The Brick Panel

Nicole G. Hall
Abstract

A masonry wall or panel is made by the stacking of individual units; typically brick, stone, concrete block or glass block. These units are bound together by mortar to form continuous vertical surfaces. Traditionally, mortar is a paste made from a mixture of sand and cement.

What other materials might serve as “mortar”?

For this thesis project a panelized system for binding brick with metal has been developed. Each panel consists of a steel frame, within which the bricks are stacked and bound together. Metal rods hold the bricks in place horizontally, while metal spacers maintain the correct vertical positioning. The panels are hung onto a steel grid and bound together to form surfaces.
The Brick Panel

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Hans Rott, Chairman

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Kay Edge
I dedicate this book to my parents.
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The Institute for Research and Coordination in Acoustics and Music (IRCAM) in Paris began in 1973 as an underground structure adjacent to the Centre Pompidou. In 1990 an extension to the building was completed. The design, conceived by Renzo Piano, was an above ground structure consisting of two towers: one of glass, and the other of terra cotta panels. It was these terra cotta panels that first inspired me to question if common cored bricks might be used in a similar way.

The panels hang on the structure of the building and act as a rain screen. Every panel is made up of twelve terra cotta tiles. Each tile is 275 x 50 x 50mm and is held within the panel frame by three bolts. The tiles are separated by washers which hold them in even vertical alignment. The structure of these panels served as a reference for me to study as I designed the brick panels.
As the founding architect of the University of Virginia, Thomas Jefferson designed what he called an academic village situated around a rectangular lawn punctuated by a circular building, the Rotunda, at the north end of the site. It was Jefferson’s intention that individuals would enter the village, or lawn, from the south and progress north towards the Rotunda. His design left the south end of the site open to views of the countryside and surrounding mountains. The west and east sides of the lawn were used for buildings housing classrooms, and faculty and student living.

Today the south end of the lawn has been closed off and the view lost due to campus expansion. The size of the University and number of buildings has grown substantially from the time of its original design. As a result, the campus itself is no longer oriented around the lawn and Rotunda. The number of academic disciplines has grown, classrooms have moved to other facilities, and new living quarters have been built for students. Despite this fact, the lawn and Rotunda remain a symbol of the University. Students consider it a privilege to live in the buildings on the east and west sides of the lawn. Only those with the highest academic standing are given rooms. The lawn is the site of the graduation ceremony held each spring and remains an everyday gathering place on campus. On a typical day, when the weather is nice, one encounters several students on the lawn reading, throwing the Frisbee, or grilling out next to the living quarters.

Jefferson’s rectangular lawn interested me with regards to my own project. Additionally, the fact that he referred to the campus as a village also caught my attention. Throughout the course of my project, due to its size and the functions within it, it has been designed as a neighborhood or village within the community at large. Although not the same the size of Jefferson’s lawn, the courtyard within the project is similar in scale. There is no Rotunda to punctuate the end of the rectangle, but the buildings frame a view of Mill Mountain, a notable city landmark, to the east. There is a sense of openness and freedom to the courtyard similar to Jefferson’s lawn. The courtyard will be discussed in greater detail later.
Roanoke was established in southwestern Virginia in a valley ringed by the Blue Ridge Mountains with passable gaps east, west, north, and south. Due to these geographic features, it’s location made it an ideal crossroads for travelers and goods. Long before the Colonials arrived, salt licks located within the valley floor attracted animals and Indian settlers. The salt licks were so plentiful the region was originally named “Big Lick”. As a geographic crossroads, and with the emergence of coal mining in West Virginia, the area developed from a farming village into a railroad hub for south western Virginia and in 1882 the railroad developers seeking a more dignified name for the growing town changed the name from “Big Lick” to “Roanoke”. As the rail lines were established and built the town grew around them. The town’s population grew rapidly expanding from 600 to 5,000 in a span of two years. The rail lines were laid down over the flattest and easiest paths, the salt licks. The largest lick was filled with rock and became the main street of the city, now known as Jefferson Street.
The Site

The site for the project is located on Reserve Avenue between Jefferson Street to the east and Franklin Road to the west. Jefferson Street, as already mentioned, is one of the oldest streets in the city. It runs along a north/south axis and serves as one of the main connectors between downtown and several surrounding residential neighborhoods. Franklin Road is also a primary connector for the city. Both streets experience heavy traffic not only from the surrounding neighborhoods but also serve two of Roanoke's major hospitals. The Roanoke River runs along the south side of the site.

The site itself is currently owned by the city. Once owned by the White Corporation, it was purchased by Norfolk and Western Railway in 1923. The railway donated the land to the city in 1940 to be used as a site for a stadium and armory. Today many rail tracks, still in use, run adjacent to or nearby the site. Additionally, because of the rail, the site and surrounding blocks were, for many years, occupied by industrial users. These uses varied from concrete plants and scrap metal offices to car repair and hardware stores. It was essentially an industrial island between downtown to the north and the residential neighborhoods to the south, east, and west.
The Roanoke River acts as the south edge of the site. The topography is basically flat, making the site prone to flooding during periods of heavy or extended rainfall. For this reason, many businesses simply moved elsewhere because they were unprepared to deal with the flooding. The stadium and armory, as well as subsequent buildings added to the site in later years, were also not designed to accommodate the flood waters and hence have suffered deterioration. Today, the armory serves as a reserve outpost that is often not used. Other buildings on the site are currently used by the city for offices. The stadium is now condemned and only the field itself may be used. The inability of the existing buildings to handle the flood waters has basically rendered the entire site useless in its present state. The buildings there no longer serve their intended purpose and the land next to the river is overgrown, making it inaccessible to the public.

Across the river from the site is the River’s Edge Sports Complex, a park containing several soccer fields, two baseball diamonds, tennis courts, and a playground. The park is connected to the site by a single bridge. The park is often used by city schools, soccer clubs, and neighboring residents. The park, although prone to flooding as well, is little affected due to the nature of its use.

To the north of the site, where former industrial businesses once resided, the land has been cleared for the new Carilion Biomedical Center. The center is planned as a series of office buildings, to be constructed over the next 10 to 20 years, that will house research and medical facilities to serve the nearby hospitals and the city. The new designs for the Biomedical Center take into account the flooding nature of the site. The primary building functions will be raised off ground level onto the first floors and higher. The ground level areas are planned for use as parking.
The Project

materials

For the purpose of this investigation, materials hierarchy was established. Brick was chosen as the primary material in order to investigate the alternate meanings of “mortar” as a binding material in masonry construction. An alternate material for mortar needed to be decided on and tested as a binding element. Additionally, a structural material needed to be decided upon. Concrete was chosen as a secondary material and its function was to serve as the structure for the project. Metal and glass were chosen as tertiary materials. It was decided that metal would serve as the binding material for the brick units and glass would be used where there needed to be openings for windows and doors to allow light into the project.
Standard hollow cored bricks were used as the primary material for the project for several reasons. First, brick lent itself to the idea being explored; second, it is a building material traditional to the area; and third, it is one of the oldest building materials in existence.

Mud bricks date back to sometime between 10,000 and 8000 BC. Fired bricks are not quite as old, but there is evidence placing their earliest use between 5000 and 4500 BC in Mesopotamia. In Sumerian culture the word for brick was sig and its meaning translates to both ‘a building’ and ‘a city’. Sig also served as the name for the god of a building. In fact, Sumerians dedicated entire ceremonies to the firing and laying of the first brick for a structure. Since their invention, the use of the brick appears worldwide in many cultures. Brick is a timeless material and is widely associated with dwellings. Brick comes from the earth and therefore serves as a link to nature. The use of bricks in history and today is not only common in homes; it is a material that has been used to make temples, roads, factories, commercial and warehouse spaces.

All bricks are made from clay, in addition to small amounts of other materials like sand. A brick’s distinct properties are determined by the amount of clay used to make the brick. Extremes range from 30% clay for making mud bricks to 75% clay for terracottas. The cuboid or rectangular shape associated with bricks is achieved by making the brick from a mold, but bricks may also be sculpted or chiseled into shape. Today bricks are primarily molded in a machine and then cut into individual units. The clay placed into the mold is wet and therefore requires drying time to harden. As the bricks dry they shrink. Once the drying process is complete, bricks are fired to achieve their hardness. The process of brick making is not exact. The amount of water in the clay, the type of clay, the amount of clay, and the types and amounts of other material used in the mix will affect the dimension, color, and strength of the brick once finished.

In modern construction, brick generally no longer serves as a structural material. Instead, it most often acts as a building’s surface or skin, protecting the walls and structure behind it. Further developing the idea of brick acting as a surface to the building was one purpose of the project. Frequently today, brick is applied to a building in order to mimic the idea of structure, when actually it is only a façade of the building. The purpose of this project was to reveal the bricks true role as the surface of the building. In order to achieve this goal, the bonding material, mortar, is removed and a metal joint and frame is used to stack the brick.
Concrete was selected as the structural material for the project primarily because of how the building form evolved. As previously mentioned, the purpose was to make it clear that brick was acting as a surface for the building and was not in any way a structural element. To enhance this idea, it was decided there should be places within the project where the actual structure of the building would be evident. Places where the structure could selectively be revealed and seen. These structural members would be exposed to the elements and would therefore need to be a material that would stand up to such exposure without needing some form of coating or cladding for protection. Additionally, because the site is located in a flood plain the structural material had to withstand exposure to flood waters during certain periods of heavy rain.
tertiary

Metal and glass were chosen as tertiary materials for the project. Metal is used as the bonding material for the panels and is the means by which the panels are hung on the structure. It is also used for the railings, some of the stairs, and to decorate certain areas of the project like the workplace lobbies. Glass was used where transparency or translucency was necessary. It is used in doorways and windows, as well as for some of the interior walkways and stairs.
The panel was designed to be 2’-1/8” x 3’-1 3/8” in dimension. Each panel consists of forty-two standard cored bricks aligned in rows of three brick each and columns of fourteen bricks each. In order to explore how best to make the panel and to determine what problems might arise a prototype was fabricated using ¼” L-angled steel, ½” diameter solid steel rods and, washers and ¼” x 1-½” tension pins. The L-angled steel was first cut to dimension and three of the four sides welded together. ¼” holes were then placed into the rods at regular intervals and the tops of the rods were threaded to receive screws. The rods were then welded to the inside bottom of the frame so that they lined up with the two outside cored holes of each brick. There were a total of six rods, two for each column of bricks. The rods acted to hold the bricks in the frame horizontally. Once the rods were secured to the inside of the frame the bricks, tension pins and washers were added. A tension pin and washer were placed under each brick and acted to align and hold the bricks in place vertically. Each row was done sequentially starting from the bottom of the panel to the top. The 4th edge of the frame was then drilled with ½” diameter holes that aligned to the threaded tops of the rods. The top of the frame was attached first with screws (so that the panel was able to be lifted and moved) and then further secured by welding.

The panels themselves could be made off site and then transported to the construction site for installation. They would act as a rain screen for the building and would be hung on the concrete structure of the building using steel C-channels. Panels would be left off in places to provide for openings such as windows and doors. In the case of the prototype the frame was made of steel. Such construction makes the panel heavy. It is estimated that the prototype weighs between 200 to 250 pounds. Therefore it would be suggested that an aluminum frame replace the steel one, making each panel lighter, easier to move and hang, and less susceptible to rust problems, as well as placing less weight on the building structure.

The extravagance of this brick panelized system does not just serve the purpose of being a rain screen protecting the building exterior. It also adds an aesthetic value to the neighborhood while still using a traditional material. It adds a new texture to the landscape and a diversity to the neighborhood with its absence of mortar, making a statement in a neighborhood constructed primarily of buildings using a traditional brick facade.
Exploration of Panel Size

5 bricks x 5 bricks
2 bricks x 5 bricks
3 bricks x 5 bricks

5 bricks x 10 bricks
2 bricks x 10 bricks
3 bricks x 10 bricks

5 bricks x 12 bricks
2 bricks x 12 bricks
3 bricks x 12 bricks

5 bricks x 14 bricks
The Master Plan

The site for the project is roughly 34 acres. Its borders are Jefferson Street, Franklin Road, Reserve Avenue, and the Roanoke River. Across the river from the site is a large park roughly the same size as the site. It was important to acknowledge the river and the park in the design of this project. Historically the three are linked: physically by a bridge and psychologically due to the fact that the site for the project is currently home to the stadium and an additional baseball field. It is also beneficial to note the changing nature of the area and the proposed future development across from the site (the Carilion Biotechnology Park). The combination of what is currently happening and what is proposed to happen on these connecting sites is important, because they will change the urban context of this area from one dominated by industry to something new, forming a greater visual link to downtown along the Jefferson Street corridor.

Keeping the planned changes to the surrounding sites in mind, the buildings for the project were placed adjacent to Reserve Avenue, leaving the area of the site closest to the river open for use as park space. This would allow the park area to be extended across the river, thereby linking the two parcels. The existing bridge would be removed and replaced with two new bridges at the east and west ends of the site.

The project itself consists of four buildings comprised of forty dwellings, and four buildings for small office and retail use, which will be referred to as the workplace. The dwellings face the Roanoke River so that the occupants may take advantage of the views to the river and the park, as well as providing visual separation from the workplace. The workplace buildings front Reserve Avenue and are separated from the dwelling units by a large courtyard which can act as a gathering space for the project users and the community. The entire project is raised a minimum of fourteen feet above ground to account for the occasional flooding of the site, to accommodate parking for the project under the courtyard, and to reveal the building structure. Sidewalks from Reserve Avenue cross underneath and to the East and West of the project maintaining a continuous link to the park and river and to what will be the Biotech Center across Reserve Avenue.
The Courtyard

The courtyard is a concrete structure with a green roof sheltering parking for the project below. The courtyard serves as the link connecting all eight buildings on the site together just as Jefferson’s lawn linked his academic village at the University of Virginia. It is also similar in scale to Jefferson’s Lawn, although longer and narrower. As Jefferson’s Lawn is broken by the geography of the site on which it is placed, the courtyard in the project is broken by openings to the parking below. The space itself is composed of four rectangular areas of open grass with a large sidewalk running along each side to connect them.

The size of the courtyard was based primarily on three issues, those being the size of the adjacent buildings, the depths and distances required for accommodating the parking below, and the size of the site. The courtyard was left as an open space so that it could be used for many purposes by the inhabitants, the workers, and the community. The scale was designed to accommodate various activities: a place for individuals to eat lunch and children to play, for outdoor art shows, theater performances, and concerts. It is a new space for people to gather, replacing the stadium.
The Workplace

The four workplace buildings were designed without a specific use, but with the thought that the 1st floor would be used for small retail (such as a pharmacy, coffee shop, or deli), and the 2nd floor would primarily be used for small offices: most likely for businesses related to the medical industry (due to the project’s location). For this reason the space was designed so that it could be easily subdivided into varying sizes. There is a central core for entrance, elevators, rest rooms, and mechanical space and a corridor placed along the south façade for access to the individual spaces. Additionally the second floor corridor links the four workplace buildings together via the stairs located between each of the four buildings.

The basic structure of the workplace buildings is a grid of columns and beams. The structure is completely covered by panels from the 1st floor up except for on the South façade. The South façade is characterized by its large panes of glass and their supporting structure. As already mentioned this is the location of the corridor. The North side of the corridor is made up of the brick panels. This is the only space within the project where the panels are placed on the interior of the building. This was done to keep the same language of the building surface already established and to allow the actual building structure to be revealed. The corridor acts to absorb sunlight in the winter, warming up the interior space and in the summer would be shaded by the roof overhang projecting from the façade. The interiors spaces were designed to feel like a loft or warehouse, in homage to the once industrial nature of the site. The columns and beams are left exposed and the spaces are left open so that inhabitants can define uses as needed. The floor is a polished concrete dyed a warm color similar to that of the brick exterior. The walls are finished in a smooth plaster except in the lobby, where metal slats are placed horizontally to denote that this area serves as the building’s entrance.
workplace entrance from 
Reserve Avenue
ingress/ egress stairs from Reserve Avenue to courtyard
workplace
lobby entrance
workplace
exterior from courtyard
The Dwellings

The four buildings housing the dwellings are comprised of forty individual units, ten in each building. The dwelling units themselves have six variations ranging in size from approximately 600 square feet to 2000 square feet. In order to achieve a certain diversity of inhabitants there needs to be some choice in the size of the dwelling. The range of sizes allows the project to accommodate singles, families and retirees. The structure is basically the same grid pattern of columns and beams used for the workplace. The dwellings are placed within the structure so that their patios are always open to the sky, and always face south. The entrances to the dwellings are always placed along the north façade thereby allowing the inhabitants to enter from the courtyard. The arrangement of openings and patios appears random, but is created by the fenestration of each of the six dwelling choices. The patios for the dwellings are all the same size, 200 square feet, regardless of the size of the interior space.

The interior spaces, like that of the workplace, are for the most part open in the living areas and walls are placed where there are water closets and bedrooms. The columns and beams once again are left exposed, the walls are a smooth plaster, the floor a warm colored polished concrete. The ceilings within the space are just under eleven feet high. The walls within the space are only eight feet high, except in the location of water closets which have walls that extend to ceiling height. The eight foot walls help to divide the interior spaces, while the exposed ceiling expanses maintain an openness within the dwelling. The interior spaces of the units all include a kitchen, living and dining area, and bedrooms (from one to three based on the size of the unit).
dwellings
exterior from courtyard
dwellings exterior stairs from ground and courtyard level
dwellings
perspective view
from patio
dwellings
south facade
facing
Roanoke River
dwellings - layout 1
dwellings - layout 3
dwellings
view of green roof from patio
dwellings
view from
courtyard
Plans
section through workplace
Variations

Architecture, in the case of this project, is highly influenced by the building’s surface, the brick panels. How the panels are made, their size, spacing, and the way they are hung all affect the architecture. Therefore the way the panel is made and hung for this project may be varied in another project. The panel size could be changed and made more horizontal as opposed to vertical; the panels could be hung sideways; the columns of bricks could be arranged so that some protrude forward and others are held back; the washers and pins that hold the bricks vertically could be made more evident by bringing them forward further articulating that joint. There are an endless number of possibilities left to be explored and examined yet not all would be a viable or good variation.
Panel Wall as designed for project.

Variation 1

Variation 2

Variation 3

Variation 4

Variation 5

Variation 6
Conclusion

Throughout the course of the project, the brick panel has been foremost in my thoughts; the exploration of how it is made and attached to the building as an exterior surface and its role as a primary element in the architecture of the project. It is an idea I hope to explore further as I develop and grow as an architect. The design and building of the prototype has created more questions than providing answers. Such questions include; is the use of a standard cored brick the right choice or would it be more advantageous to create a specific brick for the panel? Can bricks be hung without a frame or mortar? How would further articulating the joint change the panel appearance? Is there an easier way to secure the brick in the panel vertically, possibly using some modified form of e-tension rings fastened to the rods? The prospect of further developing and exploring these ideas is exciting. It is important that as architects we explore new ways of using traditional materials in addition to creating new ones. This project is a step towards that.

The project did not arise from this idea alone, however. In part it derived from my investigations regarding cities, urban planning, and public spaces. Through architecture we can invest in the future of our cities; environments which play a key role in the future of our society.

It is important that abandoned and dilapidated areas of cities be reclaimed and used. First, because we must reduce sprawl. If we continue to build outward, eventually the center will rot and we will be left with no unifying core. We must start preserving the land that surrounds our communities so that we and our future generations have places to experience nature without power lines, factories, and suburbs nearby. It is important for cities to have communities of diversity, where the needs of many are met. There are people today that would enjoy having the option to walk or bike to work, to the market, or to visit friends as opposed to driving. Developing places within our cities for people to live and work makes this possibility viable. For this reason, I chose to design a mixed use project that encompasses home, work, and play. The idea of reclaiming a relatively unused site is what lead me to choose the location for the project: a place within the city where people could live, work and enjoy the river. I wanted a project that would acknowledge its surroundings and the nature of the site as well as being a place that anyone could use.

In the fields of architecture and urban planning, there is much discussion of master planning and cities; discussions regarding the orientation of city blocks, the amount of green space a city should have, and numerous other topics. Jane Jacob's writes in her book The Death and Life of Great American Cities about the urban conditions of Boston, New York and Chicago, but several points made in her book are valid even for a city the size of Roanoke. One is that cities, and the spaces within them (parks, dwellings, recreation centers etc...), need diversity. These places need people in close proximity to use them and need to be designed to be used by different people at different times of the day in order to be safe and add value to a community. This project works to accomplish such goals. It is a place where people can work, where varying
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