions.
- The interactions involved materials that are highly preferred by the child, promoting and shaping techniques embedded in natural contexts, and child-initiated or natural interactions.
- In pivotal response training (PRT) (Koegel et al. 1999) certain behaviors are seen as central to wide areas of functioning.
- Changing these pivotal behaviors is thought to change other associated behavior's without specifically targeting the associated behaviors.
- Pivotal response techniques include child choice, reinforcement and correcting behaviors.
- PRT involves teaching pivotal behaviors or those central to a child's day to day functioning (e.g., motivation, responsively to multiple cues, self-initiation, empathy, self-regulation, social interaction).

Peer-Mediated Strategies: -

- Peer-mediated strategies (Strain and Kohler, 1998) also demonstrate a naturalistic application of behavioral teaching.
- The typical peers of a child with an autistic spectrum disorder are instructed in a more adult-centered, mass-trail approach, while children with autistic spectrum disorders are taught by their peers in a more child-centered naturalistic approach.
- In peer-mediated intervention, peers are taught to initiate play with children with autism through sharing offering assistance suggesting play ideas and showing affection.
- Teachers remind peers to use their initiation strategies to facilitate play with their peers with autism.
- Peer-mediated intervention has therefore been purported as a promising practice for increasing social and communication skills in children with autism.

Limitations of Literature: -

- There are limitations of this literature review.
- While this researcher attempted to be exhaustive in reviewing the literature available on communication interventions used with children with autism to develop language, some research may have been overlooked.
- As such, this review may present a biased view regarding the effectiveness of the behavioral and developmental-interactive intervention approaches.
- Further, other strategies and interventions that exist to build language were not discussed in depth. In addition, this literature review is merely a summarization of previous research.

3. SPATIAL ASPECT OF DESIGN.

3.1. ENVIRONMENTAL DESIGN CONSIDERATIONS TO ADDRESS EDUCATIONAL AND BEHAVIOURAL ASPECTS.

Autism is a developmental disorder that leads to a different and characteristic pattern of perceiving, thinking and learning. To understand the needs of children with autism in the physical environment, it is necessary to know more about their deficits and behavioural characteristics. The present study tries to establish relation between learning behaviours and teaching strategies, and its implication on designing educational spaces, which is summed up in the table-A. Several authors have described autism and have grouped the features and behaviour in their own way, present research takes widely accepted 'Diagnostic and statistical manual of mental disorders'-DSM-IV(IV) as defining tool for autism that is based on 'triad' of deficits (Jordan, 1997), social interaction, communication and repetitive behaviours. The study also includes 'sensory dysfunction', which is often associated with autism and is closely related with the perception of the environment. The 'environmental design considerations' that defines enabling environment for children with autism are identified based on (i) A Literature survey: to understand learning behaviour of children in educational spaces (Siegel, 1998, Jordan, 1997, Maurice, Green & Luce, 1996, Schopler, 1995) (ii) A Field survey: to observe environmental interventions adopted in existing educational settings in various countries. These 'environmental considerations' are then summarized as 'design parameters' to recapitulate and evaluate enabling aspects of educational environment.

3.2. ENVIRONMENTAL DESIGN PARAMETERS WITH A STRONG CONNECTION TO AUTISM.

Literature on autism and environmental adaptations by teachers in the existing environment clearly define autism as a condition that affects environmental design. While summarizing the environmental design parameters, eighteen design parameters emerged as the most dominating ones. These eighteen 'design parameters' that defines the enabling environment for autism and acts as a measurable quantity in the study are as follows:

- Provide Physical Structure
- Maximize Visual Structure
- Provide Visual Instructions
- Offer Opportunities for Community Participation
- Present Opportunities for Parent Participation
- Present Opportunities for Inclusion
- Maximize Future Independence
- Offer Generous Space Standards

- Provide Withdrawal Spaces
- Maximize Safety
- Maximize Comprehension
- Maximize Accessibility
- Provide Assistance
- Maximize Durability and Maintenance
- Minimize Sensory Distractions
- Provide Sensory Integration
- Provide Flexibility
- Provide Monitoring for Assessment and Planning

Physical structure sets clear physical and visual boundaries to segment the environment so that each activity is clearly associated with a physical space (TEACCH, 2004, Stokes, 2001), for example by strategically placing furniture to define individual and group activity, play, reading, snack and other areas in a classroom. The segmented areas are further organized for the activities to be performed in that area, for example the independent work area may further be organized so that a child clearly knows how to carry out an activity. Visual structure incorporates concrete visual cues in the environment, to utilize visual strengths of individuals with autism, to make them more independent (Hodgdon, 2005, Stokes, 2001). Visual structure may be used for different purposes in all environments in which children learn and play, for example in storage areas, work areas or in common areas. Visual Instruction is a way of giving necessary instructions or sequence of steps to follow an activity, using visual mode (Harker & King 2004, Stokes, 2001).

FIGURE 1. A classroom with segmented individual & group activity area.

FIGURE 2. Colour and number coded storage area in a classroom.

(Source: 10.26687/ARCHNET-IJAR.V3I3.189)

Depending upon an individual's ability, it may be given in the form of written instructions, photographs, pictures, line drawings or visual schedules in the spaces where activities are to be performed. The instructions may be presented both in structured and naturalized teaching environments, and other areas in the school building. Opportunities for Community Participation refer to involvement in the community activities in everyday occupations. For many pupils with autism the educational curriculum includes everyday activities such as shopping, crossing the street, going to church or using public transport, thus, a location close to community activities is an advantage for educational spaces (Siegel, 1998, Jordan, 1997). The schools may also develop an environment to support teaching of such skills. Such activities may spontaneously lead to the integration in the community, as well as create training & job opportunities for the children with autism. Regular Parent Participation in educating children with autism is very important for long term success. Participation is essential for goal selection in individualized educational plan to address their individual educational needs, parent teacher meetings and many other times (BB-94, 2001, Jordan, 1997). Possibility to observe children without distracting them is very helpful to deal with the issues together with teachers and therapists. Segregation of children with special needs is morally unjustifiable; it promotes isolation, alienation and social exclusion. Children with autism should be given opportunities in the educational environment to interact with able bodied peers (Young, 2004, BB-94, 2001). In Inclusion, they are placed in inclusive settings with 1:1 aide, modified curriculum and environmental support to accommodate their specific needs. An environment that supports self-help, domestic, vocational and Independent Living training help children with autism to live with dignity in future (Mostafa, 2008, Harker & King, 2002). Since a lot of children with autism do not learn these skills like regular developing peers, they have these goals in their educational curriculum. Environment supporting independent skill development includes provision of spaces supporting such training in the classrooms school lawns, cafeteria etc.

FIGURE 3. Picture instructions for toilet activities.

FIGURE 4. A location close to community pool is an Advantage.

(Source: 10.26687/ARCHNET-IJAR.V3I3.189)

People vary in their attitude to the threat that loss of personal space or proxemics induces. People with autism can be sensitive about this and get threatened by crowding and react accordingly (Humphrey, 2005, Harker & King, 2002). A Generous Space Standard may help them deal with social stimulus comfortably. Some people with autism are social isolates; many have difficulty in handling socially demanding situations and prefer to operate on fringes of social groupings. Providing Withdrawal Spaces is helpful for children, to avoid unnecessary stress and anxiety in socially demanding spaces (Harker & King, 2002, BB-94, 2001). Withdrawal area is used as a place for students to get away from distractions and stimulations and regain some self-control. Children with autism are vulnerable in the environment due to their impaired communication, imagination and sensory dysfunction. Constant supervision is intrusive and difficult thus environment itself should be carefully assessed and managed for risks (Humphrey, 2005, Harker & King, 2004). Maximizing Safety refers to minimizing threats to the pupil within the school buildings due to their own condition, unawareness or any disaster. For safety in educational environment there may be concerns for escapes, sharp edges, nontoxic materials etc. Complexity is not harmonious; it causes stress to everyone. For low functioning children with autism confusion easily takes-over, with complexity in layout, spaces, shape and form. Schools planned with simplicity and clarity maximizes Comprehension, thus less effort is required to understand, use and enjoy the building (Humphrey, 2005, TEACCH, 2004). A clear layout, organization of spaces, clear zoning, simple forms, and no visual clutter may assist children with autism to perceive the built environment easily.

FIGURE 5 A resource/parents room overlooking classroom.

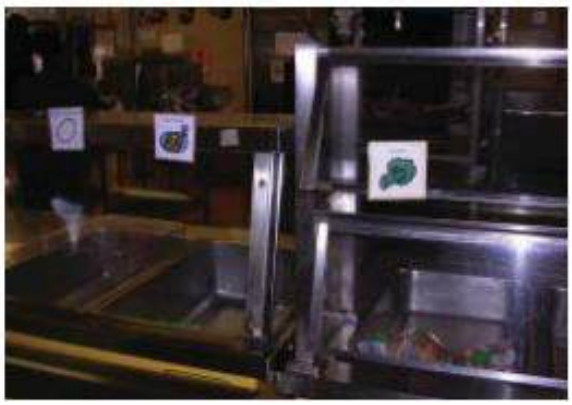


FIGURE 6. An inclusive cafeteria with picture a symbols.

(Source: 10.26687/ARCHNET-IJAR.V3I3.189)

Thus, extra Space for Assistance is extremely helpful in the different areas like classroom, toilet, dining areas etc. for teaching children with autism (Harker & King, 2002). Overall, we see a pattern in the behaviours of children with autism, but individual behaviour may vary a lot. They may be accidently or deliberately heavy on the built environment, therefore, it becomes important that the building design reflects Durability and Easy Maintenance without mirroring the institutionalized feel (Humphrey, 2005, Harker & King, 2002). This is possible when architects design easy to clean surfaces, robust finishes, strong furniture and equipment's and fittings, those are serviceable and cheap to replace. Some researchers believe that autistic

behaviour is credited to a form of sensory malfunction, when assimilating stimulatory information from the surrounding physical environment. Architect Archnet-IJAR, International Journal of Architectural Research - Volume 3 - Issue 3 - November 2009 Incorporating the Behavioural Dimension in Designing Inclusive Learning Environment for Autism RACHNA KHARE AND ABIR MULLICK 51 through his design has control over this input and he can design calm and Least Distractible Environment conducive to learning (Mostafa, 2008). Sensory dysfunction makes children with autism either oversensitive or under sensitive to the sensory inputs (as discussed in earlier); this effects their perception and understanding to the surrounding environment (Mostafa, 2008, Harker & King, 2002). Sensory Integration rooms or sensory areas provide multisensory opportunities in the environment that help children to integrate their senses for better understanding. Sensory integration calms children with under reactive senses and develops tolerance in over reactive children.

FIGURE 7. A corner in the classroom to teach self-hygiene.

FIGURE 8. A large, structured classroom with high ceiling and natural light.

FIGURE 9. A large window from monitoring room to assessment area.

(Source: 10.26687/ARCHNET-IJAR.V3I3.189)

4. LITERATURE CASE STUDIES.

4.1. Moss brook Special Primary School, Sheffield, UK.

FIGURE 10. Site plan.

(Source: Google earth)

- The building, a prototype for the future of classroom design, is for a special primary school teaching mainly autistic children, situated in Sheffield's green belt.
- The architect's scheme makes the building a tactile, sensual and interactive environment in its own right.
- Overlooking a pond, which the school has developed as a nature conservation area, the building is a simple shed, which refers to the former farm buildings that once stood on the site of area 25,184sq.m.

Moss brook science teaching base:

FIGURE 11. Children playing outdoor.

(Source: Sarah Wigglesworth Architects)

- Moss brook special school is a school for children with severe disabilities and autism.
- The unit is a science teaching base within the existing grounds of the school, but sited next to a large pond and nature reserve.
- It is not designed exclusively for children with autism but to include them.

Main Teaching science

Figure 12. Teaching space.

(Source: Sarah Wigglesworth Architects)

The unit consists simply of a science classroom, with three smaller ‘resource rooms’ each dedicated to a different scientific theme.

Exercise Space:

- The other principal space is a ball pool, which gives the children instant access to physical exercise in a weather.
- As previously stated, Daily life therapy pioneered in Japan stresses the importance of physical exercise as part of the working day.
- These principal spaces are separated by a hallway which provides access to the unit's washroom facilities.

FIGURE 13. Classroom.

(Source: Sarah Wigglesworth Architects)

Individualized Teaching space: -

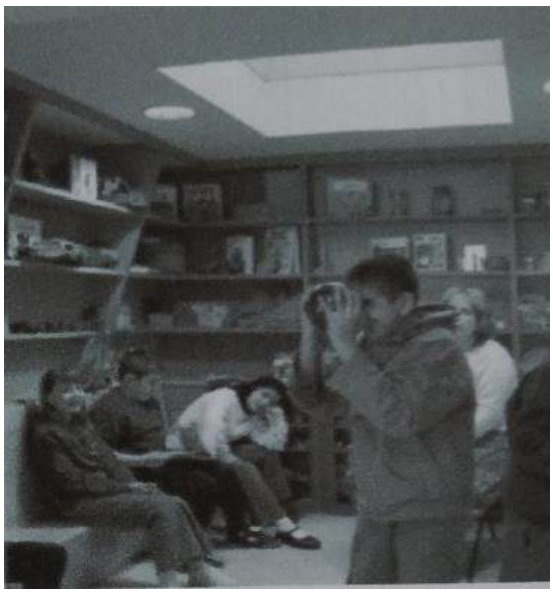


FIGURE 14. Child using kaleidoscope.

(Source: Sarah Wigglesworth Architects)

1. The three individualised resource rooms are quite different in character to the main space and are top lit.
2. They are situated on the north wall of the building they allow the children to receive individual or small group teaching, often focusing on specific demonstrations of scientific processes or properties.
3. They also allow children to study quietly away from the rest of the class.
4. All the windows to the unit have internal blinds.
5. These are capable of completely blacking out all light sources for audio visual presentations.
6. Also, the lighting in the three resource rooms is more subdued than in the main space allowing children to retreat to a darker space.
7. The architects tried to create an environment that reflected the way these children operate and experience the world in several ways.

FIGURE 15. Tactile table for learning.

(Source: Sarah Wigglesworth Architects)

Relationship to Nature:

1. The building forms a natural gateway to a nature conversation area.
2. The teaching space overlooks this area, which enables the children to experience the natural habitat of plants and animals all around.
3. Indeed, the building is intended to encourage wildlife to inhabit places within it.
4. There is a window under the building and the hope is to encourage a badger set to live there. The 'crib' wall to the north is home to a myriad of plants and wildlife.
5. The teaching space has framed views of the meadow, picture windows and wildlife.
6. Cameras are mounted on and around the building and the pond, bringing an enhanced view of the world into the classroom.
7. This notion of bringing the outside world into the classroom was one of the drivers for getting.
8. As stated in section D above, the building utilises different materials for their natural properties to enable the children to experience natural process in an immediate way.
9. The three resource rooms are renders in different colours to reflect different qualities.
10. In this way the children can access a variety of environmentally different spaces depending on their mood.

11. The building is detailed in a simple fashion allowing the natural qualities of materials to take precedence.
12. The walls to the pond and meadow are white, with a very neutral, light grey vinyl floor.
13. The classrooms for the future project were set up by the DIES In 2002 and resulted in 27 new primary school projects around UK.
14. Individual Projects were intended to explore the government's latest education initiatives about responding to educational and technological change. Chinless contains a critique of 4 of the classrooms for the future constructed in Sheffield including moss brook.
15. The school council was on board but took a back seat allowing the two members of staff to pursue their agenda as end users.
16. The university of Sheffield students carried out interactive work with the pupils, who built models and did extensive drawings illustrating what they wanted from their environment.

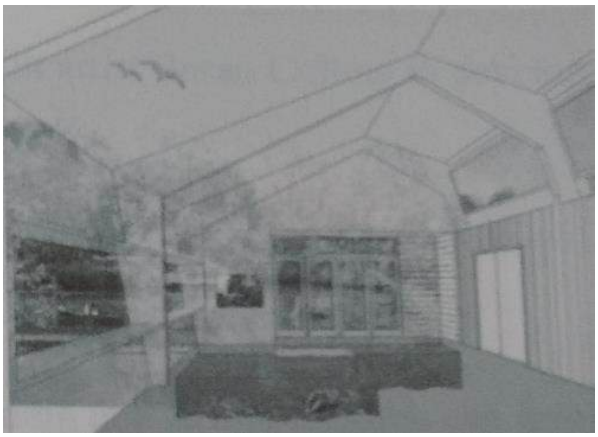


FIGURE 16. Inter spaces.

(Source: Sarah Wigglesworth Architects)

Analysis:

1. The building is properly planned, it has interacted building structures with nature.
2. The students are properly trained by equipment's naturally.
3. The spaces are well used according to the activities.
4. The place is far away so it's away from the noisy surrounding due to these children can grow in peace environment.

Conclusion:

They have interacted building structure with nature and has the space where they can teach children and make them independent.

S.W.O.T Analysis

Location: - Moss brook Special Primary School, Sheffield, UK.

Total Area: - 25,184sq.m.

Strength:

- This case study covers most of the aspects related to design for especially abled children.
- The school campus has a built-up area including classrooms, toilets, Administration canteen clubhouse and therapy rooms etc. and outdoor playing area for children's.
- The indoors consisting of tactile symbols on floors and walls for children to follow.
- The campus has no distracted surrounding the site surrounding is green and well planted with fresh air.
- The site has a single approach road, reducing disturbances due to traffic.
- The place is far away so it's away from the noisy surrounding due to these children can grow in peaceful environment.
- Passages are well covered, and skylight is provided.

Weakness:

- There are no green spaces within the campus.
- Lack of Parking Space within the campus.
- The site has only one entry and exit.
- No Visitors toilet outside the superstructure.

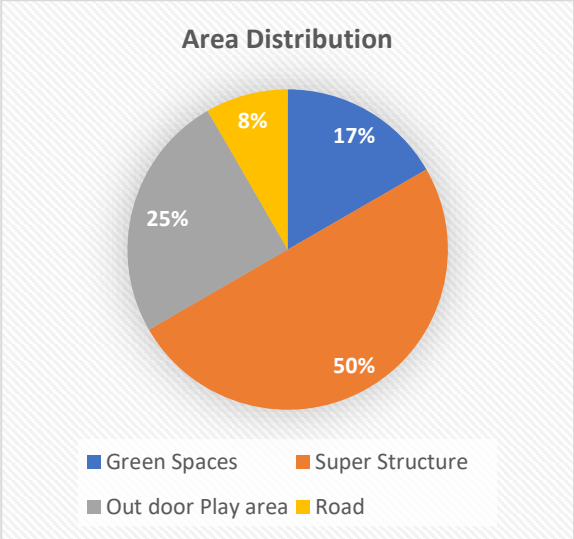
Opportunity:

- Tensile seating structures could be provided outdoors.
- Outdoor Cafeteria and eating spaces can be provided.
- Outdoor play area can be sheltered by providing a structure.

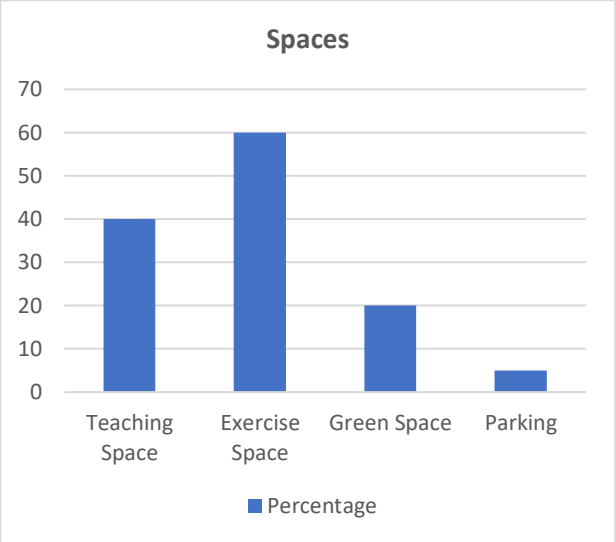
Threat:

- No threats.

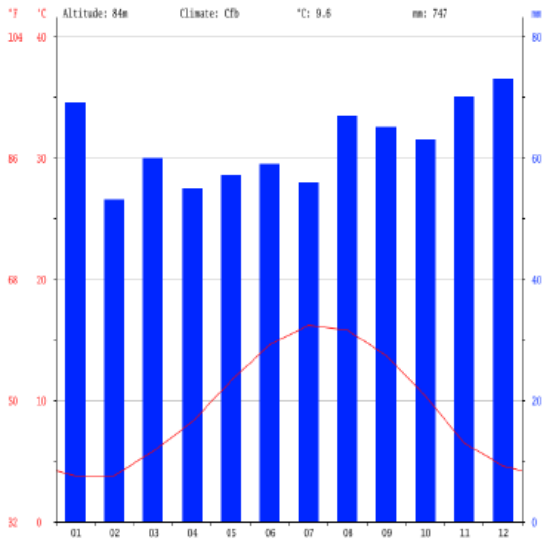
Area: -



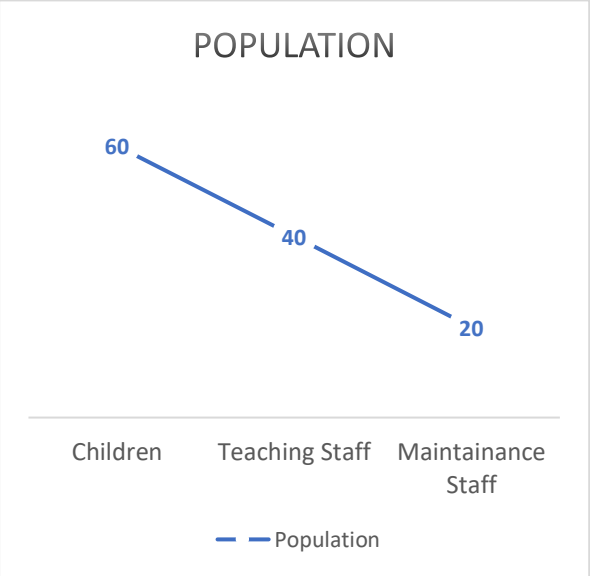
Spaces :-



Climate :-



Population :-



(Source: Author)

4.2. Northern School for Autism – Reservoir Campus:

FIGURE 17. Site plan.

(Source: Therapeutic gardens Australia)

The Northern School for Autism with two campuses in the State of Victoria (one based in Lalor and the other in Reservoir) have designed with the children's physical and emotional needs in mind.

FIGURE 18. Children's play area.

(Source: Therapeutic gardens Australia)

Northern School for Autism – Lalor Campus:

The outside spaces have been designed based on the principle that children with autism spectrum disorder need to be physically stimulated to release pent-up energy and frustration. Catering to the need for autistic children to develop and strengthen their fine and gross motor skills, a number of safe but challenging, fun and engaging play equipment pieces have been included, both fixed and moveable.

FIGURE 19. Playground.

(Source: Therapeutic gardens Australia)

Northern School for Autism – Reservoir Campus:

Both campuses feature a bike track with well delineated edges to the paths and this facility is coupled with a bicycling education program. Climbing nets, a ropes climbing course, slides, tunnels and bridges are also featured to allow children to progressively improve their physical skills and gain self-esteem, confidence and independence.

FIGURE 20. Child playing with toys.

(Source: Therapeutic gardens Australia)

Northern School for Autism – Reservoir Campus:

The play areas are secure spaces, with age-appropriate activities and discrete places for children to withdraw from sensory over-stimulation when necessary. Water play is encouraged at both campuses through facilities such as sand and water tables. Swings and other equipment that stimulate the vestibular and proprioceptive systems of students are also used to help reduce behaviours such as excess rocking, spinning and hand flapping during indoor learning times.

Some educational activities are held outdoors, and the furniture has been carefully chosen to be durable and fit for the purpose, with both shaded seating and full-sun seating available. This allows for students with photosensitivity to have proper facilities.

FIGURE 21. Small seating space for child.

(Source: Therapeutic gardens Australia)

Example of a Sensory Garden for children:

Whilst this school has provided several excellent facilities for stimulating the physical needs of students, we would argue that it is sadly lacking in interaction with nature. There are very few plants included in the design and students are missing out on the multitude of benefits that interacting with nature can bring. A sensory garden, together with other simple natural elements such as stones and logs, would be very easy to introduce to the spaces. You can see some examples of sensory gardens for children in this post. Retrofitting many of the design principles and elements of natural spaces can usually be done with a minimum of cost and effort. The health benefits, the improvements in sensory integration, the knowledge gained by interacting with flora and fauna, as well as the pure enjoyment of nature would all heighten the schooling experience for students and expand their life skills.

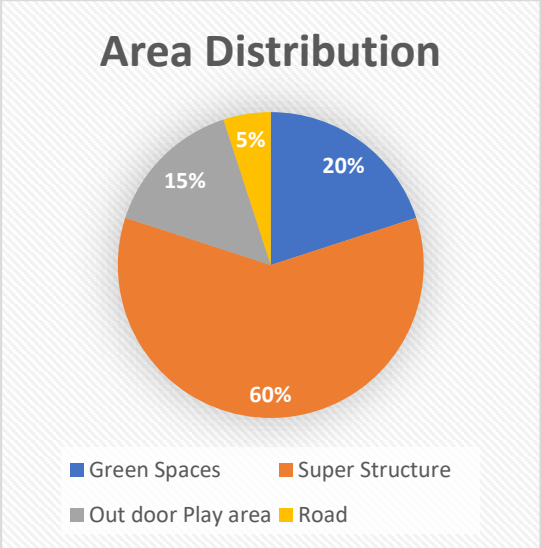
FIGURE 22. Flower garden.

(Source: Therapeutic gardens Australia)

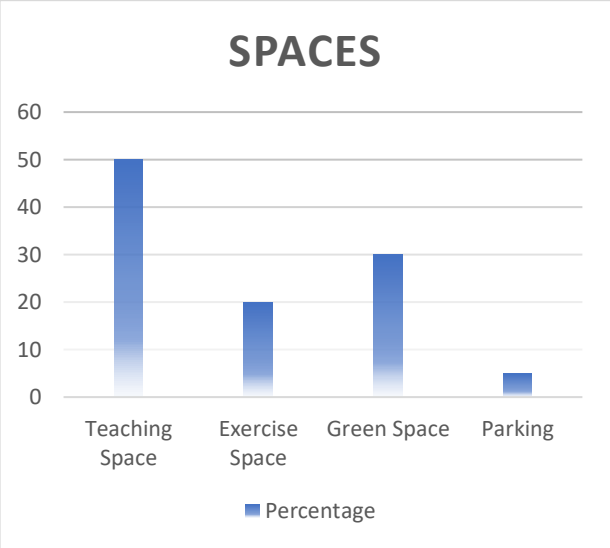
Example of a Sensory Garden for children:

A more holistic approach to the advantages, beauty and health outcomes of students with autism spectrum disorder would certainly maximise the use of the space and intensify the myriad of positive results achieved through interaction with nature and exploring outdoor spaces.

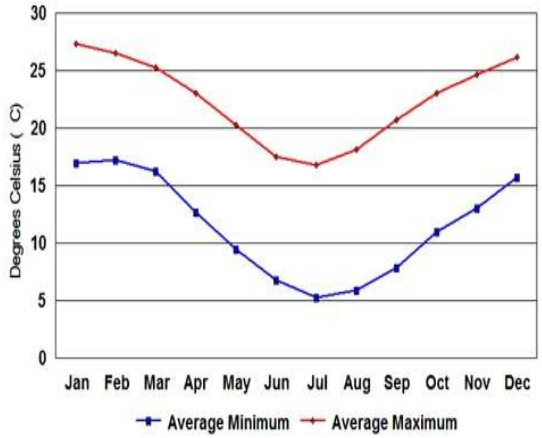
Area: -



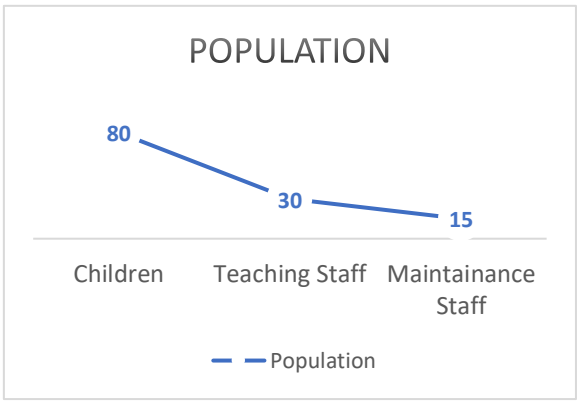
Spaces :-



Climate:-



Population :-



(Source: Author)

4.3. COMPARITIVE ANALYTICAL CHART: -

Locations.	**Moss brook Special Primary School.**	**Northern School of autism.**
Classrooms.	The three individualised resource rooms are quite different in character to the main space and are top lit.	Some educational activities are held outdoors, and the furniture has been carefully chosen to be durable and fit for the purpose, with both shaded seating and full-sun seating available.
Parking.	Parking is provided on the eastern part of the site.	Parking is provided in the southern side of the site not hampering any activities on the site.
Outdoor activities.	Outdoor activities badminton court are provided on the western part of the site with ample of circulation space and ventilation of fresh air.	The outside spaces have been designed based on the principle that children with autism spectrum disorder need to be physically stimulated to release pent-up energy and frustration.
Administration	Administration is placed centrally on the northern part of the site.	Administration becomes an important part situated centrally along the structure and emphasized.
Exercise space	The other principal space is a ball pool, which gives the children instant access to physical exercise in a weather.	Both campuses feature a bike track with well delineated edges to the paths and this facility is provided.
Open areas	Open areas for morning activities on the eastern side of the site which receives early sunshine.	Open areas for morning activities on the entire eastern side of the site sweeping from northeast to southeast which receives early sunshine.
Overall review	Pretty feasible design with all activities strategically planned and ample of open space provided in relation to the children's usage of these spaces.	The Northern School for Autism with two campuses in the State of Victoria (one based in Allor and the other in Reservoir) have designed with the children's physical and emotional needs in mind.

TABLE 2. Comparative analytical chart.

(Source:Author.)

4.4. DESIGN PARAMETER RATING SCALE: -

Environmental Design Parameters	Highly Recommended	Recommended	Recommended with reservation	Not sure	Not recommended	Comments
1. Provide Physical Structure- organize physical environment through clear physical and visual boundaries to establish context of activity associated with a physical space.						
2. Maximize Visual Structure-organize visual environment through concrete visual cues and visual importance by incorporating colour coding, numbers, symbols, labelling, illuminated sign boards, highlighters etc.						
3. Provide Visual Instruction- give sequence of steps to follow an activity (in the spaces where activities are to be performed) in the form of written instructions, pictures, visual schedules etc.						
4. Opportunities for Community Participation- involve pupils in the community activities in every day works such as shopping or using public transport.						
5. Opportunities for Parent Participation- involve parent in school activities to address pupil's individual educational needs.						
6. Opportunities for Inclusion - present an environment to the children with autism to interact with able bodied peers.						
7. Maximize Durability and Maintenance- durability and maintenance of equipment, hardware, furnishing, fitting, furniture etc from damage and misuse by pupil.						
8. Minimize Sensory Distractions- least distracting settings that are away from any visual, auditory, tactile distractions.						
9. Provide Sensory Integration- include multisensory stimulations in the environment like opportunities for Rolling, jumping, spinning, vibrations, music, different visual experiences etc.						
10. Provide Flexibility- relating to broad spectrum of functional skills and diverse teaching models.						
11. Provide Monitoring for Assessment and Planning- monitoring pupil with minimal distraction for assessment, safety and activity planning.						

TABLE 3. Design parameter rating scale.

(Source:Author.)

REFERENCE LIST:

Tiwari, R.., Purkayastha, K.., & Gulati, S.. (2021). Public Health Dimensions of Autism Spectrum Disorder in India: An Overview. *Journal of Comprehensive Health*, *9*(2), 57–62.

https://doi.org/10.53553/JCH.v09i02.002.

https://www.researchgate.net/publication/268143084_User_Centric_Evidence_Based_Inclusive_School_Design_Guidelines_for_Children_with_Autism.

https://www.researchgate.net/publication/249956095_Designing_Inclusive_Educational_Spaces_with_Reference_to_Autism.

https://www.researchgate.net/publication/360996126

https://www.researchgate.net/publication/289115473

asd: 18 million Indians have autism: Learn more about 3rd most common developmental disorder; know the basics of parenting children with ASD - The Economic Times (indiatimes.com)

https://www.researchgate.net/publication/360996126_THROUGH_THEIR_OWN_WORDSA_GLIMPSE_INTO_THE_ROLE_OF_DESIGN_IN_LIVES_OF_PERSONS_WITH_AUTISM

http://www.nationalautismcenter.org/

www.autism-india.org/

http://autismsocietyofindia.org/resources/

https://www.autismresearchcentre.com/

www.centerforautism.in/

www.seattlechildrens.org

Archnet-IJAR, Volume 3 - Issue 3 -November 2009

https://www.researchgate.net/publication/11006677_Communication_Intervention_for_Children_with_Autism_A_Review_of_Treatment_Efficacy.

A dissertation report on

Climate Responsive Architecture of Rajasthan

Dissertation to be submitted
for the award of the degree of

Bachelors of Architecture

**HITKARINI COLLEGE OF ARCHITECTURE
AND TOWN PLANNING**

RAJEEV GANDHI PROUDYOGIKI VISHWAVIDYALAYA
December, 2023

Submitted by:

Guided By:
Ar. ASHIMA C GROVER

CERTIFICATE

This is to certify that the synopsis entitles Climate Responsive Architecture of Rajasthan submitted by ----- to HITKARINI COLLEGE OF ARCHITECTURE AND TOWN PLANNING for the award of the degree of Bachelors of Architecture, is a Bonafide record of the research work which will be carried out by her under my supervision and guidance. This B.Arch. Dissertation synopsis along with recommendation is being forwarded to the Director.

Under the guidance of

Ar. Ashima C Grover
Dissertation Guide
Date:
Place: Jabalpur

Ar. Neeraj Agrawal
Director
Date:
Place: Jabalpur

ACKNOWLEDGEMENT

I am grateful to Hitkarini College of Architecture and Town planning, for giving me the opportunity to research and write this dissertation report. For the critical comments on the drafts, I would like to thank my guide **Ar. ASHIMA C GROVER** for his guidance and supervision. Their excitement and willingness to provide feedback made the completion of this dissertation an enjoyable experience.

I devote my special thanks to other faculties too who helped me to complete my research with their guidance and knowledge.

I am also very thankful to my family and friends who helped me directly or indirectly in entire course of project.

TABLE OF CONTENT

DISSERTATION

Climate Responsive Architecture of Rajasthan

1.1 INTRODUCTION:

Rajasthan, a state in northern India, is known for its rich cultural heritage and traditional architecture. Rajasthan contributes to a huge chunk of traditional and ancient styles of architecture. Rajasthan is a place which has extreme climatic conditions generally difficult to live for a normal human body. So as an architect it is important to consider the climatic conditions and traditional local material in a that area before designing. A structure which makes the place more habitable and does not let the extreme climatic conditions affect the structure. **I have chosen this topic of research because I feel creating a better environment in a harsh climate** like hot and dry arid regions is very necessary. As it will help in the well-being and the betterment of the human life habiting that place.

1.2 NEED FOR STUDY:

Rajasthan is a place which has extreme climatic conditions generally difficult to live for a normal human body. So as an architect it is important to consider the climatic conditions the **traditional construction techniques and have knowledge about local material** in a desert area before designing to make the place more habitable .

1.3 AIM OF DISSERTATION:

To study the climate responsive architecture for hot and dry climate Rajasthan.

1.4 OBJECTIVES:

- TO study the hot and dry climate.
- TO study the climate responsive architecture Rajasthan.
- TO study parameters for understanding spaces and architectural elements in hot and dry climate
- TO study different traditional/vernacular construction and materials used in Rajasthan.

1.6 SCOPE AND LIMITATIONS:

- **Scope:**

Study about building construction techniques and materials used in Rajasthan and how they can be improved to meet the challenges of modern times.

- **Limitations:**
  - To study only about climate of Rajasthan.
  - No site visits
  - No field measurements.

1.5 METHEDOLOGY

CHAPTER.2
LITERATURE STUDY

2.1CLIMATE STUDY

2.1.1 Understanding hot and dry climate

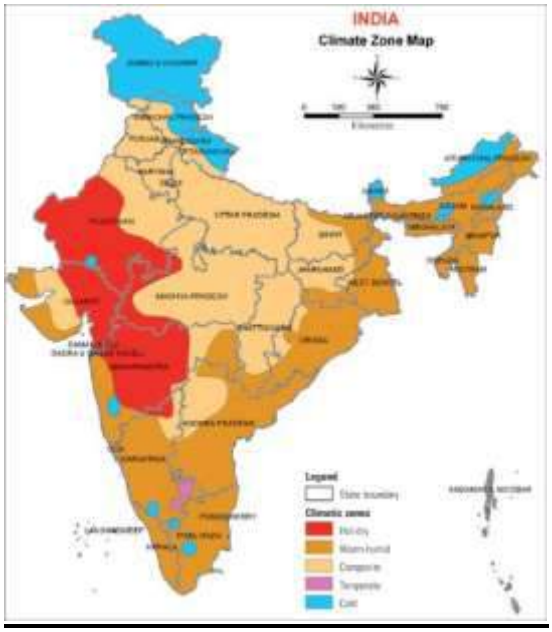


Fig 1. climate zones of Hindi map
Source : indianetzone.com

India can be divided into six climatic zones, namely, hot and dry, warm and humid, moderate, cold and cloudy, cold and sunny and composite.

The hot and dry zone lies in the western and the central part of India. The State of Rajasthan has mostly hot-dry climate zone & partly composite climate.

Monthly mean temperature remains 30 degree Celsius and relative humidity 55 %. Hot winds blow during the day in summer and sand storms are also experienced. The night is usually cool and pleasant. A generally clear sky, with high solar radiation causing an uncomfortable glare, is typical of this zone. Hence, the air is much cooler at night than during the day. In such a climate, it is imperative to control solar radiation and movement of hot winds.

2.1.2 Characteristics of Hot and Dry Climate

1. The temperature in such areas varies between 27°C and 49°C during the day and 22°C at night.
2. The humidity is low to moderate, and the skies are typically clear.
3. Low humidity causes less rainfall, which reduces the number of plants in the area.
4. There isn't much wind, but when there is, it's hot and dusty.
5. Precipitation in this type of climate is deficient, ranging from 50mm to 150 mm annually since the air is completely hot and dry.
6. In this type of climate, the sky is typically clear and blue. Even so, occasionally, dust storms fill the entire sky, producing an unbearable glare.
7. Only thick leaves and thorny plants may easily survive here due to the extremely loose and sandy soil, low humidity and little rainfall. (vyas, 2022)

2.1.3 Design Criteria

The design criteria should therefore aim at resisting heat gain by providing shading, reducing exposed area, controlling and scheduling ventilation and increasing thermal capacity. (Verma1, 2019)

Climate Responsive Architecture

The goal of climate-responsive architecture is to create a comfortable interior while reducing the building's reliance on artificial energy. A climate-

responsive building design reflects the weather conditions in the precise area where the building is constructed.

2.2 VERNACULAR ARCHITECT URE

2.2.1 Introduction of Vernacular Architecture

Vernacular architecture can be defined as a type of local or regional construction, using traditional materials and resources from the area where the building is located. Consequently, this architecture is closely related to its context and is aware of the specific geographic features and cultural aspects of its surroundings, being strongly influenced by them. For this reason, they are unique to different places in the world, becoming even a means of reaffirming an identity. (Soni, 2021)

Factors Influencing Vernacular Architecture:

- Climate
- Culture
- Material

Culture -
Culture is the knowledge and behaviour pattern sharing of a social group. Culture encompasses religion, language, cuisine, dance, music and art. The behavioural pattern is responsible for space requirement. (Soni, 2021)

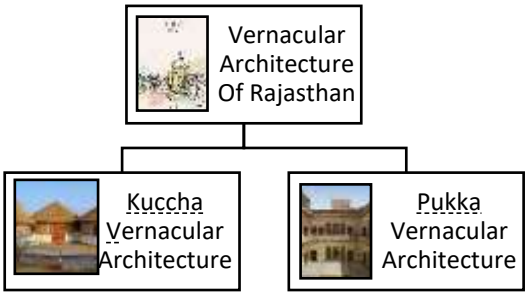
Indian Vernacular Architecture In A Hot & Dry Climate

Hot and dry climatic zone, includes Jaisalmer, Jodhpur, and the Thar Desert, is in the northwest of India (Rajasthan and partly Gujarat). Flat, sandy, and rocky, this area has little vegetation, including cacti and spiky plants. The climate is dry here because of the low humidity. Sand storms are very frequent in this area during the summer months when winds are blowing quite hotly. The climate and culture of the desert region are artistically expressed in the building. (Soni, 2021)

Vernacular Design Concept for Hot and Dry Climatic Regions of Rajasthan:

- Climatic courtyard planning
- Shading elements
- Textured walls
- Thick slabs and walls

2.2.2 Vernacular architecture of Rajasthan



2.2.3 Types of Vernacular architecture

-***The Kuccha*** is defined by the Dhani in Rajasthan and the boonga in the Kutch region, while
-***The Pukka*** architecture is dominated by the haveli kind of architecture prevailing mainly in Jaisalmer district.

Rajasthan's Kuccha and Pukka vernacular architecture clearly differ from one another. (camilla-ghisleni, 2020)

Kuccha Vernacular Architecture

1. Bhunga House
2. Meena House
3. Khadrat House

4.

1. Bhunga House

Fig.2.The traditional house of Rajasthan and Kutch Source: Vernacular
Source: Architecture Accommodating Local Culture

- Bhunga House is a traditional construction type
- This construction type has been in practice for more than 200 years.
- A Bhunga consists of a single cylindrically shaped room topped by a conical roof.

Architectural features:

• **Site**: Typically found in flat terrain. They do not share common walls with adjacent buildings, with a typical distance of about 3m.

•**Building Configuration**: Bhunga is circular in plan, with cylindrically shaped walls and topped with conical roof

•**Building typology**: house (single family, 5-10 inhabitants). Bathroom and toilets are constructed in a separate structure. Settlements of one whole family- built on the plinth

• **Building materials and construction**: Traditional roof consists of light-weight conical roof of thatch and wooden supporting members. The mud walls are simply extended into the ground for a foundation (without footing).

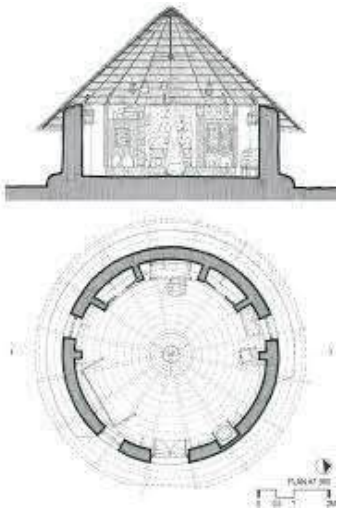


Fig.3. Plan and Section of Bhunga House Source: Department of Architecture & Interior Design\

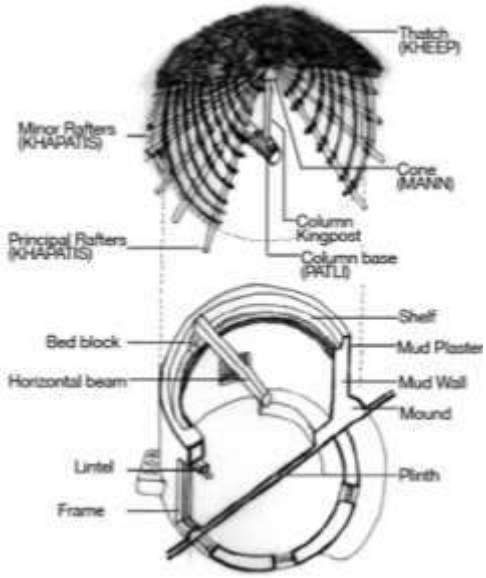


Fig.4.Showing the Components of a Bhunga Source: International Journal of Engineering Development and Research

• **Clustering**: Arrangement of open spaces reflect their life-styles and social structure. On a raised platform on which Circulation is carried out. (camilla-ghisleni, 2020)

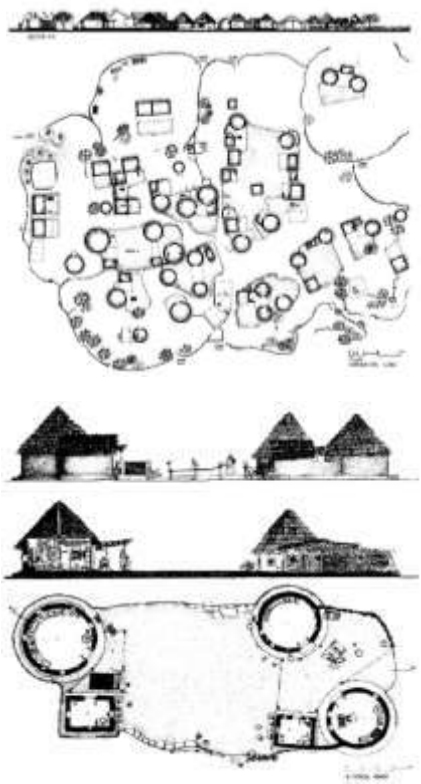


Fig. 5. The Clustering arrangement of houses

Source: The Eco-friendly Rajasthani Homes

2.Meena House

Fig.6 The traditional house of Rajasthan and Kutch
Source: Architecture Accommodating Local Culture

Architectural features:

• Meena's have more sense of privacy.
• Have a tendency to stay scattered.
• No clustering whatsoever, handful houses found.
• A single room structure.
•A single entrance. No windows/openings
• Door is the only source for light.
• Wall paintings by women (meena tribe)
• White paint in the interiors.
• Most of the hills have not more than two or three houses.

3.Khadrat House

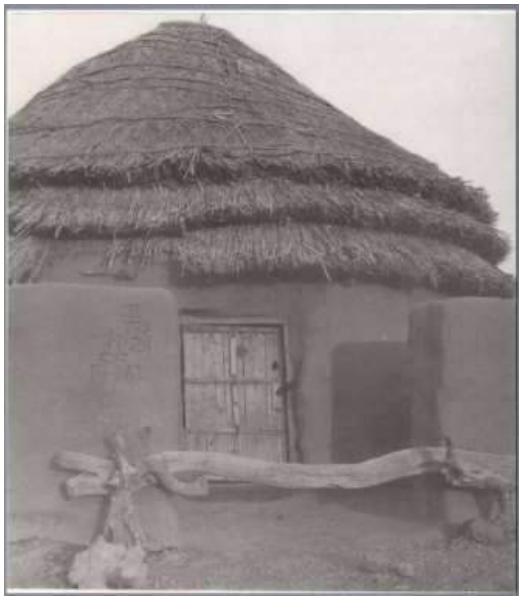


Fig. 7. Khadrat House Source: Vernacular Source: Architecture Accommodating Local Culture

• Khadrat is a small village situated 60km from Bikaner.
• The later type of house shows an early stage of contemporary house development.

Fig. 8. Cluster view Source: Vernacular Source: Architecture Accommodating Local Culture

• The older side of the village with its clutters of circular Jhumpa's about 50

houses loosely positioned.

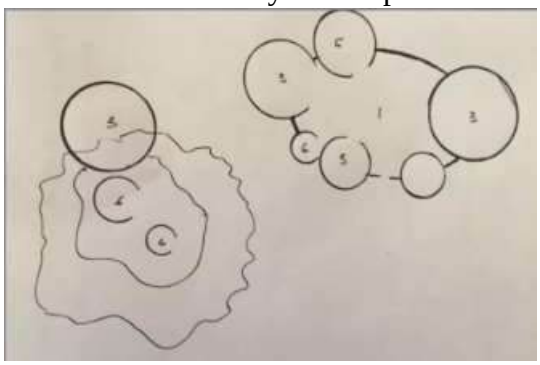


Fig.9.shouing the cluster Source: Vernacular Source: Architecture Accommodating Local Culture

Three kinds of plan formation are observed in this village

- In larger houses inner courtyards for the people and outer courtyard for cattle
- In second category, the house are without the courtyard for animals. The animals rest outside the inner court wall.
- The third category of houses has two jhompas with ottas but without courtyards. The inside and outside of the house are strongly defined by an emphatic entrance.

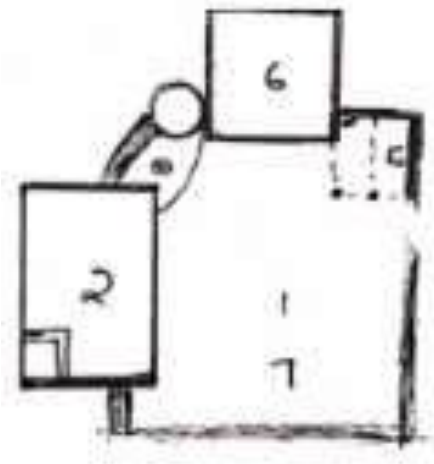


Fig 10. Plan of the house

• The most special element in these houses are the conical thatched roof.

• In unbearable summer days the jhompas with its 3 layered thatched roof keep the inside environment cool. (camilla-ghisleni, 2020)

Fig 11. 3 layered thatched roof

• The materials used in making the thatch are the main twigs from jowar,bajara or millet from their agricultural production.

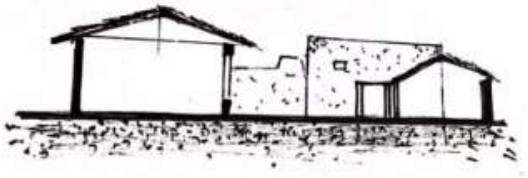


Fig.12. Section and placement of house Source: Vernacular Source: Architecture Accommodating Local Culture

• The gates of these houses are generally made of natural logs. The log is often fixed to another similar forked one so they are locked together. These rough logs are about 15-20 cm in diameter and are heavy to lift, a large stone bowl filled with water is placed just outside the entrance and the roof is constructed with hay. (camilla-ghisleni, 2020)

• Typically each house has open courtyard around which 5-6 jhompas are posted.

- A low wall defines the court.
- The outer boundary walls are defined with weed hedges on vertical stone strips.
- Walls are mud plastered.
- The personal rooms are small where the courts are large.

The people built only to the minimum extent so they wasted very little. By scooping out depressions or adding projections they created little thick plastered niches which held oiled lamps for their deities. (camilla-ghisleni, 2020)

The Pukka Vernacular Architecture

HAVELI- Mansion, Residence, Dwelling, Estate, Habitation, Manor, Villa.

Fig.13.Patwon Ki Haveli Jaisalmer Sourse:www.tourmyindia.com/

The Havelis were adorned with magnificent and attractive paintings and were surrounded on all sides by a single huge entrance gate.
In isolation from the outer world, this gave protection and comfort. (camilla-ghisleni, 2020)

Architectural features:

• Narrow meandering streets negotiating the topography of the settlement, with dense tightly packed havelis built around a courtyard with exquisite carved stone facades.
• Two-three storeys high, with a rectangular deep plan and a very narrow frontage on the street, built around a courtyard or a series of courtyards.
• Raised platform on either side of the main entrance gate along the streets known as otla or basali – semi private zone and an extension of the house in the street. (camilla-ghisleni, 2020)

Typical Features Of Havelis:

• **Jharokha**

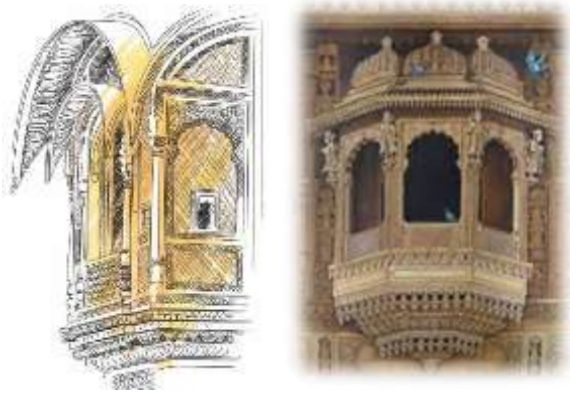


Fig.14 Jharokha

Sourse:www.tourmyindia.com/

❖**Social Aspects of jharokha**

- Jharokha is a kind of suspended or over hanging enfolded balcony.
- It is basically stone window which projects from wall plane.

Generally employed for:-

- Additional architectural beauty to the mansions.
- As a sight-seeing platform.
- Permit woman in pardah to witness the vent.

❖**Climate Responsive Aspects jharokha**

- It aids in diffusing natural illumination thereby reducing glare and heat gain.
- While admitting sunlight to reduce mechanical lighting.
- To protect from angular precipitation, vertical elements called fins were also introduced on either side of a windows.

❖ **Elements Of Jharokha**

- Chajja like platform work as a roof with different tiers and detailed carving. These chajjas can be arched

sometimes depending on the shape of the balcony.

- Decorative columns to support the overhang with different motifs carved out. Railing with decorative floral pattern and animal symbols, etc.
- Brackets or corbelling to support with same level of carved design with play of mass. (Archinomy, 2020)

- **Chhatris**

Fig.15.Chhatri Source : theprakritistory.com/

- Chhatris are the elevated pavilions or porches in dome shape.
- It stands as a symbol of honour and pride used to portray the fundamentals of admiration in Rajasthan's Rajput architecture.
- 'Chhatri' refers to a canopy or an umbrella. Held at the shekhawati area.
- Chhatris are generally simple structure with single dome built inside four pillars carrying several domes along with a basement containing various rooms. (Archinomy, 2020)

- **Jaali**

Fig.16 Jaali Source : theprakritistory.com/

❖ **Social Aspects**

- Jaali is normally a perforated stone or latticed screen, usually with an ornamental pattern.
- Came into existence on account of the Pardah System , which did not allow women to be seen in public.
- This enabled women to observe the outside world by remaining out of sight.

❖ **Climate Responsive Aspects**

- Jaali is used to penetrate the direct sunlight and allows only the diffused light to come indoors.
- Used to filter the dusty storms.
- Also used to create buffer spaces. Nowadays, Water drip channels are being used to make the hot dry air cool down as it moves inside.

▪ Fig.17 Showing Climate responsive aspects of jali Source : theprakritistory.com/

- **Stepwell**

- Bawdi or Baoli is a pond or well where water can be filled by climbing down steps.
- It could be roofed and were secluded.
- Most of the living stepwells act as a leisure spots besides providing water.

Fig.18 Showing steptwell Source: theprakritistory.com/

❖ **Climate Responsive**

- Its Architectural Function is used to maintain the temperature of atmospheric air on the ***micro*** level.
- ***How does it effect on micro level?***
  The evaporation helps in moisturizing and cooling down the Hot and Dry Air. Hence, makes the surrounding environment favourable.
- ***Why Baoli's are deep inside the earth?***
  Under Earth atmosphere is always lower than the atmosphere above. Used to get the pure underground water.

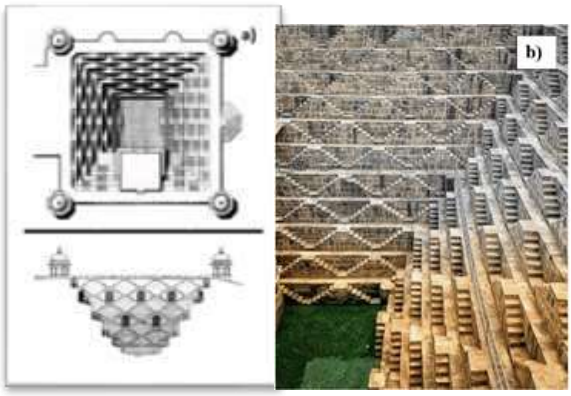


Fig.19 (a)Plan, Section And (b)View of Bali
Source: https://www.mdpi.com/

Courtyard

Fig.20.Courtyard
Source: www.architecturaldigest.in

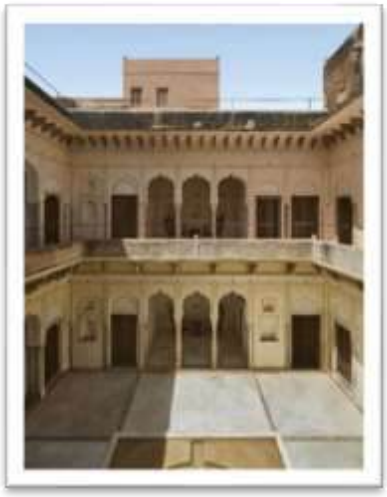


Fig.21 Image of courtyard
Source: www.architecturaldigest.in

- Courtyards The sprawling havelis had large open to air courtyards between two parts of the building and the courtyard spoke of a very soft and delightful ambience with fountains for birds, with spices and dried food laid out in the sun, and for rituals, marriages, festivals and social gatherings.
- Courtyards, nearly square in shape give connectivity to area.
- Chandni The heart of the Haveli is a courtyard, the centre point from where all spaces originated.
- The courtyard provided the transition between the public and the private spaces of the Haveli. (Archinomy, 2020)

2.2.3. Passive Design Stragies

According to reports "Passive design" is design that works with the local climate to maintain a comfortable temperature in the home. Good passive design should reduce or eliminate the need for additional heating or cooling depending on your location and often relies on an active occupant to work properly. (camilla-ghisleni, 2020)

2.2.3.1 Planning

Fig.22 Indigenous planning layout
Source: google image

A typical town of Rajasthan presents a very compact picture of houses and other buildings huddled together so that they not only shade each other but also considerably reduce the exposed open spaces around them.
The height of the building compared to the width of the streets is large to create shaded cool environment for the pedestrians and other social activities on the streets

- **Settlement pattern**

The triangular fortification and the city of Jaisalmer's twisting, narrow lanes with substantial buildings on either side set them apart. It offers a good number of spacious open areas that can be used as gathering places. (Gupta, 2017)

Fig.23.Settlement pattern
Source: google image

A court-yard with an underground level is a defining feature of the home's planning and design. Through a series of spaces that serve as the interaction between the house and the street, the house opens into tiny streets.

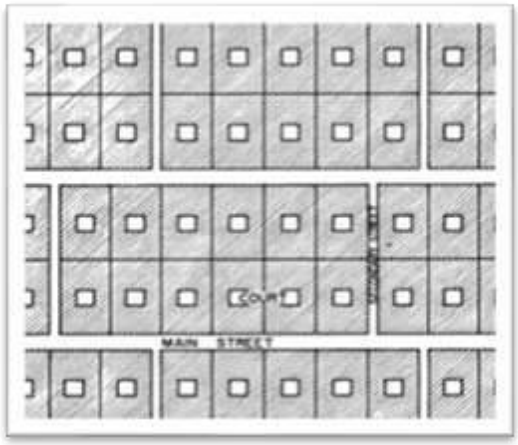


Fig 24. Planning including central courtyard in each residence

Source : google image

- **Street pattern**

Nearly in an East-West alignment, all main roadways are practically perpendicular to the direction of dust storms. These streets are home to the well-known havelis with jharokas and ornamental facade. The streets are winding and fairly narrow. The height of the structure is greater than the width of the street, which creates a pleasant, shaded environment for people walking and engaging in other street activities.

Fig.25.Ancient city streets of Jaisalmer in Rajasthan, India

In order to offer a shaded, cool environment for pedestrians and social activities at the streets, constructing heights is often better than roadway widths. In order to offer a shaded, cool environment for pedestrians and social activities at the streets, building heights are often better than roadway widths. (Gupta, 2017)

- **Orientation**

A building's orientation and form must be in the proper direction to obtain the best climate response. Orienting a structure according to the sun's path and wind direction, placing the long face in the north-south direction to minimize east-west exposure, can be incorporated in the design strategy. To reduce unnecessary heat loss and gain, the building's design must be more compact. (Gupta, 2017)

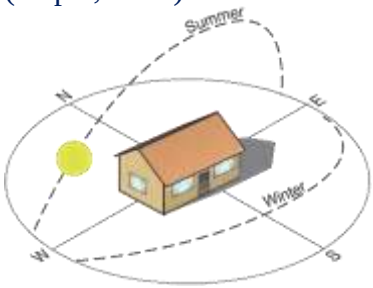


Fig.26. building's orientation
Source: https://www.google.com

The building is always oriented by the cardinal directions: North, South, East, West, Northeast, Northwest, Southeast and southwest. Each of these directions is considered as energy by itself. Hence the spaces in different orientation are considered differently for design purposes which is a very climate sensitive approach. For example the East or the North walls are made more open to light and air as the West is the heat gaining side in the warm humid climates of India

The placement of the building within the site is the first step toward forming the grid for internal planning. The centre of the plot is generally not where the centre of the building is placed, only exception being temples. The climatic logic behind this is that in the house the outdoor and indoor is designed as one. (Gupta, 2017)

Generic house

An open veranda enclosing the courtyard, a closed-off chamber, and an underground living and storage area make up the classic Jaisalmer home design. Simple single-story homes and ornate havelis are both examples of courtyard house variations.

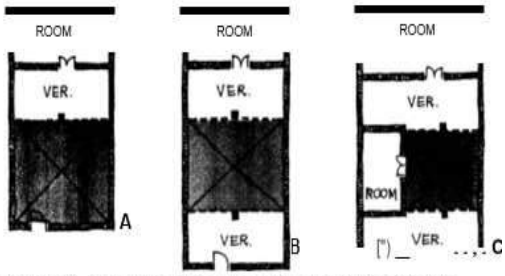
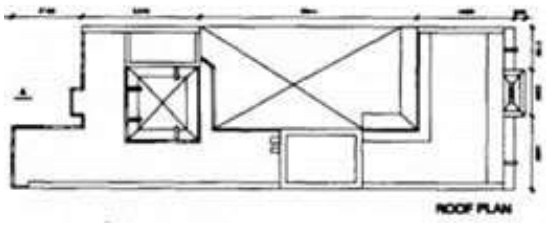


Figure 6: Small houses in Jaisalmer (V. Gupta, 1985)

Fig .28 plans

Source: https://www.google.com

Figure 7: Middle income houses in Jaisalmer (V. Gupta, 1985)



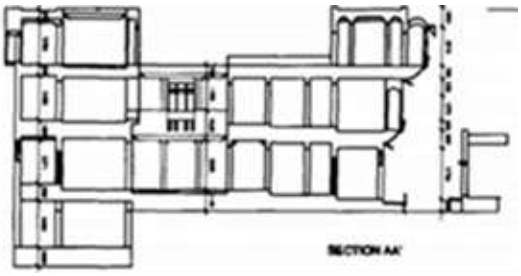


Fig.28.Typical haveli (Krishan, 1996)
Source : earchpaper

- **Section details**

In Jaisalmer, the urban design made sure that no structures were directly

exposed to the sun. Buildings close together reduce heat gain and keep hot breezes at bay while allowing cooler air to flow through the structures and open spaces. (Verma1, 2019)

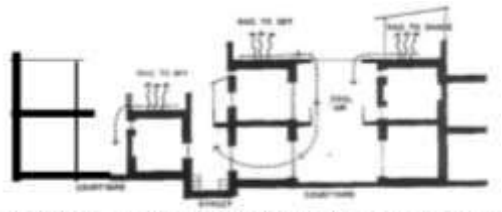


Figure 9: Shahajahanabad House's typical section. Parapets are not constructed toward the courtyard in order to facilitate the passage of cold air into the house. (Source author)

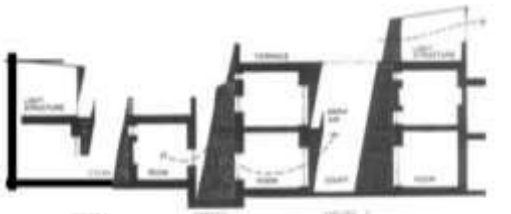


Figure 10: Typical section of homes in Shahjahanabad(A lightweight structure is built above the huge main building. (Source author)

- **Building envelope**

The primary elements of a building envelope are materials

used in construction, roof, walls, fenestration and shading.

Low energy materials are preferred. In hot climates,

insulation is placed on the outer face so that the thermal

mass of the wall is weakly coupled with the external source

and strongly with the interior. In hot regions, insulation on roofs can be provided using earthen. (Verma1, 2019)

- **Texture**

Control of heating by texture of surfaces:

The heat inside of the building is controlled by the use of textures in Jaisalmer. This is organized at three levels.

- At the town scale the buildings are of unequal height with parapets and high walls, creating uneven sky lines and desired shading of each other.
- Secondly, the building facades have large number of projections like jharokhas and chajjas which provide shade to the facades.

Fig.28.Typical haveli facades
Source : https://www.archinomy.com/

- Thirdly, the front part of the facade which remains exposed are controlled by creating deeply carved patterns. Use of such devices minimizes the heat gain by providing shading due to texture. Such devices also result in increased convective transfer of heat because of increased surface area. In summer in day time when the major heat source is Sun the exposed textured surfaces will be cooler than plain surfaces. (Archinomy, 2020)

Fig.29.carved patterns.
Source: www.archinomy.com

In evening when ambient conditions are cool the increase surface area helps in cooling it faster. However, an extended surface will warm up faster than a plain surface under winter conditions due to low solar altitude, therefore the location in context of these surfaces is very important. (Archinomy, 2020)

2.6.8. Building form

The amount of heat that radiates from a building to the sky can also be affected by its uneven shape. The radiative component is often neglected in calculations of heat loss from walls since it is anticipated that walls will "see" other walls at the same temperature and that the amount of radiative heat loss will be extremely little. This assumption is not necessarily true, as shown by the fact that the additional wall area of an uneven building mass emits more heat to the sky, keeping it colder than a more compact mass. It follows that the Jaisalmer's huge wall sections and uneven architectural design should aid in keeping the structure cool. (Gupta, 2017)

2.6.9. Solar shading devices

Solar shading devices is another control medium for solar heat gains in form of horizontal (canopies, awnings, horizontal louvers, overhangs), vertical (vertical louvers, projecting fins), screening (movable insulations, vegetation etc.) or egg crate devices (jail's, grills). These devices reduce the heat gains and thus provides comfortable indoor temperature, reducing the cooling costs. They also act as an aesthetic element and also satisfy daylighting needs if properly designed. Mughal architecture used inclined and deep shades to cover more surface area with deep carvings which creates self-shading effect (Figures a and b). Horizontal shading devices are best suited for south oriented whereas vertical for east and west facing facades. (Gupta, 2017)

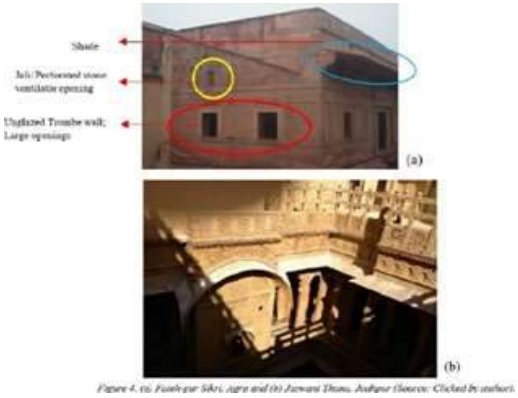


Fig.30.carved patterns.
Source: www.archinomy.com

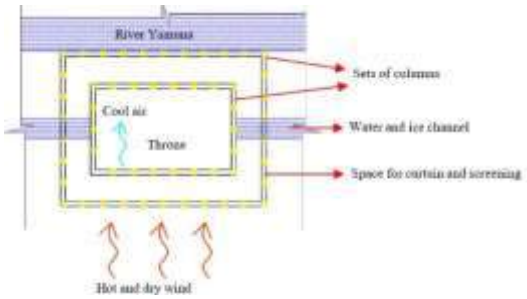


Fig.31

Ancient buildings were able to keep themselves cool without using the movable screens or curtains rather with the use of some passive techniques as seen in Diwan-e-Khas, Red Fort, Delhi, India. Two sets of columns spaced at 4 m have been placed. The provision of curtains and screens has been provided in these sets for use as per the need. During summers, three screens were used, out of which two were made of sprinkled grass to take advantage of the evaporative cooling. Whereas during winters, these screens were replaced by heavy quilted curtains. During the days, these curtains were rolled up to allow the sun to penetrate and were rolled down in the evening hours to retain the solar gain. These type of screens and curtains are also presently seen in Deegh Palace, Rajasthan, India. Roll up bamboo screens were also used in vernacular architecture as screening device for shading purposes and also for east and west orientations.

- **<u>Ventilation And Daylighting</u>**

Natural Ventilation

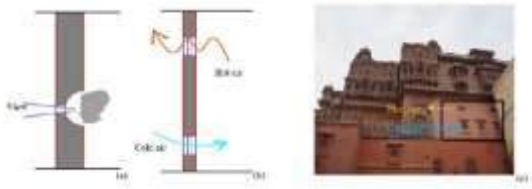


Fig.31
source (Verma1, 2019)

Night ventilation works well in this climatic zone as diurnal variations are high. In this process, buildings are ventilated at night when ambient temperatures are lower to resist heat build-up.

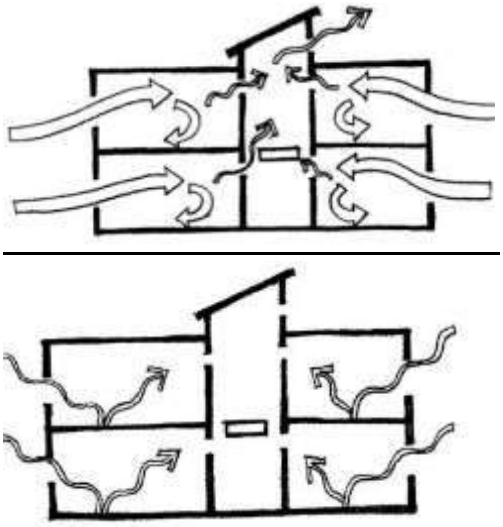


Fig.32
source (Verma1, 2019)

The details of the windows and the openings were also taken care of in the vernacular architecture. Examples included small windows (lesser than 100 mm in diameter) used in Amber fort, India in order to ensure the visibility without letting the light or air in (Figure 6a). Openings installed for ventilation purpose were seen in Shahjahanabad, India. These were installed near the floor level and near the roof level in order to let the cool air in from the bottom opening and let the hot air out from the top opening (Figs. b and c). At some places jalis (perforated stone or latticed screen) have been used to maintain privacy (Figures 4a, 6d and 6e), let the air and light enter the building and also allow the visual connectivity from inside to the outside surroundings (Figures 5d and 5e). Diffused light is allowed to enter the interiors during sunshine hours, and at the same time the interiors are not visible from the outside. For the outside view, small opening is provided at the eye level

of the viewer in sitting position (Gupta, 2017)

- **Radiative cooling and Courtyard planning**

Courtyards are important for daylight & ventilation and has a cultural significance too. Ventilation in hot dry climate is useful if the air is cool. Thus, the courtyard should
(a) be proportioned to be mostly shaded, and
(b) contain cooling elements like trees, soft paving and water bodies if water is available.
(Afreen, 2018)

Courtyard ratio
Cooling elements in courtyard

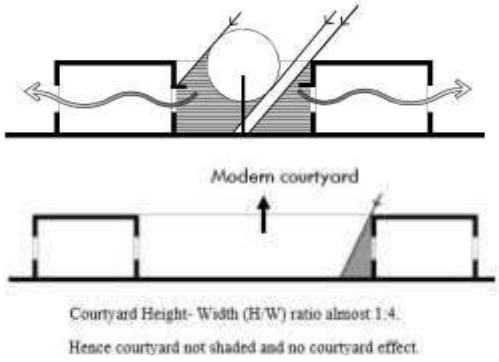


Fig.32
Source: (Verma1, 2019)

Courtyard planning is visible in havelis and forts of Rajasthan, India for cooling effect .Courtyards were the main architectural element used in planning generally integrated with water bodies, vegetation and usually open to sky to enhance evaporative cooling, provision of shade and infuse maximum daylight in the buildings. In Shahjahanabad, India, the lower floors are used to spend the hot days while the nights are spent on the terrace taking advantage of the radiative cooling. The rooftops are sprinkled with water for evaporative cooling effect. Whereas during the winters, the days are spent on the sunny rooftops and the nights in the enclosed rooms (fig 3). The buildings in Shahjahanabad, India were designed to allow the heavy cool air to enter the building. There was no provision of parapet wall towards the courtyard and solid parapets were constructed towards the street. Large openings are provided towards the courtyard to take advantage of radiative cooling so that the cool air is passed through the interiors. (camilla-ghisleni, 2020)

Fig.33
Source: (Verma1, 2019)

Trombe wall

Another planning tool widely seen in vernacular architecture is thick walls i.e., Trombe walls . They can be seen in Shahjahanabad, Jaisalmer, India. The natural, ventilated air also

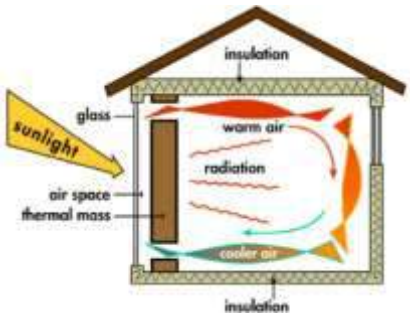


Fig.31
source (Verma1, 2019)

enters the chambers at the same temperature. The Trombe wall of 600 mm thickness is also seen in all the buildings of Banaras Hindu University, Varanasi. The inside temperature range was found to be about 25-28 °C when the outside temperature was in the range of about 45-48 °C.

CHAPTER 3.
CASE STUDIES

1. Rajkumari Ratnavati Girl's school

- Location: Salkha, Rajasthan
- Project type: School
- Area: 9000 square feet
- Architect: Diana Kellogg Architects Client: CITTA Foundation

Fig.32. Rajkumari Ratnavati school Top view Source :Vinay Pajwani.com

Fig.33. Rajkumari Ratnavati school Bird eye view Source :Vinay Pajwani.com

A non-profit agency that helps improvement in a number of the world's maximum economically difficult, distant, or disenfranchised places, CITTA commissioned Diana Kellogg of Diana Kellogg Architects to create the architectural marvel known as the Rajkumari Ratnavati Girl's School.

Rajkumari Ratnavati Girl's School in Rajasthan is an architectural marvel. This **school is made of sandstone**, which is located right in the middle of a desert.

The design tackles various elements of challenges like temperatures rising up to 50 degrees Celsius, Sandstorms and heatwaves.

The school is located just a six-minute drive away from Jaisalmer's famous Sam Dunes, which have taken shape in Kanoi village, with an ***aim to educate girls and empower them.*** The school serves more than 400 girls, from kindergarten to class 10. This helps the families that live below the poverty line in the region where female literacy barely touches 36 percent.

Fig.33.Plan of Rajkumari Ratnavati school Source:Dkarchitects

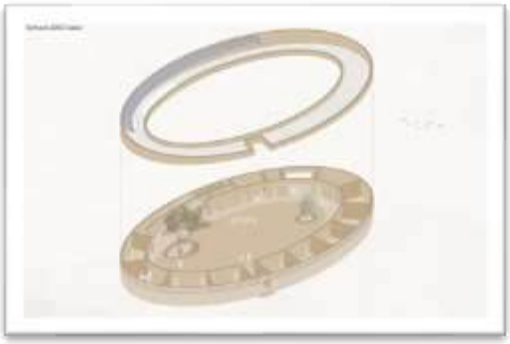


Fig.34 AXO view of Rajkumari Ratnavati school (Source Source:Dkarchitects

Space and Form

Rajkumari Ratnavati school has an ellipse structure. It blends seamlessly into the

planes of sand dunes in the region of Jaisalmer. The structure has striking curved walls reminiscent of Rajasthan's famous forts.

The oval-shaped building has a paved central courtyard. The newly-completed structure is part of a larger complex called the GYAAN Centre, which will include an exhibition space called the Medha and the Women's Cooperative building, where local artisans will teach women traditional handcraft techniques.

Fig.34. Rajkumari Ratnavati school Bird eye view
Source :Vinay Pajwani.com

Construction and Craftsmen ship

The school was constructed by local craftsmen. In that many were of the girls' fathers. Works were done with hand-carved Jaisalmer sandstone sourced from the area. Moreover, to make the school aesthetically pleasing it took the work of stone cut art by the local workers. in fact, the architect describes the craftsman as magicians for their stonework. It reduces the carbon footprint from transportation and logistics.

Fig.35 Seating niches in the wall

Source :Vinay Pajwani.com

Water Harvesting System:

The design is efficient enough as it follows the local ancient water harvesting techniques to maximize the rainwater and recycle grey water in the school. Therefore, the courtyard in the complex can harvest 3.5 lakh litres of water and store it in its belly.

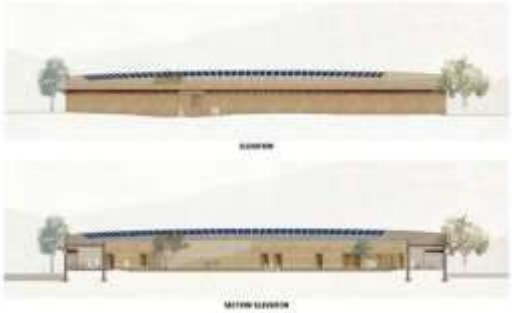


Fig.36.Section and elevation drawings

Building Orientation:

The building orientation maximizes the prevailing wind and keeps maximum sunlight out. The design also inputs solar panels for the lighting and fans in the building.

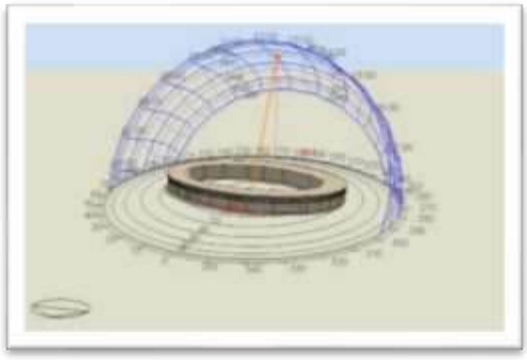


Fig.35 sun path of Rajkumari Ratnavati school
Source:Dkarchitects

Vernacular design process:

The use of local materials to create the infrastructure helped reduce carbon emissions. The skilled craftsman working on sandstone made the construction process economic. The material protection from extreme heat during the day, and warmth during evening hours. However, to allow enough room for ventilation, drawings were revised to

make the classrooms and other offices bigger in size.

Usage of Jaalis:
Jaalis help in keeping the heat out and the elliptical shape of the building also helps bring aspects of sustainability. Therefore, this creates a cooling panel of airflow, in addition to passive solar cooling where temperatures peak close to 120 degrees.

Fig.36.Jaali design allows light and wind Source: Vinay Pajwani.com

Solar Canopy:
The solar panels on the top level of the structure work act as a canopy. It provides shade while simultaneously powering the building. The cooling system uses geothermal energy during the night to cool the building during the day. Moreover, a solar canopy on the roof with a metal framework doubles as a jungle gym with seesaws, swings, and monkey bars for the girls.

Fig.37.Local laborers took part in the construction process Source: Vinay Pajwani.com

fig.38 Staircase Details of Rajkumari Ratnavati school source : (Archinomy, 2020)

Fig.39.Courtyard Partition Wall of Rajkumari Ratnavati school Source: (Archinomy, 2020)

Front View of Rajkumari Ratnavati school Source: (Archinomy, 2020)

Material Palette for Rajkumari Ratnavati Girl's School

The local **sandstone** is the main component of construction. This provides protection from extreme heat during the day, and warmth during evening hours. The inner walls of the building have plastered with lime, which insulates the building.

Sabyasachi Mukherjee designed uniforms for the students using the material Ajrak. It is a form of block printing native to the region in the desert. Ajrakh is distinctly Indian and has a powerful style. It sensitizes children to the importance of local heritage. Above all, it helps to give them a better understanding of our culture and helps in sustaining the crafts of the region.

Fig.41.The school is built with yellow sandstone
Source: (Archinomy, 2020)

Every attempt was made to create an economically sound shape as it turned into built for a non-income business enterprise that helps the training of girls, consistent with a assertion from Kellogg. In line with the Jaisalmer sandstone, she tells RECORD, "I knew I desired to make a constructing that each included and advanced out of the herbal landscape. I changed into additionally committed to sustainability and using the stone in a current way to spotlight the neighbourhood artisans."

Future plan of Rajkumari Ratnavati School (Source Diana Kellogg Architects)

2. Patwaon ki haveli

The havelis were essentially enormous residences for both the public and employees. These are airy buildings that were built around one or more courtyards. To block the glaring sun and sweltering wind and to preserve the privacy inside, the front facade of the havelis had modest apertures. There are no outside windows on the havelis except for the front facade, reflecting the introverted nature of the society's traditional needs. To protect the privacy, there was typically a courtyard for men and the general public and another for women. (Afreen, 2018)

Fig.43. Patwaon ki haveli source: (Archinomy, 2020)

The haveli is rectangular in shape and is aligned from north west to south east. Three main floors, two wind pavilions, and a basement floor make up the six stories of the havelis. A central courtyard exists. A wind shaft is created by the two linked stairs. Stone makes comprised the havelis' roof, walls, and interior spaces. The lower stories have balconies and jharokha to give shade. For directing wind away from the built form, there are small vertical ducts and staircase shafts available. (Afreen, 2018)

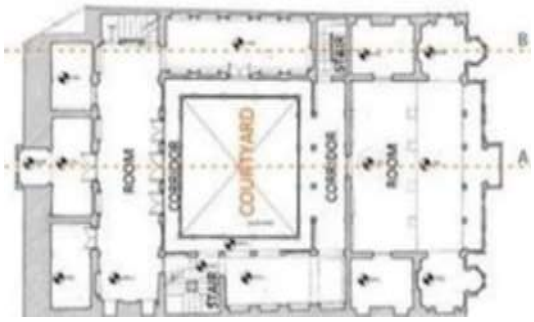


Fig.44.Plan of haveli

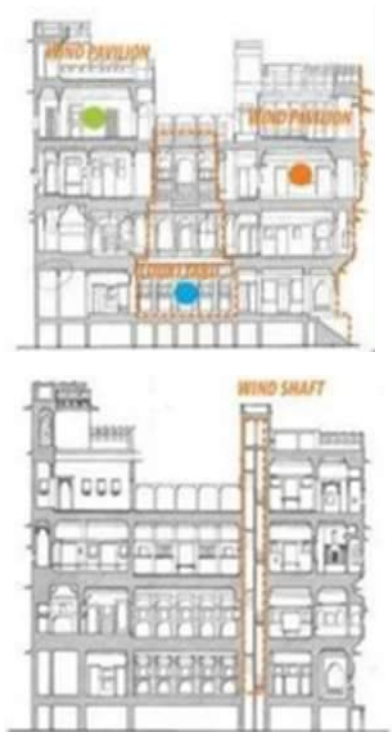


Fig.45 section of haveli

(Source author) (Archinomy, 2020)

About the Plan: The structure is divided into two patios; the patio depicted on the fa9ade is much smaller than the actual patio. The core living cottage is located in the three-story initial component of the structure. The additional adaption is included in the two-story-tall back portion.

Fig 46.Views in Patwaon ki haveli
Source: (Afreen, 2018)

The courtyard is a crucial tool for reducing the heat inside the house. In the summer and winter, it behaves differently.

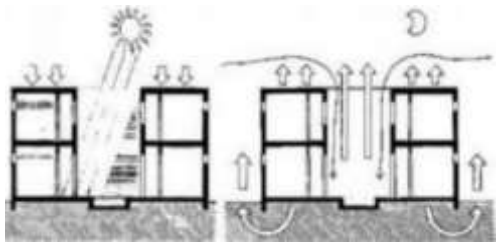


Fig 47.Conceptual sketch of courtyard

Source: (Afreen, 2018)

Jharokha are utilized to provide shade and lessen the intensity of the sun. Jali is added to it for the air circulation in order to improve performance. The intake of solar radiation into the building is decreased by shade mechanisms like chajjas. The section provides an example of how solar radiation enters a building during the summer and winter solstices.

Fig.48. Jharokha
Source: (Archinomy, 2020)

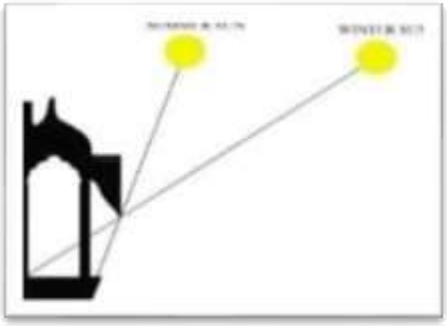


Fig.48.Conceptual sketch of Jharokha
Source: (Archinomy, 2020)

A wall with a dark texture has a shadow on a part of the surface. This keeps the sunlit surface cooler and cools faster at night.

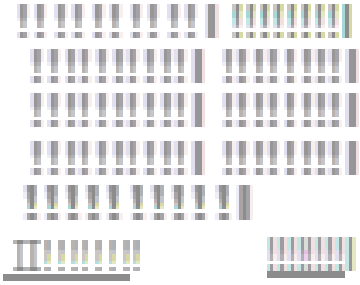


Fig. showing Wall texture

Source: (Archinomy, 2020)

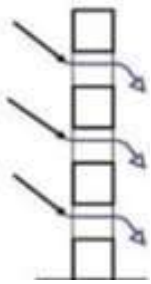


Fig. 51.Air movement through jali
Source: (Soni, 2021)

By compressing the air that passes through the holes in the jali, the temperature is lowered. It is created by variety of patterns and textures. (Soni, 2021)

3.Nathmal ki Haveli

fig.52. Nathmal ki Haveli
Source : google

Nathmal ki Haveli is one of the most beautiful havelis in Jaisalmer. It was built in the 19th century by two architect brothers, who built two havelis independently. (Soni, 2021)

fig.52. Nathmal ki Haveli (Afreen, 2018)

About the Plan: The structure is divided into two patios; the patio depicted on the facade is much smaller than the actual patio. The core living cottage is located in the three-story initial component of the structure. The additional adaption is included in the two-story-tall back portion. (Soni, 2021)

….

Fig.53 Plan And Section
Source: (Archinomy, 2020)

Building Form: The entire structure has a concave roof and skewed ceilings with tall parapet walls and a sweeping wind canopy. Sunshades and balconies are kept in the Eaves at the forward lay. The external flush units of the structure are sharply carved with flared fins at the base levels. Spotty building plans also made clear how much heat is lost through walls. The lumpy building mass scatters more heat to the sky along its elevated wall areas, keeping it cooler than a more homogenous mass. (Soni, 2021)

Spaces: The family's study space is situated above the doorway on the first level. This lavishly decorated room has two stories. A great number of little ventilation pockets are located in the uppermost portion of the space, along with window apertures with wooden shutters facing the street. Create these apertures to ensure heat expulsion through ventilation. The lower floor was designed with a strong sway for assets. Due to the fast destruction of the ambient heat curl in the soil, the coldness of several degrees remained stable throughout the year. (Soni, 2021)

Windows: Jallis or lattice windows are often properly fitted in windows and balconies. Windows can be covered with curtains for privacy and to decrease dust, but they can let in wind at the same time. Stone flounce is used to make doors and is matched with timber doors. (Soni, 2021)

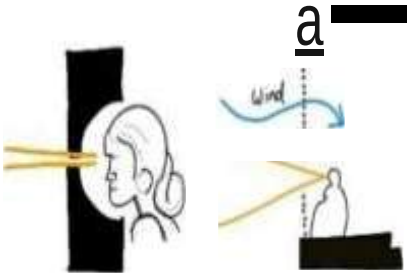


Fig.Depiction of windows functionality (Source author)

Roofing: A coat of reed or grass is applied to the ceiling along with separated timber beams, and the tip is then secured with a strip of soil. These are then polished with mud plaster or stone floor. The inside's cool air conditioning is controlled by the way the dirt and grass are covered. Without the use of carved mortar details, stone joints are kept together by panel- mounted iron cramps. (Soni, 2021)

Air duct: Perpendicular ducts and stair shafts lessen the quantity of wind that enters the house and direct air flow over the courtyards. The Yards provides all of the backdrop areas with the essential lighting & ventilation. During the

summer, the back courtyard receives no shade at all, while the fa9ade receives little sunshine. The sun is completely blocked out from the trail and thin shafts. The vertical channel's differential heating ensures continuous movement over the home. (vyas, 2022)

4.Streetscape

Location: Jaisalmer

City layout

Fig.52. Fort Street layout

Source: (Afreen, 2018)

In order to offer a shaded, cool environment for pedestrians and social activities at the streets, constructing heights is often better than roadway widths. In order to offer a shaded, cool environment for pedestrians and social activities at the streets, building heights are often better than roadway widths. (vyas, 2022)

Fig.52. Street view Source: (Afreen, 2018)

In order to offer a shaded, cool environment for pedestrians and social activities at the streets, constructing heights is often better than roadway widths. In order to offer a shaded, cool environment for pedestrians and social activities at the streets, building heights are often better than roadway widths.

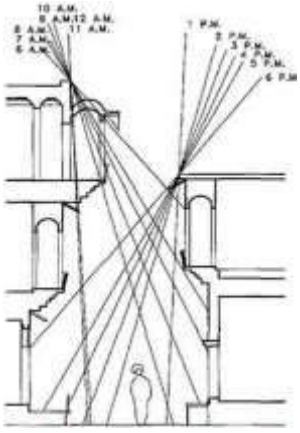


Illustration of typical streets characteristics of Jaisalmer

CHAPTER 4
LEARNINGS

The study of climate responsible architecture in Rajasthan provides several key learnings:

1. Sustainable building techniques: The traditional architecture of Rajasthan demonstrates the use of local materials and construction methods that are well-suited to the region's climate and environment. By studying these techniques, we can learn how to build structures that are more resilient to natural disasters and minimize their environmental impact.

2. Climate adaptation strategies: The vernacular architecture of Rajasthan reflects how communities have adapted to the region's unique climate challenges, such as extreme heat, dust storms, and monsoons. By understanding these strategies, we can better prepare for and respond to climate-related disasters.

3. Community resilience: Traditional building practices often involve the collective knowledge and labor of local communities, highlighting the importance of community resilience and self-reliance in disaster management. By studying these practices, we can learn how to empower and support communities in building their own resilience.

4. Cultural heritage preservation: The study of vernacular architecture also emphasizes the importance of preserving cultural heritage in disaster management. By recognizing the value of traditional architecture and indigenous knowledge, we can ensure that disaster management efforts are inclusive and respectful of local communities' cultural identity and heritage.

Overall, studying the climate responsible architecture of Rajasthan provides valuable insights for disaster management, including sustainable building techniques, climate adaptation strategies, community resilience, and cultural heritage preservation. These learnings can inform more effective and culturally sensitive approaches to disaster preparedness and response

CHAPTER 5
CONCLUSION AND DISCUSSION

In conclusion, the study of climate responsible architecture in Rajasthan offers important lessons for sustainable and resilient building practices, climate adaptation strategies, community resilience, and cultural heritage preservation. By understanding and incorporating these traditional practices into modern disaster management efforts, we can better prepare for and respond to the unique climate challenges of the region. Additionally, by respecting and preserving the cultural heritage of Rajasthan's architecture, we can ensure that disaster management efforts are inclusive and respectful of local communities. Overall, the study of climate responsible architecture in Rajasthan provides valuable insights that can inform more effective and culturally sensitive approaches to disaster preparedness and response.

References

abd. (n.d.). xyz. doi:66156

Afreen, S. (2018). *Passive Design Techniques as a Sustainable Solution for Thermal Comfort in Transitional Spaces of an Institutional Building.* Jaipur: IJSR. doi:10.21275/SR20715152848

Archinomy. (2020). *The Vernacular Architecture Of Rajasthan*. Retrieved from archinomy.com: https://www.archinomy.com/

camilla-ghisleni. (2020, november). vernacular. *What is Vernacular Architecture?*, 15. doi:ISSN 0719-8884

Gupta, N. (2017, jan). Exploring passive cooling potentials in Indian vernacular architecture. (Neha, Ed.) *E"Journal of Buildings and Sustainability", Volume 2*, 30. doi:6823

Soni, A. S. (2021). *Vernacular Architecture- Mirror of Climatic.* International Journal of Innovative Science and Research Technology , International Journal of Innovative Science and Research Technology . , Indore: International Journal of Innovative Science and Research Technology. doi:IJISRT21JAN285

Verma1, A. (2019, June). Design guidelines for Hot and Dry climate. (A. Verma, Ed.) pp. 63-73. doi:10.9790/9622- 0906026373

vyas, a. (2022). *International Research Journal of Engineering and Technology (IRJET).* kanpur: 2023. doi:ISO 9001:2008 Certified Journal