

# 06

## Technical Investigation

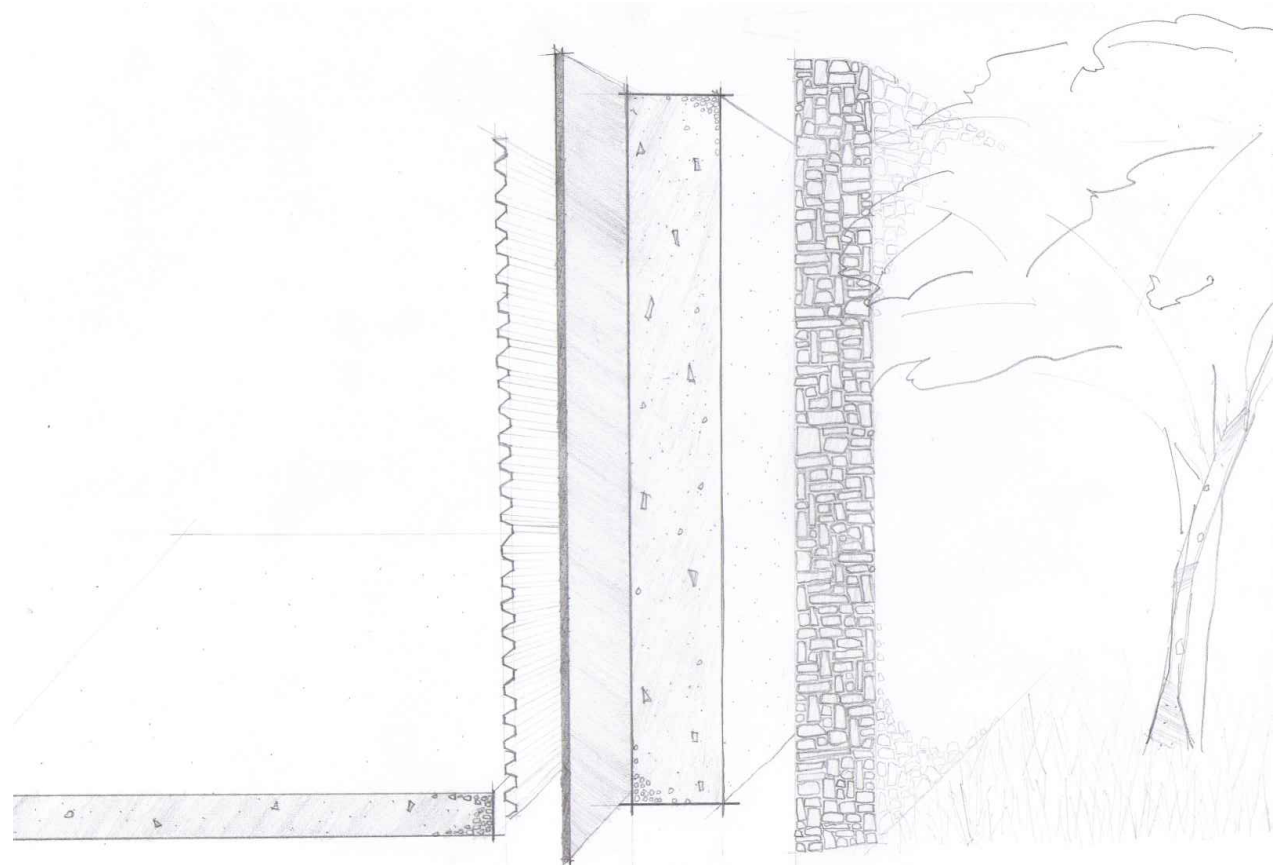


fig. 6.1. Sketch indicating the concept of layering and progression. (2010)

## + Technical Investigation

The following is a study in the poetics of construction. The study was done by the author to understand the relationship between stereotomic and tectonic qualities.

### POETICS OF CONSTRUCTION

Construction and technology have evolved over the past centuries. The way in which we perceive construction and the theory thereof - from the construction of the Great Egyptian Pyramids, to the most recent buildings, has not changed much. Even though technology in construction has evolved, the poetics thereof has been reused and continuously explored. Many architects have developed their own “signatures” within construction, by either details, the uses of light and materials.

The German architect, Gottfried Semper (1803-1879) pointed out in his *Die Vier Elemente der Baukunst* [Four Elements of Architecture]; that the “earthwork”, the “hearth”, the “framework/roof” and the lightweight enclosing “membrane” classify the craft of building into two distinct procedures: “tectonics” and “stereotomics” (1995:5).

Whereas “tectonics of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix, and the stereotomics of the earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements” (*ibid*).

These procedures are evident in the relation to how a construction detail would be designed and the use of different materials, within its specific purpose. The art of combining these construction procedures in a design is therefore often explored by well-known architects. The importance of the dialogue created between heavy and light, core and skin; should be explored in all architectural designs. The author can observe that these relationships should be investigated in the construction process by interpreting the value of the spaces created in the building procedure.

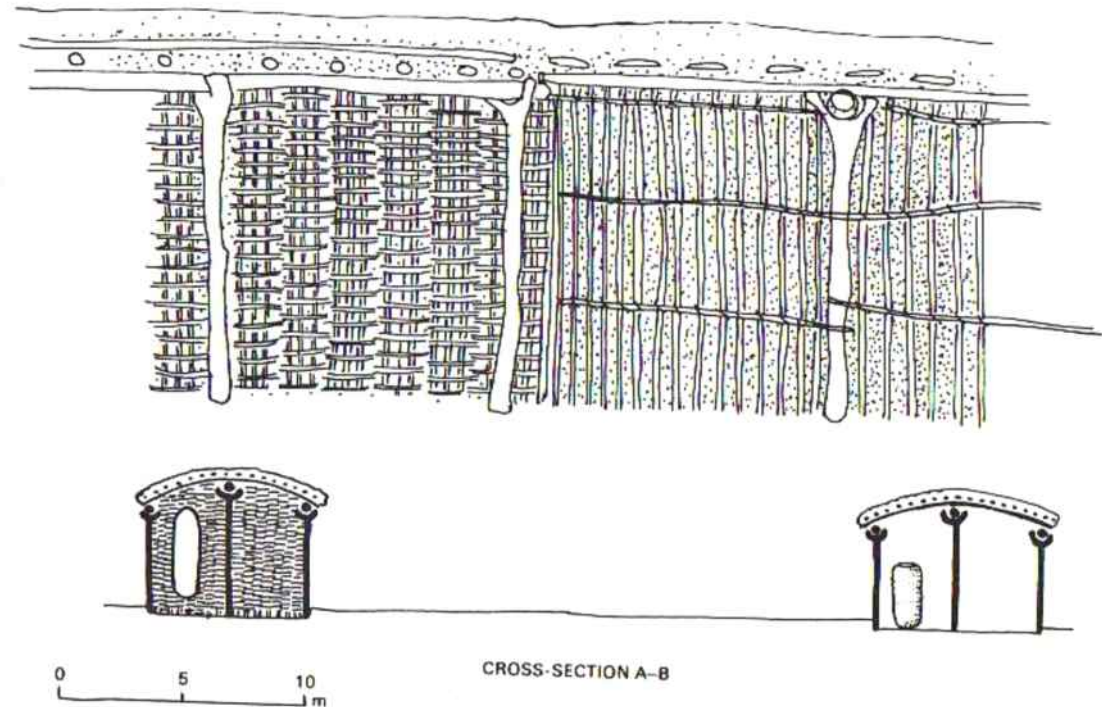


fig. 6.2. Gogo houses of Tanzania, detail of infill walls. (1995:7)

The interplay of light and heavy construction therefore creates curiosity in the design and space making process. By combining these procedures through the use of material, light and detailing the poetics of space is created.

The architectural theorist Kenneth Frampton testifies to the two modes of building: the “compressive mass” and the “tensile frame” (*ibid*). Semper also pointed out that, “the history of culture as it manifests occasional transpositions in which the architectonic attributes of one mode are expressed in another for the sake of retaining traditional symbolic value” (*ibid*). Frampton also stated that Semper’s Four Elements was borne from vernacular building throughout the world.

Architect and theorist Roger C Fisher states that “It could be argued that regionalist architecture will be generated by the designer directly responding to the following aspects in a specific way: climate, materials, site, defence, economics, and religion. To this could be added the particular cultural expression of the community” (1998:123). In addition, Semper illustrated that when traditional masonry is bonded into coursework, it is also a form of weaving. This illustrated that heavy construction, like masonry or concrete, can be perceived as woven or lighter entities within design construction.

Fig 6.3 indicates how Louis Kahn used light and filtered light to illustrate the concept of tectonic qualities to a space. The light was used to soften and lighten a space in a heavy, stereotomic environment.

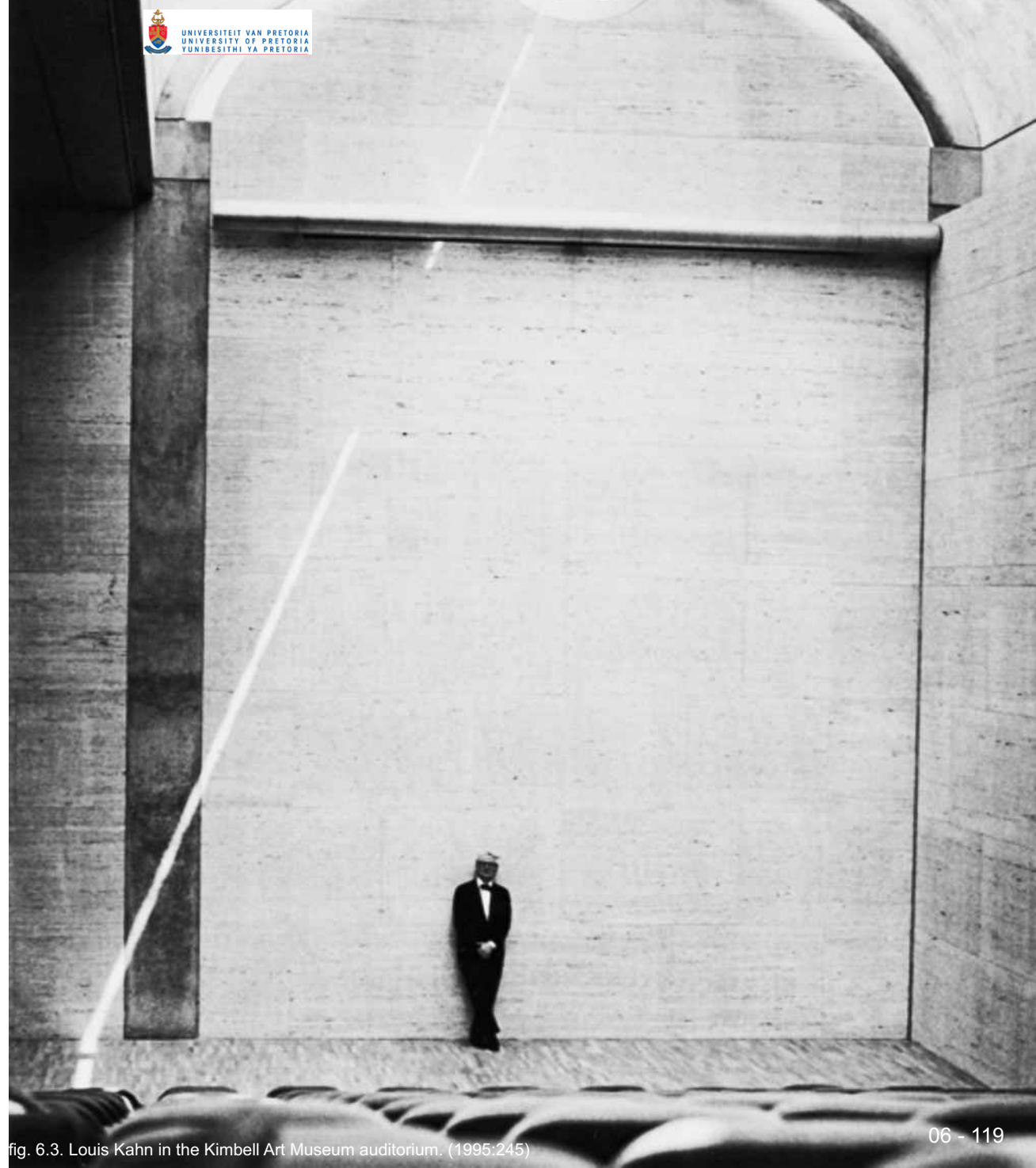


fig. 6.3. Louis Kahn in the Kimbell Art Museum auditorium. (1995:245)

## STUDY ON THE POETICS OF CONSTRUCTION

The following is a study done by the author to further his understanding in the use of different materials to illustrate their stereotomic and tectonic values. The study was done to understand that light materials could also be used as stereotomic.

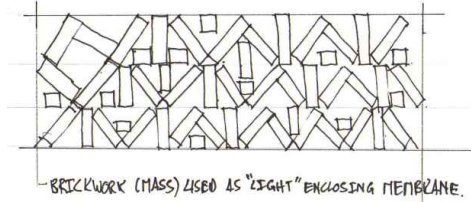
1. Weaving - weaving is a means to respond to the vernacular and the interplay of tectonic and stereotomic principles.

2. Vernacular - The use and precedents set by traditional vernacular architecture principles, should be interpreted and further developed today. The use of local heavy and light infill materials should be brought into regionalist designs.

3. Heaviness - The perception of heavy materials, e.g. brickwork and concrete, could be used as a "light" material, by means of weaving & light. The stereotomics of the earth, could be separated from the light material, creating articulation and hierarchy.

4. Lightness - Lighter materials, tectonics, could be used to "soften" heavy materials, and like heaviness, create distinction between the two, but in the same sense marrying the materials in an architectural manner.

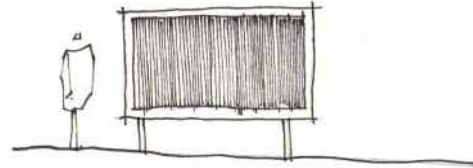
5. Light - light could be used as a building material, creating sensual spaces and the detailing thereof, also relates to the physical detailing of filtering the light into a space. Light is inevitably one of the profound design & construction generators.



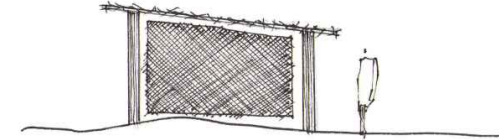
- BRICKWORK (MASS) USED AS "LIGHT" ENCLAVING MEMBRANE.



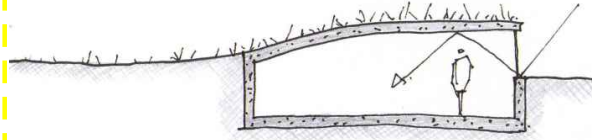
- STEEL USED AS WEAVING OF HANDRAIL.



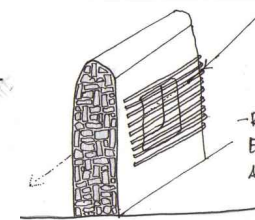
- NEW & OLD USED TOGETHER - LIGHT vs HEAVY



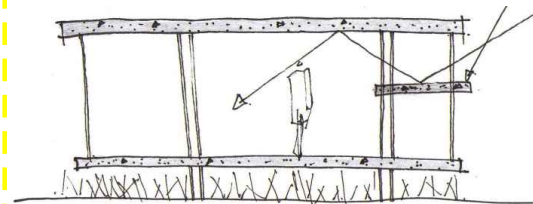
- USE OF LOCALLY AVAILABLE MATERIAL, INTERPLAY OF TECTONIC INFILL PANES & COLUMNS FIXED TO STEROTOMIC. (EARTH).



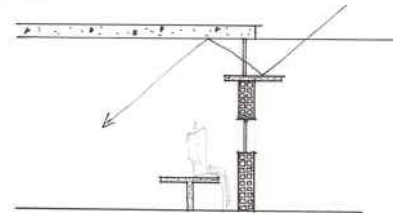
- HEAVINESS OF EARTH, SOFTENED BY USE OF NATURAL LIGHT.



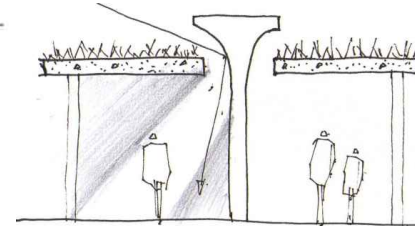
- RATTLED EARTH USED AS MASS & HEAVY ELEMENT, WITH LATS AS SLIM CONTROL ACTING AS A WHOLE, BUT LIGHT vs. HEAVY.



- HEAVY MASS IS PERCEIVED AS LIGHT, BY SEPARATING IT FROM THE STEROTOMIC. (EARTH).



- REFLECTED NATURAL LIGHT - CONTRAST OF HEAVY & LIGHT. LIGHT AS A MATERIAL IN DEMAND.



- LIGHTING A SPACE WITH NATURAL LIGHT, MASS IS PLACED IN CONTRAST WITH "LIGHTER" CREATION.

## TECHNICAL CONCEPT

The technical concept therefore is derived from the study of the poetics of construction. The architectural typology of the Fort influenced the concept by means of structural mass being used. The structural mass of the Fort that is sunken into the landscape has stereotomic qualities.

The concept is therefore incorporated into the buildings, through the use of mass and buildings being sunken into the ground. The earth in this sense also becomes stereotomic.

The visitor centre's walls and floors have stereotomic qualities by retaining the earth. This references the typology of the Fort. The stereotomic mass becomes the primary structural element. The steel and timber screen containing the stereotomic structure have tectonic qualities. This tectonic structure becomes the secondary element in the structural system. This play between light and heavy not only relates to the architecture of the Fort, but it also illustrates movement through the building. One enters a tectonic structure and then is guided through the space towards the stereotomic structure. This spatial quality is also facilitated by the progression from the contained towards the retained space.

The movement from tectonic to stereotomic also has a definite threshold, where the visitor moves from the defended side towards the defensible side towards the Fort.

The glass, windows and doors become the tertiary structure, where they act as thresholds between spaces and also between stereotomic and tectonic structures.

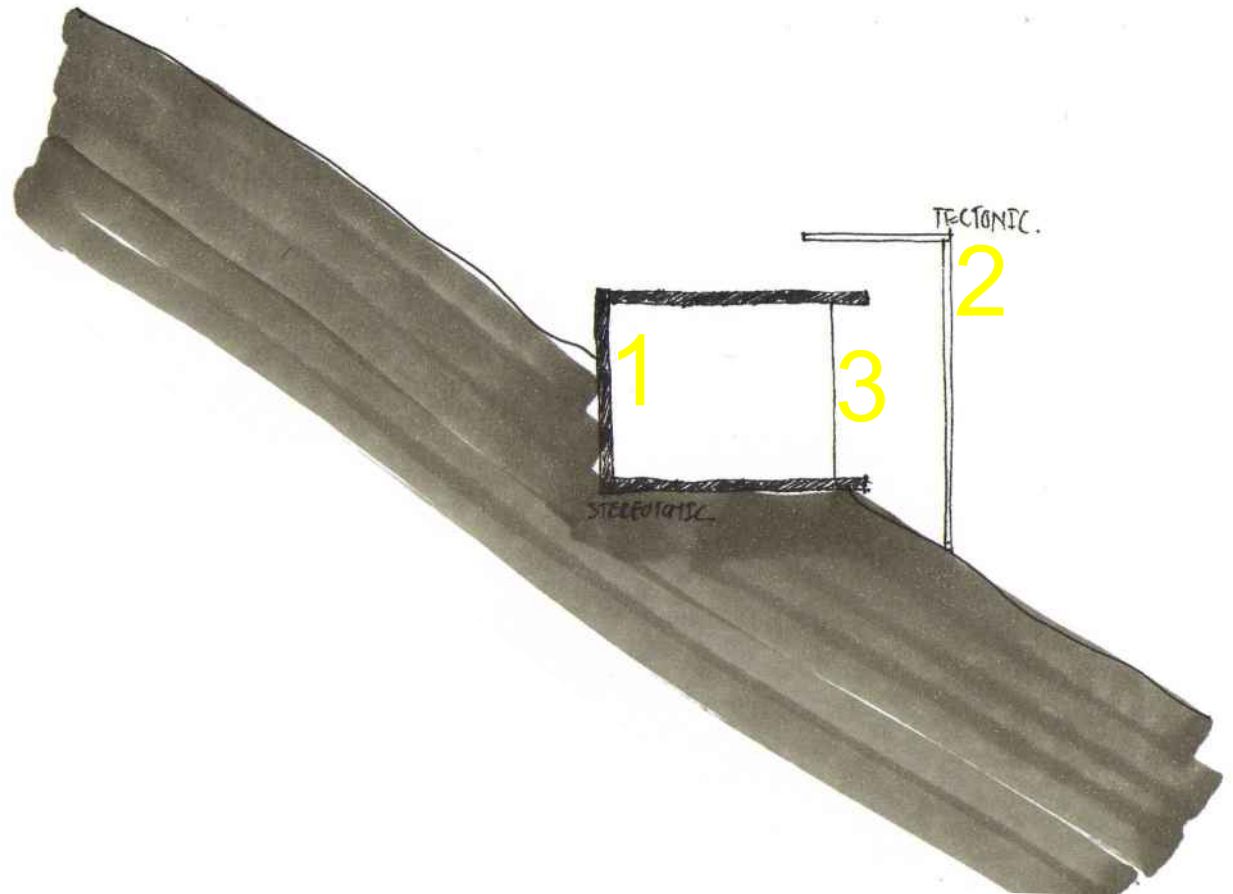


fig. 6.4. Conceptual diagram of stereotomic vs. tectonic, indicating retained vs. contained. (2010)

## TECHNICAL PRECEDENT

The following precedents were studied by the author to learn about the correct use of materials and importantly the response to existing heritage buildings.

MUSEO DI CASTELVECCHIO, VERONA, ITALY, BY CARLO SCARPA (1906 - 1978)

The study of the Museo di Castelvecchio involves the study of how Scarpa approached the detailing of existing structure and the new.

Scarpa pulled the old away from the new, to distinguish between the two different structural qualities. Scarpa's detailing of the steel stairs at the Museo di Castelvecchio illustrates these principles, where he left a small gap between the new steel stairs and the existing masonry wall. This illustrates the idea of the old being celebrated and made the primary expression where one sees the old masonry wall in its pure form as an object, but you are subtly reminded of the new addition to it.

Scarpa illustrates the subtle approach by bolting these steel stairs sensitively to the existing masonry wall. These stairs curve upwards, as if they give way to the masonry wall, illustrating the sensitivity to the existing.

This detailing is perceived by the author, as tectonic meeting stereotomic. The existing masonry wall becomes the historical stereotomic element, where the steel stairs become the tectonic. The connection between these two elements are blurred and the intermediate gap between the two elements belongs to neither.

The gap therefore illustrates not only where new meets old, but also how the tectonic element meets the stereotomic element, in a subtle and blurred manner. The author notes the attention to detailing by Carlo Scarpa, and wishes to illustrate the same approach to detailing and conceptual manner in which new meets old. In this dissertation's case, how the new meets the old West Fort.



fig. 6.5. Scarpa's steel stair detail at the Museo di Castelvecchio. (centralbranchlibrary.com:2010)

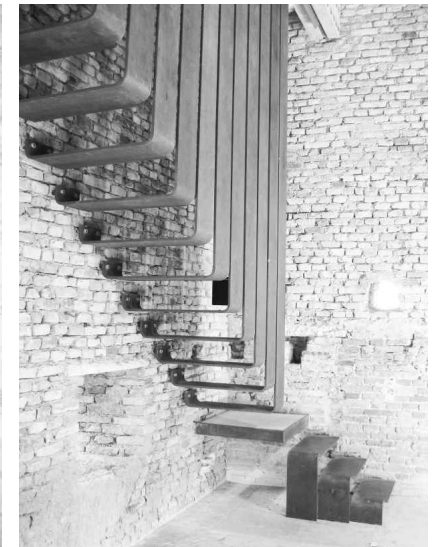


fig. 6.6 - 6.8. Scarpa's steel stair connection detail. (centralbranchlibrary.com:2010)

The following study by the author concerns the use of *Beton Brût* (Raw concrete) in various ways. The quality of the concrete and the finish it produces and the way it influences the user's experience are of interest to the author.

Materials, in renowned Swiss-French architect Le Corbusier's (1887 - 1965) mind occupied two distinct categories - natural and artificial. Concrete was for him a "material of the same rank as stone, wood and baked earth". Le Corbusier added that the "experience is of importance. It seems to be really possible to consider concrete as a reconstructed stone" (2007:18).

Le Corbusier chose finishes precisely for their abrasive, unsympathetic and downright defensive qualities. At La Tourette the interiors of the cells are finished so outrageously rough that a smooth panel is provided next to the bed to avoid continual injury and snagging of blankets. Such materials, so painful to the touch, seem to express something of the hardships of the life of the monk or indeed the pilgrim. A similarly repellent finish was achieved in the outbuildings of Ronchamp, except in reverse where imprints of stone can be seen in the surface of the concrete (2007:45).

The author intends to use *Beton Brût* for the finish of the concrete walls. The way in which Le Corbusier finished the cells at La Tourette is extreme and harsh. The author does not want the exact same brutal effect, a smaller, finer stone will be used in the aggregate to attain a smoother finish. The raw concrete therefore will have the *Brût* aesthetic and will be symbolic of the heritage and "oldness" of the Fort, illustrating to the user that the new material is used in an old manner, thus creating a feeling of used and *Brût*, relating to the harshness of a war or Fort environment and atmosphere.

The ruins of the Fort (fig. 6.9) is also symbolic of the concrete and vice versa.



fig. 6.9. The *Beton Brût* is symbolic of the Fort ruins. (2010)

## MATERIALS

The material palette consists of various materials, but the three primary materials and finishes are Concrete, Stone and Steel.

These materials will be discussed briefly by the author briefly, to determine their structural qualities and their influence in the design process.

### CONCRETE

The raw concrete finish will be used throughout the buildings. As discussed earlier, the concept of the concrete becoming symbolic of the Fort and ruins is important to illustrate that the new buildings are didactic in their use of materials as well. This means that the visitor will be aware of the rough, raw concrete, therefore visually and physically experiencing the material.

### STONE

Dry packed stone walls again become symbolic of the Fort, which was partially built with concrete, but mainly of a very hard sandstone material. Certain dry packed stone walls come to function as land art elements, creating an aesthetic as if they are “growing” from the landscape, but still maintaining the Fort’s position as primary structure.

The stone walls become stereotomic, structural elements in certain spaces, while also functioning as directional elements as land art walls in the landscape. These walls “pull” the visitor through the spaces and lead them up the mountain.

The visitor experiences the stone walls as directional and symbolic to the Fort on approaching the visitors centre. As the visitors moves into the visitors centre, the floor finish becomes slate tile, cut in various shapes. The interior is therefore slate stone tiles and once exiting the building, the plane changes to stone walls again. This is to distinguish between exterior and interior, but keeping the threshold minimal.



fig. 6.10. The *Beton Brüt* finish the author intends using. (2010)



fig. 6.11. Dry packed stone wall is symbolic of the sand stone walls of West Fort. (centralbranchlibrary.com:2010)



The stone walls will be constructed by using stone from the site. Finer aggregate could be used in the concrete mix, to attain a *brüt* finish.

## STEEL

The steel forms part of the secondary structural elements. The steel used in the project is mainly mild steel and a small amount of cor-ten panels as cladding.

The mild steel forms part of the tectonic elements. The steel becomes structural and contains the stereotomic elements.

The steel and timber viewing platform in the courtyard of the Fort will create a tectonic aesthetic in a stereotomic context. The extension of the existing canon ramp, will be constructed from mild steel. The mild steel also becomes symbolic on a smaller scale of the Fort, where mild steel beams were used as lateral support for the tunnels moving underneath the ground.

The cor-ten steel will enhance the effect of the archaeological research centre becoming a ruin in the landscape. The weathering steel will ensure that the building will look like a ruin before its time.

The mild steel will be finished with two coats of red oxide primer and painted black.



fig. 6.12. Sand stone wall of West Fort. (2010)

## STRUCTURAL SYSTEMS

The structural systems are divided into three categories; Primary, Secondary and Tertiary.

### STEREOTOMIC - PRIMARY

The following exploration was done by the author to further the technical development concept. These diagrams and images illustrate the application of the concept to the technical investigation done by the author.

The stereotomic structure becomes the primary structural element. The stereotomic mass acts as the retained element, which relates to the architectural typology of the Fort. The heavy, sand stone walls act as the stereotomic elements, retaining the soil, but also retaining the enemy in a conceptual manner.

The primary structure therefore is constructed of reinforced cast in-situ concrete. As discussed earlier, the *beton brut* aesthetic is used as final finish to the concrete.

The conceptual technical sketches (fig. 13), illustrates the development of the concept of retained and contained elements. Where the concept started as a diagram, evolving into structural and material systems.

In certain spaces the stereotomic becomes stone walls. Where this relates again to the symbolic relationship to the Fort. In fig. 6.15 we can see the relationship between the concrete as retained stereotomic mass and the stone wall, which also acts as a retaining element.

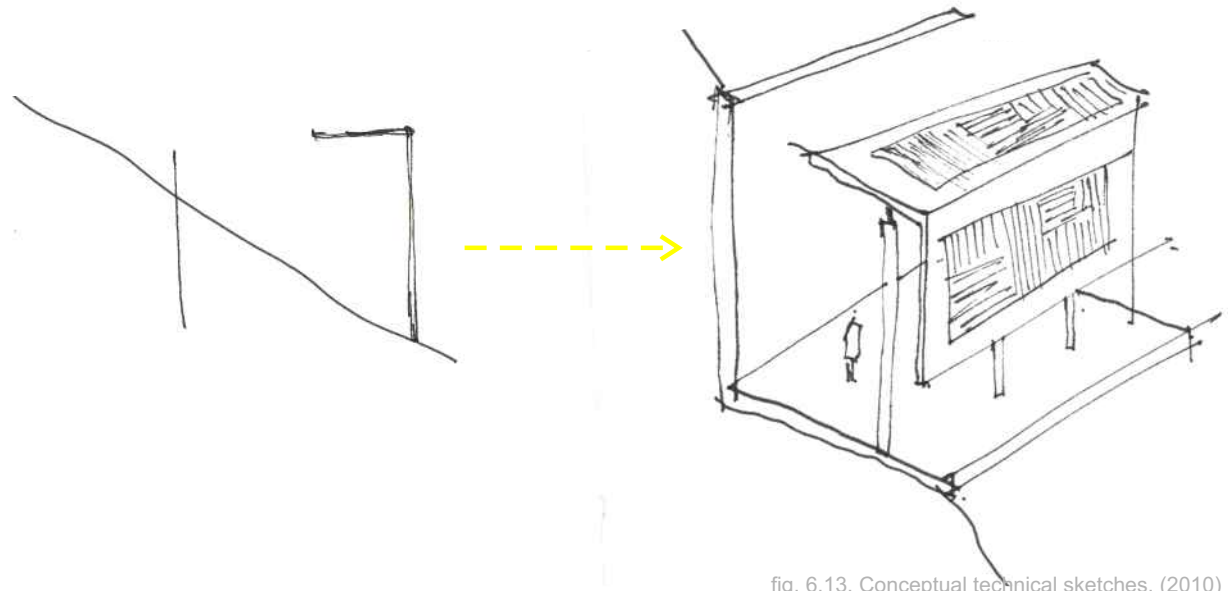


fig. 6.13. Conceptual technical sketches. (2010)



fig. 6.14. Image indicating the structural systems. (2010)

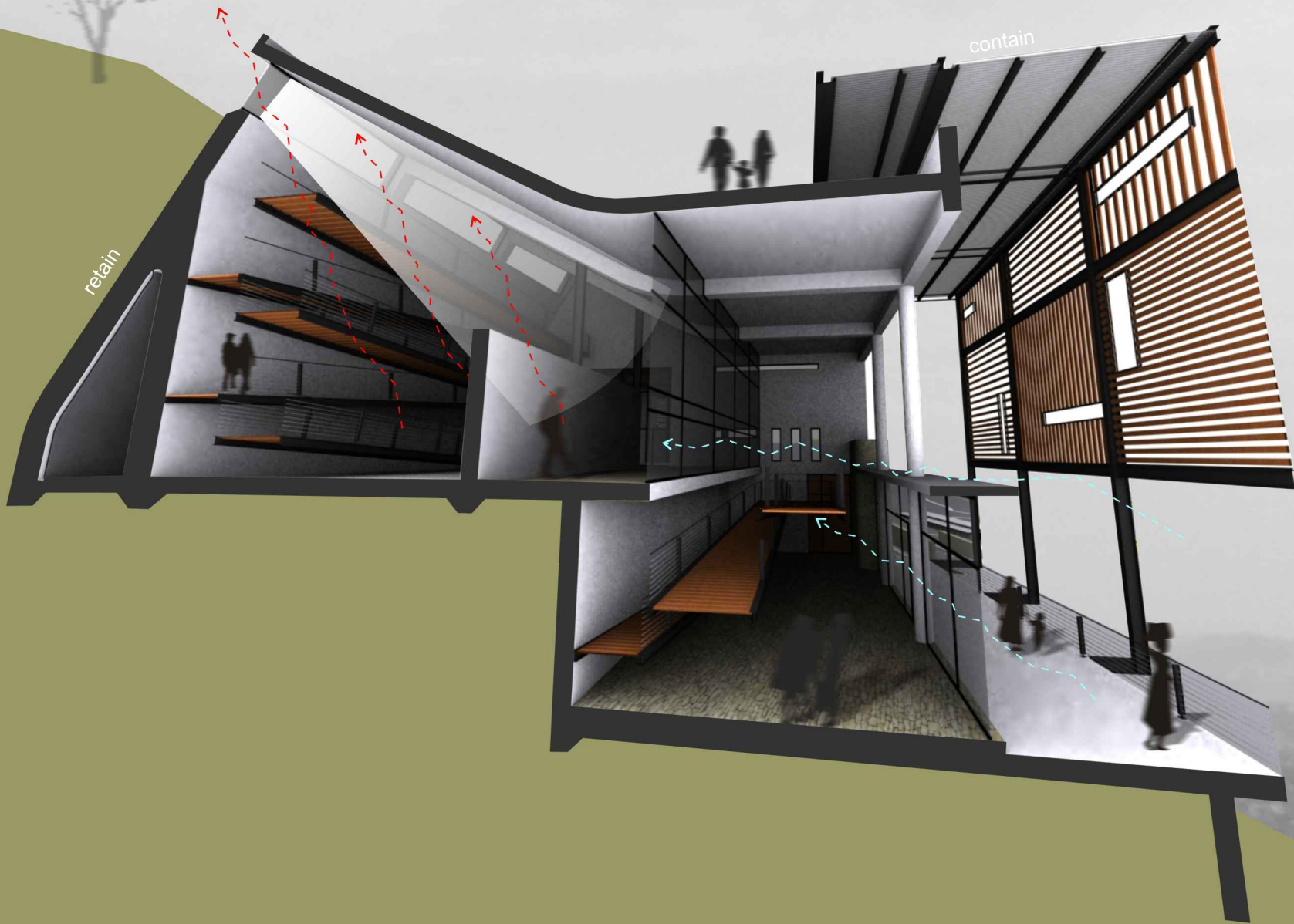


fig. 6.15. Section through visitors centre indicating possible thermal activity. (2010)

## TECTONIC - SECONDARY

The steel and timber screen becomes the secondary tectonic element in the visitors centre (fig. 6.17). This screen acts as the contained element. This concept illustrates the way in which the lighter materials clip onto the heavy stereotomic elements. The idea is that the structural elements become directional as well. This means that the screen at the entrance guides the visitor through the building and spaces towards the stereotomic element.

These spaces become thresholds between the defended side and the defensible side of the Fort. The light materials give way to the heavier, stereotomic mass, which illustrates to the visitor that he is not just moving through these spaces, but also approaching the Fort.

The tectonic structure at the crafts market area and the archaeological research centre is designed to illustrate the same concept. At the research centre the visitor moves again from the stereotomic element towards the tectonic element. This is again symbolic of archaeology, where the visitor moves from underneath the ground towards the landscape and also the practice of archaeology, which is done underground and explores layering. This design again becomes directional and illustrates to the visitor the circulation and movement through the building, but also that the visitor is moving away from the Fort - again becoming a threshold towards the city.

The tectonic elements in these buildings are indicative of the idea of them eventually becoming ruins in the landscape as discussed earlier by the author.

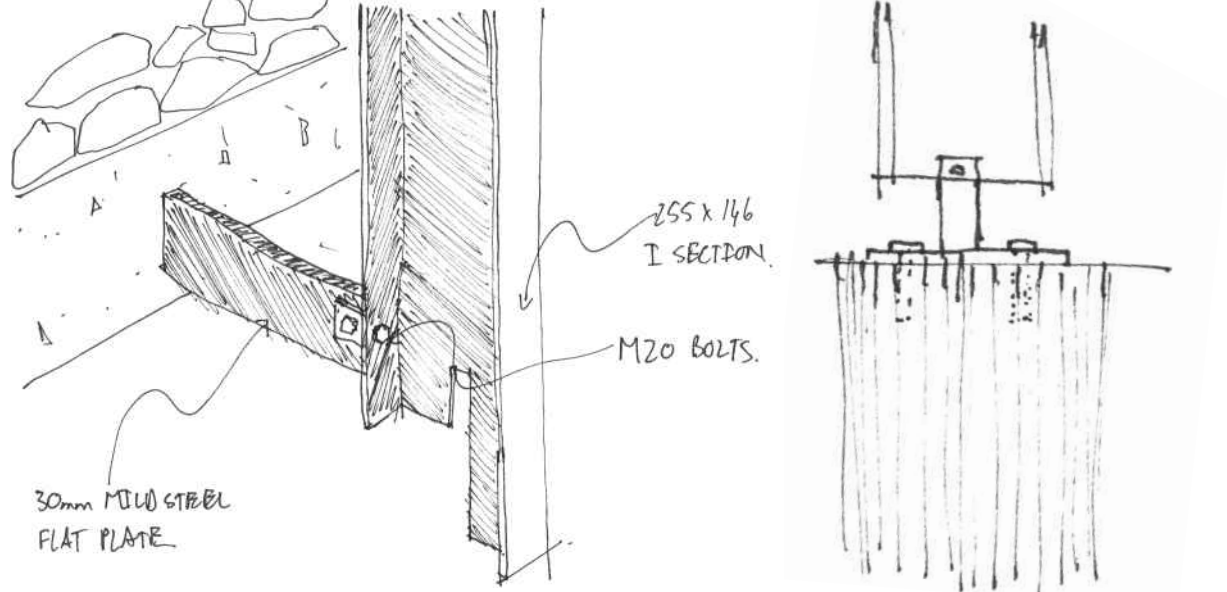


fig. 6.16. Connection detail sketches. (2010)



fig. 6.17. Layering of components and materials of screen. (2010)



fig. 6.18. Section through crafts market area, illustrating the concept of contain and retain. (2010)

## TERTIARY

The glass screens, windows and doors form part of the tertiary structural system, where they act as thresholds between the stereotomic and tectonic structural elements.

The tertiary elements become the binding elements within the structural system. They tie together the stereotomic and tectonic elements. The glass screens and windows act as permeable thresholds, which also become the threshold between exterior and exterior.

The tertiary elements become miradors cut into the stereotomic and tectonic elements. They act as viewing portals, where the visitor will capture certain views that are focused on various iconic monuments within the city scape.

These portals / miradors are symbolic of the Fort and it's military like environment, where the enemy was watched by the military through various portal holes from in the Fortifications and the Blockhouses. This again also informs the concept of the visitor becoming the *camera obscura*, capturing views in a similar, military like manner.

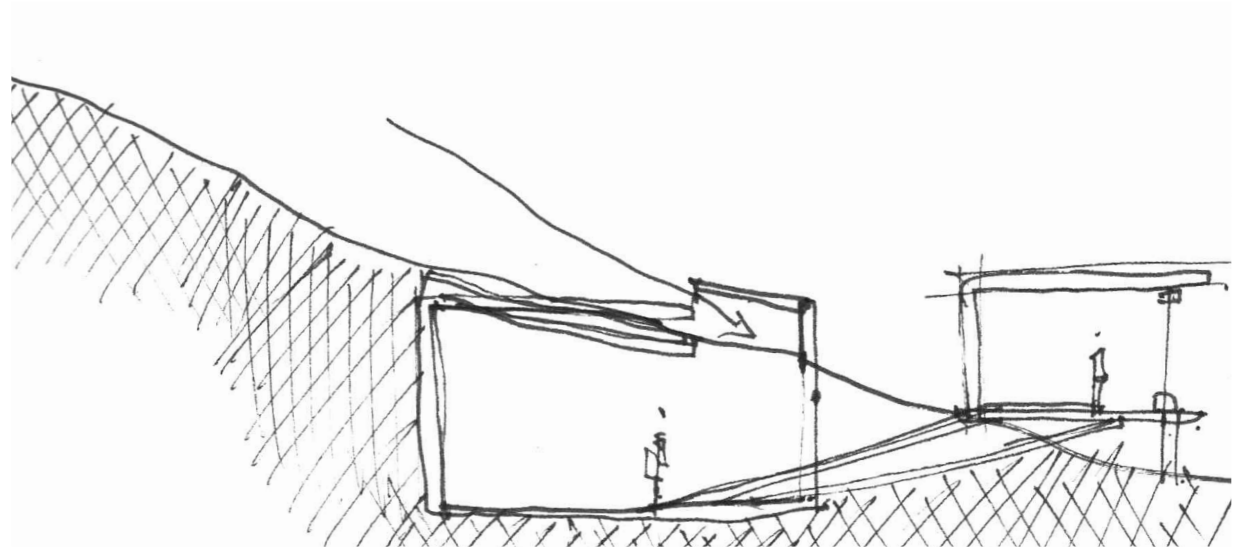


fig. 6.19. Structural system sketch indicating stereotomic vs tectonic system. (2010)

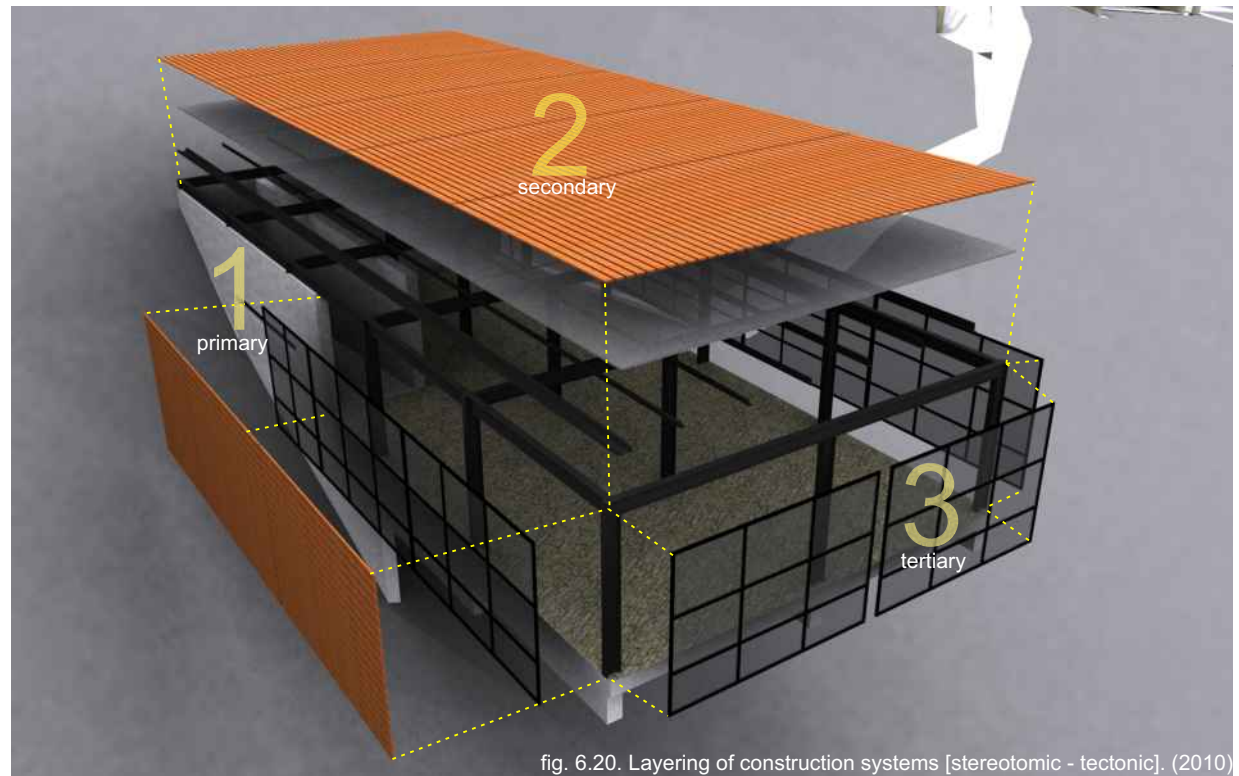


fig. 6.20. Layering of construction systems [stereotomic - tectonic]. (2010)



fig. 6.21. Archaeology Research Centre [stereotomic - tectonic]\_material layering, but also building layering in terms of construction poetics. (2010)

## DETAILING

The detailing is focused on the principle of the intermediate connection between the stereotomic and tectonic elements.

As discussed earlier, the connection detail of the steel and timber screen at the visitors centre becomes the in-between element. This illustrates that the connection does not belong to the stereotomic element, nor the tectonic element. The connection is therefore an element by itself. It relates to the concept of becoming an intermediate threshold. An element which subtly connects two systems together.

The connection detail of the extension to the canon ramp in the Fort's courtyard, is influenced by the author's earlier study of Carlo Scarpa's, Museo di Castelvecchio, where Scarpa pulled away the new from the existing. This demonstrates that the new structure acknowledges the importance of the existing structure. The new addition does not touch the existing sand stone walls of the Fort. This indicates the sensitivity of the author to the existing structure and the approach to the Fort being the primary monumental artefact. The importance of the Fort is shown through this detailing and the respect of the author towards the historical importance of the Fort.

The visitor will perceive the prominence of the Fort in the landscape and the designed ensemble of the Fort as he moves through the spaces, becoming aware of detailing as he passes from the existing ramp onto the new steel extension.

The ramp extension is done to rehabilitate the Fort's original canon ramp. A certain part of the ramp remains, therefore the visitor will experience the new and existing, but also the ramp as it originally was.

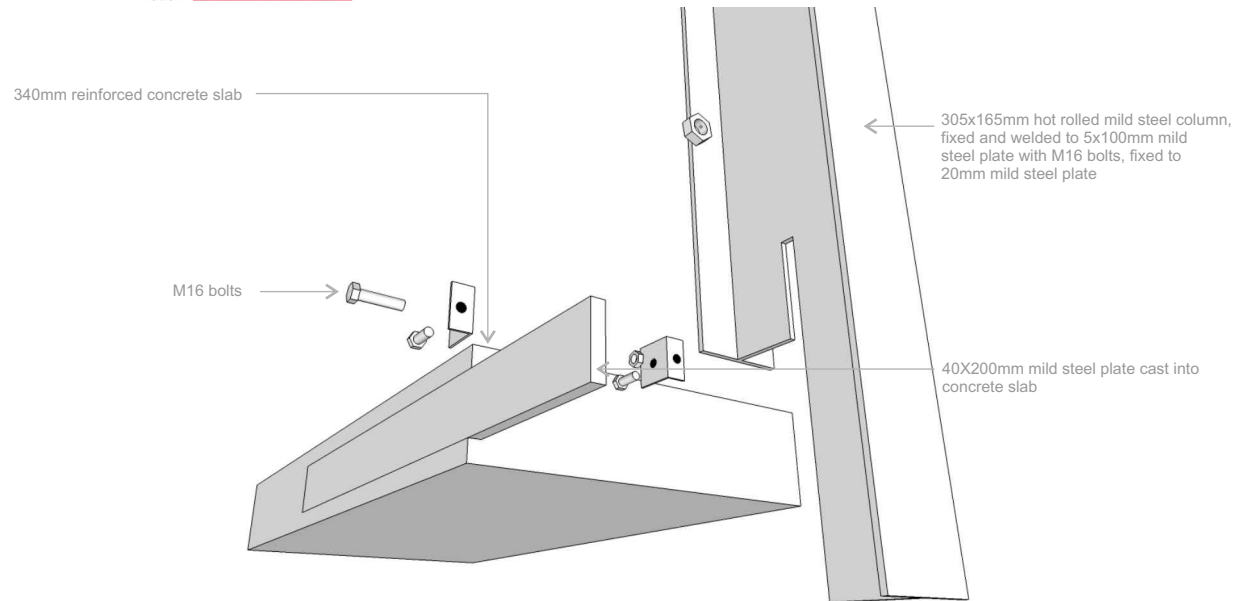


fig. 6.22. Connection detail where tectonic meets stereotomic, the connection becomes the "in between". (2010)

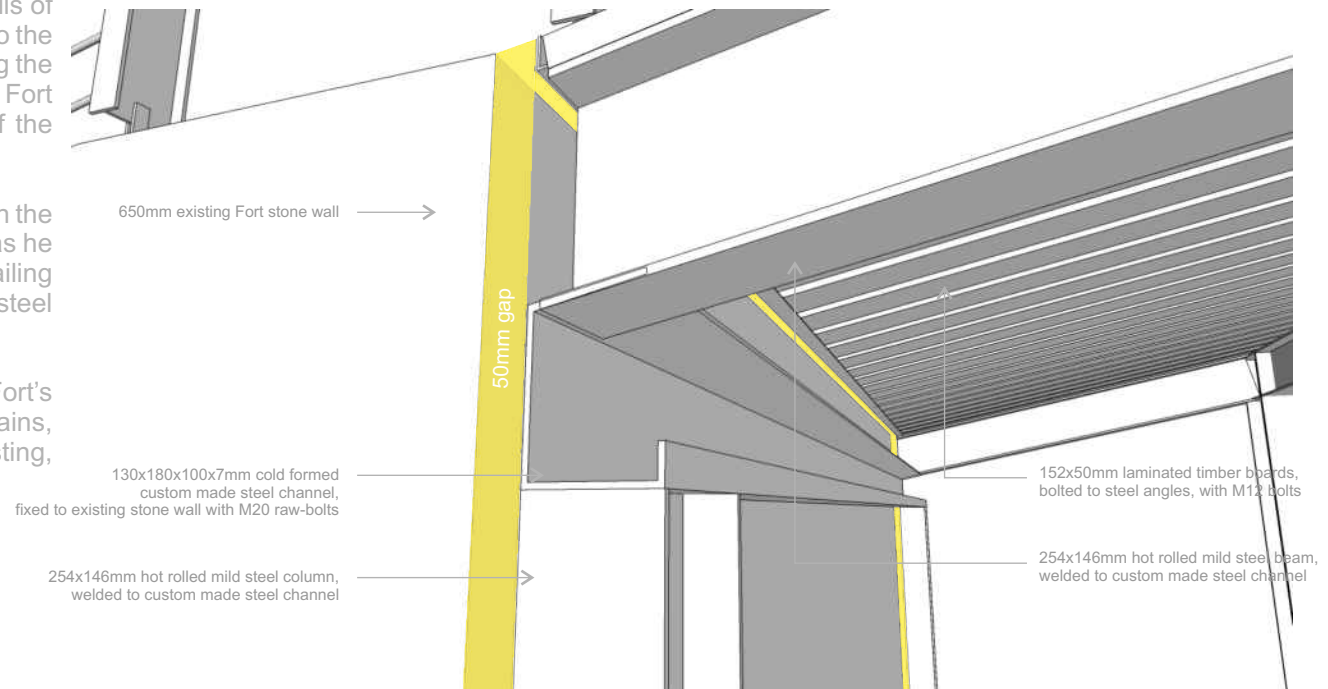


fig. 6.23. Connection detail where new meets existing (Fort). (2010)



## SUSTAINABLE SYSTEMS

The buildings will function as a passive system. The idea is that all the buildings will be lit by filtered sun light during the day, either through windows or through light shafts. At night the building will be artificially lit with energy saving lights. The system will also provide natural ventilation.

In fig 6.15, 6.18 and 6.25 it is illustrated that the buildings will be passively ventilated and natural sunlight will enter the buildings. This means that during the day no active systems will be used except for the kitchen and ablutions.

Cold air will enter from below, through the ventilation pipes and into the building, hot air will then rise and exist at the top. In the case of the visitors centre, cold air will enter through the steel and timber screen and the shop front openings. Hot air will then escape through the window openings at the top. The building is two thirds submerged into the landscape, which will also aid in keeping the building cool in summer.

In the case of the archaeological research centre, the cold air will enter the building through an underground ventilation system. The prevailing winds will be directed into a pipe, which is then filtered into the research lab area and auditorium through a series of vents.

The hot air will then escape through the light shaft protruding the landscape above the lab area. This chimney effect will keep the building cool during summer. The light shaft will also provide natural light to filter into the lab area, creating a sustainable working environment.

During the winter months, the ventilation shaft will be closed and hot air will be trapped in the building to ensure a warm working environment. The light shaft will therefore also serve as a ventilation chimney.

The kitchen and ablutions will be artificially lit and therefore contain a suspended ceiling.

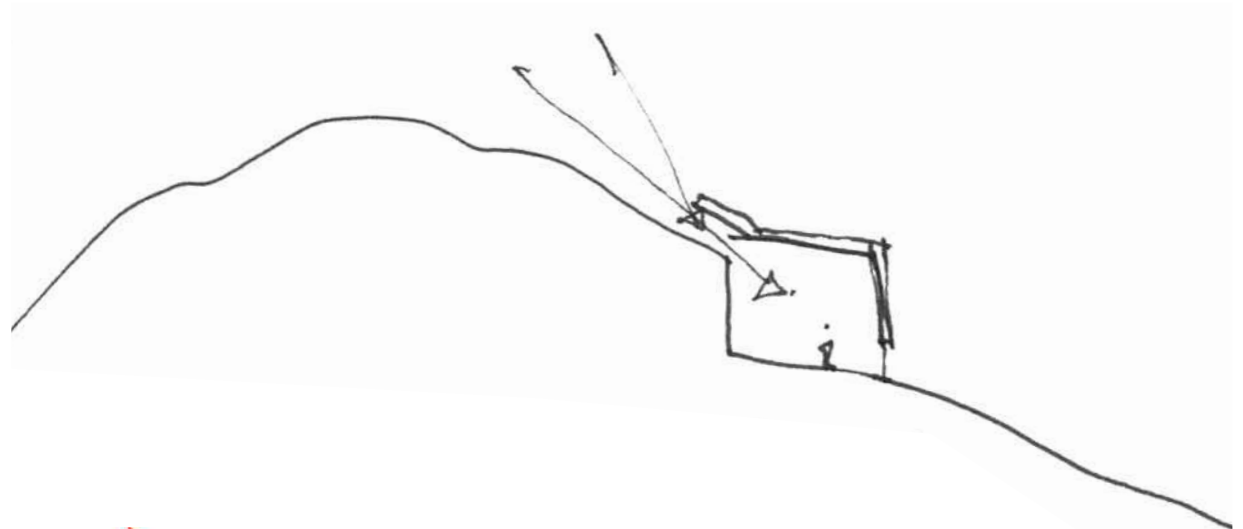


fig. 6.24. Conceptual sketch showing the passive ventilation approach. (2010)



fig. 6.25. Passive ventilation through the Archaeological Research Centre. (2010)

Water collected from the crafts market roof will be used in the local communities' dwellings as grey water to flush toilets and also for irrigation of ornamental and vegetable gardens. This concept also educates the local people about sustainability.

The run-off water from the roofs will be collected in water tanks from where it will then flow into a large underground water storage reservoir. The water will then be reticulated to the various dwellings and used accordingly.

Therefore the local people are connected physically and conceptually to the project and benefit from the project through business opportunities and water preservation.

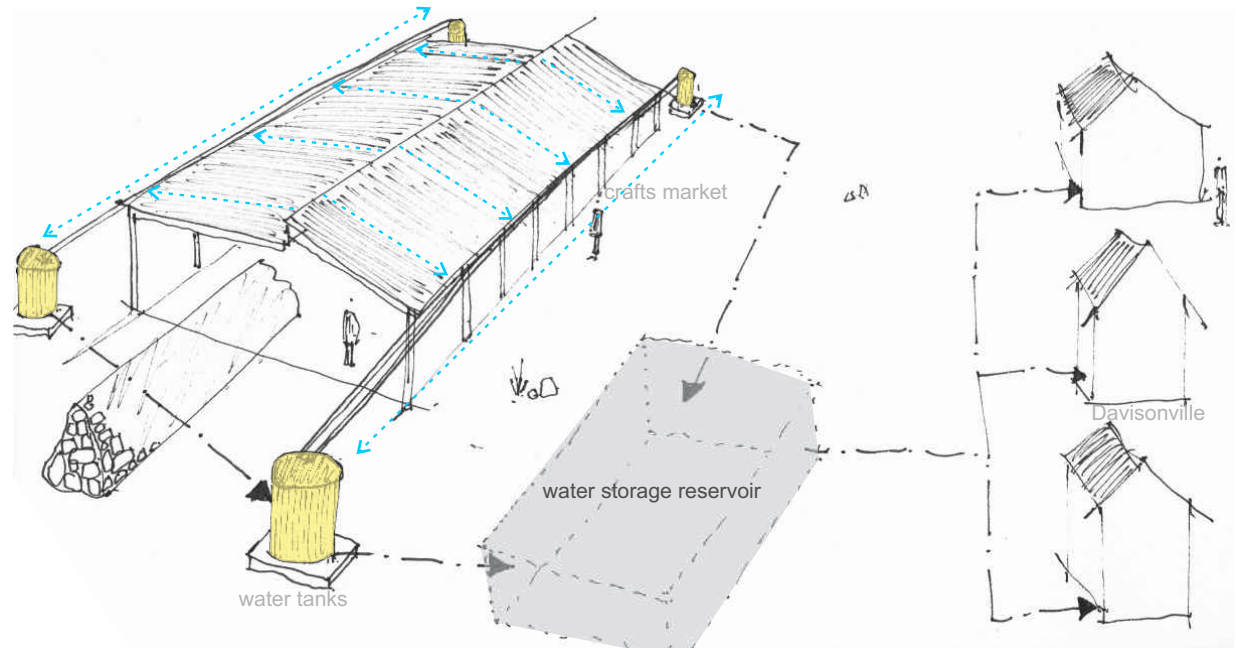


fig. 6.26. Sketch indicating the water collection process. (2010)

## LEED

The LEED (Leadership in Energy and Environmental Design) green building certification program encourages and accelerates global adoption of sustainable green building and development practices through a suite of rating systems that recognize projects that implement strategies for better environmental and health performance (2005:4).

LEED is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high-performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health; sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. LEED focuses on the design of the building and not on its actual energy consumption, and therefore it has suggested that LEED buildings should be tracked to discover whether the potential energy savings from the design are being used in practice (*ibid*).

The author used the LEED rating system to “certify” the design dissertation. The eventual rating is a reflection of the design response to sustainability and environmental sensitivity. The rating achieved is therefore an indication of the author’s intent to keeping materials and systems as sustainable and environmentally friendly as possible.

This approach also indicates the author’s sensitivity towards the environment and built environment, but as importantly, the sensitivity towards the site and the Fort as artefact.

The LEED rating achieved by the project is indicated in Appendix A. The dissertation received a Gold LEED rating. Therefore, this means that the project is of a high sustainable standard.

The author chose the LEED rating system as a guide to certain design decisions throughout the design process. The rating system helped the author to make certain choices regarding materials with low emitting VOC’s and adding bicycle parking.

The rating was achieved by comparing the design and design principles to each credit in the LEED checklist. Each credit is awarded for various sustainable approaches and methods used in the project. The author used each credit to score the design accordingly and fairly to the best of his knowledge.

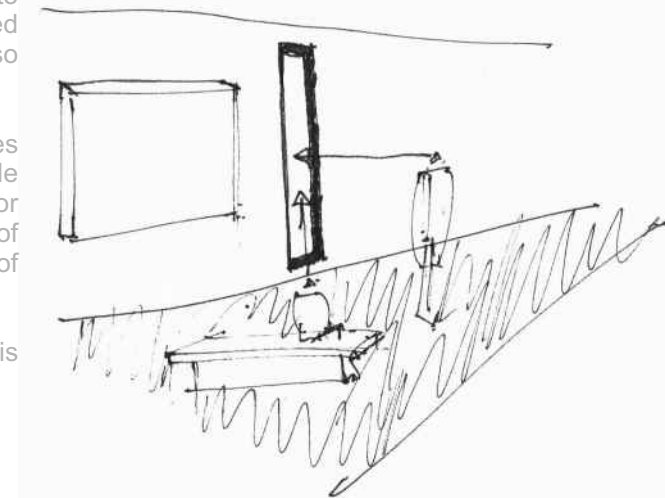
The LEED rating system also rates the building in its construction phases. Therefore, the author made assumptions to what materials he will use. The materials with the lowest emitting VOC’s will be used. The stone that will be used for the dry packed stone walls will be stone collected on site.

This then ensures that a low embodied energy is generated and scores highly on the LEED rating system.

It is therefore concluded that the author used the LEED rating system as a guide in the design process to making sustainable design decisions, but also using it as a tool to assess the design decisions made. The rating achieved is a reflection of design decisions made, but also assumptions made by the author.

In the LEED rating system checklist, credit 8.1 describes the requirements to attain the specific credit; “to provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.”

Therefore it is noted that the author addressed this matter in the project to attain the credit.



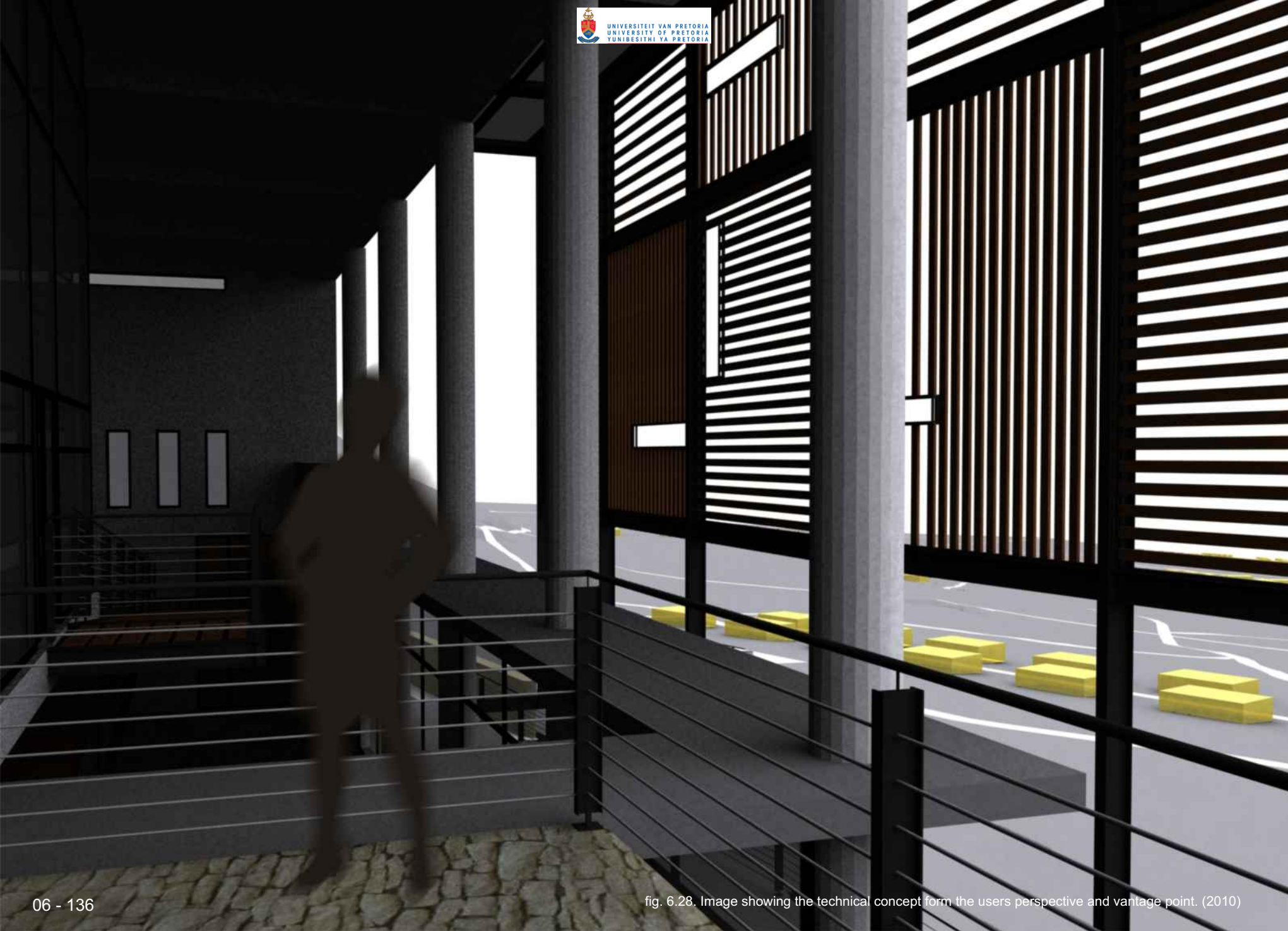




fig. 6.29. Interior view of library area, with the city scape becoming the backdrop view. (2010)