Independent study: A Comparison of Sustainability Projects in Developed vs. Developing Countries
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Summary:

In this paper we will try to analyze what basic difference lies in the thought and approach to sustainability in the developed and developing nations and why is it needed in that particular context. We shall also try to observe paths that are generally trudged by some of the selected green platinum buildings in contrast with the contemporary buildings built in that particular area to achieve the sustainability. We will also try to observe as to what certain reasons can drive the client and the architectural firm to become sustainable in a certain style. In the end, we will also try to compare the platinum LEED rated buildings, and observe what differences were there in their approach.

Introduction:

The humanity from the very beginning has been fascinated with the concept of constructing structures for themselves. Initially, it was the basic requirement for the people. This concept was to provide them a sense of security in this huge, vast and unsecured world. But, with the passage of time the need to build structures was shifted from the basic requirement to the symbols to depict power and then wealth. In today's world, we are in midst of huge glass and concrete jungles oblivious to its impacts on the environment. These building are far from the mere requirements of humanity, but the monuments of certain individuals and ideologies to celebrate their power. A considerable amount of pollution is caused by such thoughtless construction and maintenance of these buildings. Huge amount of resources are utilized after the death of these structure to dispose them. Thus, these building are more like mere parasites which consume the resources during the lifetime and cause more pollution after their deaths. If at this rate we keep on squandering the resources of the planet, the day would not be far, when we would end all the resources and, converting this planet into a big ash heap of chemical, constructional and biological waste. However, there still is a window of recuperating from the environmental impacts caused by the senseless constructional activities by following the sustainable techniques in construction.

Sustainability in construction is not a procedure or a method used in construction but a concept which with innovation and creativity can still make this place a better place to live. This report will discuss and compare the sustainable buildings with the conventional buildings that are generally constructed in the particular area. We will try to establish in what ways the sustainable building overrule the normal building and how two sustainable buildings are different from each other. We will also try to analyze as to how socio-economic and environmental reasons affect the need to be sustainable. We have selected two Indian and American buildings (one sustainable and one contemporary building) from Hyderabad, India and Boston, U.S.A. respectively to analyze them.

India is one of the most fast paced developing countries in the third world. The GDP (Gross Domestic Profit) of India is 9.2% at the end of the second quarter of 2006–2007 and the twelfth largest economy in the world

(1). But, all this is at the cost of having a country that is second most populated in the world, 5th largest emitters of the green house gases and contributing to the 6% of the greenhouse gases (2). Further, the major cause of this pollution to the environment is caused either by construction of buildings or maintenance of these buildings (3). The concept of sustainability has started to take momentum in India and maybe that is why in six years after the introduction of LEED (Leadership in Energy and Environmental Design) standards of Sustainability in Building Construction, India has three and two, LEED Platinum and LEED Gold rated Buildings respectively (4). The concept has started to take more and more momentum due to the need felt by the people, and the realization that the natural resources are depleting and the urgency to act now, before it is too late.

The main methodology followed in this report is by selecting two platinum rated LEED certified buildings from two different counties. These two countries belong to two different economic levels of the globe. One is a developed country with the best of resources, technology and supporting economy (U.S.A), and the latter is a developing country (India) which has a developing economy, limited resources and limited economy but huge amount of man-power. The main reason to select platinum rated building for this study was that the buildings happen to be the best of the buildings and they generally use innovative ways to achieve sustainability within the built environment. Very rarely shall one find some technological, ecological or economic errors in the given system. Firstly, the report shall cover the comparative analysis of an Indian Platinum Rated LEED building with a conventional building and observe in what ways the two buildings differ. The report shall also try to observe how the two buildings respond and reciprocate to a given set of a problem within the area. Further, the report shall observe the after-effects of having a sustainable building on the given plane and the advantages incremented on the site. In the next step, analysis of the two platinum rated LEED buildings shall be done. In this process, the report shall observe how these buildings respond to a given set of problems and further study the unique ways the buildings have achieved the concept of sustainability within the built environment and in respect to the socio-economics of the area. We have assimilated all the information from the credible sources which include the websites and some of the papers written on the buildings. The information regarding the conventional building has been assimilated with the past experiences of the author with the building, as he was involved in the process of construction of the building.

CII Sohrabji Godrej Green Business Centre (CII – Godrej GBC) is one of the three platinum rated buildings in India. It is located in Hyderabad, India. Hyderabad is a small town in one of the southern states of India. It has a tropical climate (cold winters and hot summers) (5). And in comparison to this building we have taken a conventional building from the WIPRO campus, which is nearly of the same size, shape and in the same town.

Site Location and Conservation:

PHOTOGRAPH OF THE CII – Godrej GBC VIEW (Source: www.eeinvestmentforum.org).

This project was conceived in March 2000 with CII, Govt. of Andhara Pradesh, USAID, Pirosha Godrej Foundation and with the support of the Help of USGBC (United States Green Building Council) and Mr. Karan Grover as the architect (6). Although Mr. Grover had no previous experience in handling such project but even after that he took an initiative to venture into the project and be a part of it. The site has an area of 5 acres and the building has a circular foot print spread over an area of 20,000 square feet (1900 square meters) (7). Both the projects were built by two big private companies of India, former by Godrej and latter by the WIPRO. Both the buildings selected the site that had no Brownfield history. These are the common points that both these buildings share. After the acquisition of the site, the CII – Godrej GBC took efforts to include the sedimentation and extensive erosion plans to prevent the erosion of the top and fertile soil during the process of construction (7). However in contrast, no such measure was observed to be taken by the professionals associated with the latter structure. The CII – Godrej GBC site was designed according to the contours of the site. Most of the contours were kept unaltered and stress was laid to preserve the huge boulders available on the site which was economically and environmentally viable. A pond was designed at the lowest end of the site and the slopes of the contours and hard scapes were molded in such a way that maximum part of the rainwater would be directly directed towards the pond. Root Zone treatment plan has been implemented to take care of the run off water and cleansing of the water in the area (4). Most of the hard scape (pathways, Parking area) used the pervious materials so that the rainwater could percolate through the ground and elevate the underground water table of the area. The underground water table in the area was particularly low and with this step implemented, it could really have improved the condition (8). People in this part of the country were dependent on the underground water for their basic needs and were facing severe shortage of water in the summer months. By implementing these methods, CII took a bold step to change the condition by increasing the underground water table. The pond also helped to enhance this process. By having artificial pond by the client, the site was able to generate a microclimate along the periphery of the pond which would help in a small way to maintain and improve the ecosystem of the area. The wind blowing over the pond would be cooled by the water and resulting in cooler surroundings, which could also mean reduction of the heat islands generated on the site. Thus, the site had started to contribute

the ecosystem and efforts were made to lessen the impacts of the built structure on the ecosystem, which was a positive outlook.

On contrary, the WIPRO complex paid no such stress on the site while the designing was in place and no serious steps were taken to elevate the underground water table which is a serious problem in the particular region. The pathways and the walkways surrounding the complex where made of impermeable concrete blocks. These blocks cause storm water run off and loss of the much needed water. It was also observed that most of the area along the structure was hard-scaped giving rise to the heat islands and rising the overall temperature of the site. No stress was laid either to preserve the boulders on the site or to take the sediment and erosion control plans into the thought. The design and the beautification of the building seemed to be on the top of the mind of the architect.

Design Concept and Innovation:

The CII – Godrej GBC was conceived on the principles of the ancient architectural principles of India(7). The building was circular in plan with an open to sky courtyard in the centre, which is very often seen in the historical structures. The central courtyard happens to be the integral part of the design. The courtyard makes it easier for the sunlight to enter deep into the structure. Courtyard also allows the circulation of the air throughout the structure and enhances the indoor environmental quality of the structure and further reduces the load on the air-conditioners. The structure is a single storied building. The atrium has a huge skylight to make it livelier. The architect made it a point to have all the glazing on the northern facade of the building to have the diffused light enter into the structure (7).

PHOTOGRAPH OF THE CENTRAL COURTYARD –CII GODREJ.

(Source: www.architectureweek.com)

PHOTOGRAPH OF SCREENED WALL-CII-GODREJ.

(Source: www.architectureweek.com)

PHOTOGRAPH OF THE PLAN -CII GODREJ.

(Source: www.architectureweek.com)

PHOTOGRAPH OF THE ATRIUM-CII GODREJ.

(Source: www.architectureweek.com)

With having glazing on the northern façade, the architect was able to achieve the maximum energy efficiency. The architect has also placed two forty five feet high wind towers at the two ends of the structure so as to suck the blowing air over it(7). The air that passes through these towers is fourteen F cooler than the normal air and is then sent to the air-handling unit that reduces the load on the air-handling unit. Thereby, the total energy consumption of the AHU is reduced. The structure on the southern and south-eastern side has screened wall. The south eastern side happens to be the side from which the air generally blows. Thus, the air passing through these screened walls happens to be pre-cooled by ten degree Celsius. This is also a very ancient technique used in India and often called as the Ventura Effect. These all techniques seem to be very simple and ancient but are very effective and have resulted in reducing the energy consumption of the building by 35%. The architect also stressed on the need of using techniques that are labor intensive. Labor-intensive techniques are very useful because it generates employment in the surrounding areas and is economical (9). The main reason that could be ascertained for having cheap labor in the country is that the country has population of one billion. The other major problem that can be ascertained is the high level of unemployment. The architect having a detailed experience on the field took the decision of having local construction techniques which could generate employment to the local people and be economical to the client. Some of the examples where the client used local construction is: the cladding of column with broken ceramic tiles, use of fly ash walls, lattice walls, flat slabs, traditional windows and plinth slabs.

On contrary, the WIPRO complex was far from the thought of employing the local labors fully. The building was a combination of concrete, aluminum composite panels and glass for the exterior part and gypsum paneling for the interiors, which meant the use of specialized labors and the higher project cost. The most of the building was enveloped in the glass of resflactosol of Saint Gobain which had a U- value of 5.73 W/m2 .k. But the worst part was inclusion of the glass on the southern façade of the building. This would mean that the facade would heat considerably and have huge heat intake when the temperature reaches one

hundred and ten degrees during the peak time of summers. This further would mean that the load on the air-conditioners would increase considerably as the building is centrally air-conditioned with all the glasses as fixed glasses. There is a small courtyard in the centre of the building but it is of hardy any use. Firstly the courtyard is hardly ten feet in diameter which is very small to act as a courtyard in a two storied structure. Secondly, it is covered with a polycarbonate sheet, which means that the amount of natural light will be considerably reduced. And the sheet will not allow the air to pass through the interior skin of the structure. The polycarbonate sheet fixed on the top of the atrium is more of a failure than any positive step because the total height of the atrium is just 10 meters. With the due course of time the atrium would be heated especially in the summers meaning more load on the cooling systems and resulting in the more consumption of the energy. There is no provision of plumbing and the garden in the center can not be watered directly with sprinklers, which again is a big fault.

PHOTOGRAPH OF THE CENTRAL WIND TOWER.

-CII GODREJ.

(Source: www.architectureweek.com)

PHOTOGRAPH OF THE SECTION THROUGH COURT.

-CII GODREJ.

(Source: www.architectureweek.com)

Water Efficiency:

Water happens to cover 70% of the planet, but even after having such an abundant natural resource there are certain areas that face scarcity of water most of the time. The main reason that can be ascertained to the scarcity of this resource can be the unequal distribution of resources along with the reckless and inefficient use of such a precious resource. Hyderabad also faces scarcity of water and most of the people are dependent on the underground water system for their basic needs (8). It is also estimated by researchers that if the approach to problem is not addressed soon, then in next 20 years India could face

very severe problems in the case of portable drinking water (12). It is generally observed that toilets are main areas that consume the most part of the water utilized in a building. So the water fixtures employed in the CII – Godrej GBC structure was of low water use. The urinals had waterless fixtures and the toilets had dual flush systems to conserve the water (10). The concept of waterless urinals and toilets has yet to be broadly accepted by the society and so not much stress was laid on it. Fifty five percent of the terrace of the structure had arid landscape to use less water for maintenance of the rooftop gardens and to prevent the storm water run off. The roof top gardens also provided the thermal insulation to the structure and reduced the heating of the roofs. The grey water that was produced from the structure was fully reused for the purpose of watering the gardens. Further to water the landscape, drip water technique with the sensors were used so as to use the water in a very calculated way as the area faces a severe scarcity of water especially in the summer months. In the parking area also pervious concrete blocks also prevented the storm water runoff. Thus by employing these methods the building was able to conserve 36% of water in comparison to the conventional buildings.

However, the WIPRO building had conventional toilet fixtures which meant that urinals wasted lot of water. Every time the user used a flush for any purpose it would meant that he would use one to three gallons of water to flush which could not have been required and one could have conserved it. The client had built a sewage treatment plant in the complex to reuse the grey waste water generated in the complex, which was a very complex and very expensive way to optimize the efficiency. The roof of the structure was covered with a concrete two way slab and waterproofing which would mean that all the rain water would be lost as runoff. Although, the process of waterproofing used local labors but at the cost of water which is a rarity in this area. Further there was no water harvesting chambers in the periphery of the structure to conserve the water. Thus this building behaved more or less in a very conventional way in terms of the water efficiency.

Energy efficiency:

Energy is one of the biggest problems in India. There is always a difference between the consumption and production of energy, and this lag increases considerably during the summer period. The main reason for this fluctuation is because most of the energy plants are either hydro based or coal based power plants in India because of the abundance of these resources(11). But during the summer months when the water level reduces considerably, the energy output is also reduced accordingly. Further to add to the woes, the usage of the air-conditioners, fans and other cooling devices by the general mass also increases. Hence, there is sudden lag between the production and the consumption of the energy. Sometimes the severity of this lag is such that the people have to face regular power-cuts from three to six hours regularly, even in the metropolitan area, and so is true with the area where both the sites are located. Stress is laid on this potential issue and efforts had to be taken so that the energy consumption by the building was reduced to a certain extent and it fulfilled some of its needs independently. Thus, becoming self-reliant in the production of the energy to a certain extent seemed to be a viable outcome. To solve this problem of becoming self-

reliant in the production of the energy to a certain extent, the client of CII – Godrej GBC placed photo volcanic cells on the rooftops(10).

PHOTOGRAPH OF THE P V CELLS ON THE ROOFS -CII GODREJ. (Source: www.architectureweek.com)

These cells had the capacity of 23.5 KW and could fulfill twenty percent of the energy requirements of the building (10). It is also observed that the thermal transfer generally occurs through the windows, walls and roofs. So in order to prevent the heat transfer and reduce the energy consumption in summers, architect used the double-glazing glasses with thermal properties for the windows. For the walls, the architect used the combination of fly ash based bricks, aerated concrete blocks and ceramic tiles. Further for the roofs, the architect used roof with U-value of 0.052 and insulation with R-value of R-15. In addition to this, the air-conditioners were according to the standards placed by the ASHRAE 90.1-2001. Further the energy consumption was reduced by using roof top gardens which further reduced the thermal transfer. Hence by putting all these concepts together the building ended up utilizing 88% less energy than the conventional buildings, which was a remarkable achievement in itself (4). Thus this was a potential step towards the self-reliance in the field of energy consumption.

In contrast to that, WIPRO Complex has exposed roofing with no green roofs on the top. This meant that a huge amount of thermal transfer during the summer months and consumption of more energy. In addition to this the building had a glass façade on the southern side too, which happened to be the most heated part in the summers. Hence resulting in more heat transfer. On contrary the building has slab height of twelve feet, which is good, if the building is not air-conditioned centrally, because it would take more time to heat such huge areas. But since the whole building was centrally air-conditioned, it would mean a huge amount of energy loss to cool huge spaces. In addition to this, the glass façade enveloping the building was fixed and could not be opened if the users ever wanted at some point of time, which enhanced the dependency on the air-conditioners. However one good point that the professionals associated with this building followed was that there air-conditioning system observed the standards placed by the ASHRAE 90.1-2001. This was one positive step, which they took and is generally not observed in conventional buildings these days.

Material & Resources:

PHOTOGRAPH OF THE COLUMNS CLADDED -CII GODREJ (Source: www.architectureweek.com)

But selection of appropriate material for any construction activity becomes the key element for determining the success or failure for any structure apart from the design. The need for selecting suitable and sustainable materials arises further if there is dearth for the constant supply of the materials for the construction activity. The same case stands true for India. In India, concrete, steel and wood are major components of any building system. They seem to be economical and the most conventional ones, and their supply is very fluctuating. But what people have failed to understand is that these materials not only disturb the ecosystem in various ways (air pollution, soil and water contamination) during their production and their entire life cycle but also at the end of life cycle. Right now not many towns in India have the processes to recycle the concrete fully and so these materials end up into vacant plots, which are not even official dumping grounds, causing unhygienic conditions and ugly scars on the cityscape. So it is high time that we start moving towards the sustainable materials, which not only are cheap but also are biodegradable and recyclable. Thus, eliminating the pollution to a certain degree. Another point that is a serious concern is that the points validated by LEED for using resources within the five hundred miles do not hold valid at least in terms of India. The area of five hundred miles is a big distance and should be altered as it can mean having transported resources from far-flung resources instead of the ones available in the neighboring areas, which again can void the positive points of using such sustainable materials. Even the use of scaffoldings of bamboo should be encouraged instead of steel because they are biodegradable in comparison to the steel. Same is true for shuttering where plywood based scaffolding seems to be better than the steel based. Although some might feel that steel produces better finish than the plywood but at the same time also observe that the finish they are achieving is at what cost. The CII – Godrej GBC used fly ash as a main element for building walls. Fly ash is a main output from the thermal power plants and abundantly found in India and near our site too(11). It is also a good insulator. In addition to this all the furniture was made out of the composed wood. Similarly, the architect stressed on the need of the using readily available stones like Bettum Cherta, which is readily available. Broken glass, broken ceramic tiles, cellulose fiber, quarry dust, recycled paper, which appears to be as a waste, were very

efficient materials, generated employment to the local labor and in doing so were aesthetically used. The use of all these materials needed no specialized labor and did more good to the environment than the harm. Thus also proving that for being sustainable does not mean the use of specialized materials, but instead it can be achieved by simplicity. Thereby, proving that solution to all complex problems lies in simplicity to approach.

In the WIPRO, the materials used were mostly concrete, aluminum composite panels and glass for the exterior façade and gypsum paneling along with the glass in the interior. Most of these materials required specialized labors although all the materials came from the 500mile radius and were recyclable. The material used for formwork was plywood, which happens to be biodegradable and commonly used. Further the structure had concrete one-way slabs with isolated foundations, which happens similar to the conventional building. For the purpose flooring marbo-granite was used, which happens to be commonly used material but is very rapidly depleting from the face of earth. The major disadvantage of this material is that it requires major quarrying of mountains and disturbing the natural ecosystem extensively.

Indoor Environment Quality:

PHOTOGRAPH OF THE ATRIUM WITH SKYLIGHT -CII GODREJ (Source: www.architectureweek.com)

Indoor environment is very important for a building because it can reasonably affect the behavior of the individuals using the building. It has been observed in platinum rated LEED buildings the work output of the individual increases by nearly 20% and the amount of leaves are also reduced (10). It also instigates the people to come to office and work more. The concept of enhanced indoor environmental quality is starting to emerge in India with the opening of the economic market in India. Companies have good indoor environment not only to make people efficient but also to lure customers and to show the power of their ideologies. In CII – Godrej GBC the client has used many ways to enhance the indoor environment quality of the building. There are carbon-di-oxide sensors throughout the building to ascertain the value of it in the built environment (10). Most of the building is cross-ventilated with the help of adjustable windows. The building has ambient natural light and most of the people in the building are able to have the exterior serene

view. Further there are daylight-controlled dimmers. With all these measures put into effect it is estimated that 75% of the people have become more effective (7).

In the conventional building too most of the people are able to have natural light. It is because most of the building is enveloped with a glass on most of the periphery. But the major disadvantage is that all these glasses are fixed and so natural air cannot enter the interior skin of the structure when desired. So the atmosphere inside the building is more or less artificial. There are no carbon-di-oxide monitors inside the structure to measure the content of carbon-di-oxide inside the building. But, because of the glazed façade the indoor environmental quality is considerably better than other conventional buildings in the same area.

Waste Management:

It is one of those concepts that are very nascent and people are trying to develop it with the help of non-profit organizations. With the growing awareness among the masses about the benefits for the waste management people are beginning to implement it. Although here in India the common meaning of waste management is to take whatever we can reuse from the construction waste which is very marginal as there are very few concrete recycling units and then dump it in the most convenient place available. Although this story, which commonly prevailed ten years back has started to change now. The change in the attitude of the professionals with the construction industry could be seen easily in CII – Godrej GBC. The site officials made it a point that 96% of waste generated was recycled (4). This is really a positive step to grow this nascent concept and prevent the cities from becoming a dumping ground.

Thus after comparing the conventional building with the sustainable building we have observed how and in what ways a sustainable building can be environmentally efficient. It is also understood that to be efficient one does not need look out for expensive or complex solutions but can be obtained locally with simpler solutions. So someone has rightly said," *Think globally and act locally*". Further we also observed as to what particular reasons can drive a building to be sustainable and how sustainable buildings tend to reciprocate to a given set of situations.

Now we will further try to analyze as to how two platinum rated LEED buildings from two different parts of the globe tend to achieve their goals. We will also try to analyze and compare as to what socio-economic reasons makes them act differently. By this we will be able to understand as to how many these factors play a role for these buildings to achieve their desired results.

The two buildings that we have selected for this analysis are CII – Godrej GBC, Hyderabad, India and Genzyme headquarters at Boston, U.S.A. Private entrepreneurs built both of these buildings and both the architects have derived innovative techniques in their own ways to be sustainable. The climate of Boston is much severe than of Hyderabad.

Site Location and Conservation:

PHOTOGRAPH OF THE SITE BEFORE THE BUILDING WAS ERECTED FOR GENZYME (SOURCE:www.benischbenisch.com)

The project was conceived in June 2001. This was a very complex project and it involved three different architectural firms at various levels and at various scopes. Actually, the Lyme property builder and the Genzyme corporation had a before hand understanding that 95% of the building would be used by Genzyme for its own personal use (14,16). So the building was designed in accordance with the needs of Genzyme. The main architectural firm was chosen through an architectural competition and Benisch and Benisch associates were awarded the project because of very innovative concept and different approach to the design problem. They had proposed the concept of openness and bringing out the work culture of the organization to the world. Further, since the corporation wanted the building to be sustainable, the previous experience of Benisch and Benisch architectural firm came handy as they had a previous experience in handling such projects (15). The architectural firm had an experience of doing many sustainable projects back in Europe and had the due experience. The site chosen for construction was in the downtown of Boston and was a Brownfield (14, 13). The site had the history of having a coal gasification plant on it. So the site was cleared and treated properly according to the specification before the use. The use of such a site gave them LEED credits. On contrary the site used by CII – Godrej GBC was a non-contaminated site and not in the sub-urban area but in a bit outskirts area. The major difference that one could ascertain for the particular site selection can be seen by the thought that the Genzyme management might have wanted to locate the building in the sub-urban area. The placement of this particular structure at this very site had its own advantages and disadvantages. Couple of main advantages that one could observe here was that the corporation could get points to develop the Brownfield, further they were able to acquire a prime location in the town and in addition to all it highlighted their contribution to the sustainable development of the town. The main disadvantage of using this site was that they had a site constrain as the site had structures surrounding it, so corporation was bound to fit all their requirements in the single plot with the concept of sustainability and innovation. Whereas the CII – Godrej GBC was dependent on the state government for

the site as the state government allocated the site. Another main reason for them to go into outskirts was that the town was developing outwardly as the core was fully developed and there was hardly any such large space for the development to occur at the core of the city. Also there was a substantial difference between the plot usage and plot size of the two centers. The built up area for the Genzyme and CII – Godrej GBC was approximately 322,200 square feet and 20,000 square feet respectively (14). The former structure was a 13-floored structure and the latter was a ground-storied building. Thus there was a considerable difference in their sizes. On one hand the Genzyme authorities took proper remedial measures to decontaminate the site whereas on the other hand the CII – Godrej GBC took sedimentation and erosion control techniques to make sure that the site doesn't loose much of the fertility. They also conserved much of the boulders on the site. There was also a difference in the landscaping patterns that we might observe. Here in the Genzyme, the landscape development was not only along the horizontal axis but also in the vertical axis, whereas in the CII – Godrej GBC the development of landscape development was just in the horizontal axis. The main reason that can be pertained to this particular development of the pattern of landscape is that the footprint of the Genzyme structure in ratio to the plot size was bigger than the one of CII – Godrej GBC. CII – Godrej GBC had lot of scope to develop the plot because of an enormous plot size whereas the Genzyme authorities faced the constraints of the plot size and they had to fit all their requirements in the given set of the plot. Thus we were able to see how the policies of a company along with the availability of a land along with the requirements can drive two different companies in two different directions to achieve a common objective.

Design Concept and Innovation:

The main concept revolved along the principles of sustainability, but at the same time the architect tried to bring out the working style of the Genzyme out to the world. In order to achieve the desired results, the architect tried to introduce transparency between the organization and the common masses and further within the organization through the use of the glass as one of the main materials (15). In addition to this the architect created a huge atrium with a massive skylight at the top through which the light filtered into the structure. The atrium was thirteen floors high which created an impressive scale within the built structural environment (13). Further, there were exhausts at the top near the sky-light to siphon out the heated air. In addition to the above mentioned points, in the atrium the architect placed movable Heliostats on the roof which moved as per the sun path. The major purpose of this technique was to enhance the quality of the light within the atrium. These heliostats would reflect the light into the atrium. To further enhance the depth of the sun-light into the structure, the architect suspended 786 prisms in the atrium at various levels which would reflect the light into the whole structure. The walls opposite to the atrium were also made of the reflective materials which would enhance the quantity of light (13, 16). Hence during the days the whole corporation would be well lit with the help of all these measures and the use of artificial light was nearly eliminated. The client also placed the automated blinds along the outer façade of the structure so that the blinds would close itself in the night. The main benefit of using this technique was that the light produced

from inside the building did not disturb the nocturnal wildlife surrounding the structure (14). In addition to this, there is also a fountain at the first floor of the building (13). The main purpose along with enhancing the indoor quality of the building was to enhance humidity in the closed environment in the winters as it gets very dry during the winters. Also there are thirteen terrace gardens throughout the structure which offer insulation to the structure and reduce the green house effect (16). Further they enhance the indoor environmental quality within the built environment. On the other hand the CII – Godrej GBC was based on the ancient concepts of architecture which has been explained well in detail above. But there is certainly a reason for the different approach in concepts the architects have taken. The first and prime-most reason is the Labor. In India the cost of employing a labor is very cheap in comparison to here. So, the architect could afford to use labor-intensive techniques in comparison to the Genzyme, which were more of mechanical and specialized labor oriented. Secondly, the technology in the building construction is much advanced than the one used in India. Thirdly, India still has live examples of ancient historical monuments which date thousands of years back which have been built on the concept of sustainability and people still learn from it and apply it which has been seen in the CII – Godrej GBC. Hence some of the above mentioned reasons might have affected in the origination of the concept to a certain degree.

Water Efficiency:

In Genzyme, the water efficiency was enhanced by the use of dual flush toilets along with the use of waterless toilets and the use of low water used fixtures. These steps reduced the consumption of water to a certain extent. Further, nearly 50% of the roofs of the buildings had the terrace gardens (13, 14). These gardens prevented the storm water run-off of the rain waters. Further the gardens were generally arid which meant that less water had to be used for their maintenance. In addition to all above, wherever watering of the landscape was required, water sensors were used so that excessive water was not used and it further prevented the wastage of water. The architects also decide to place parking in the basement as it would prevent the storm water runoff and prevent the water from being wasted. But just because of saving the storm water from being wasted could not have been the driving factor for placing the parking in the basement. There seemed to be some other design criteria's along with the requirements of the client which could have made them take such a decision. With the implementation of all these techniques the architect was able to conserve about 32% of water requirements of the buildings in comparison to the conventional buildings surrounding it (14).

We have already discussed above as to how the CII – Godrej GBC conserved the water. In both the cases, the two buildings had used nearly the similar techniques on the conservation of the rain water system, but the main purpose of both the organizations was to conserve water. It should also be noted that it might not have been the LEED as just the driving force for them to conserve water but it must have been the situations both the buildings were facing. Both the buildings were facing very serious problems in the

underground water table. Both the areas were running low on the water aquifers and with these methods they were trying to reciprocate to the situation (8.17). It is high time that we start keeping a tab on the amount of water used so that we might be able to know as to how much water we are using and conserving too. If we do not act now to improve the condition, the day is not far when countries could go for war on water as they are doing now for oil.

Energy efficiency:

PHOTOGRAPH OF THE ATRIUM FOR GENZYME (SOURCE:www.benischbenisch.com)

In Genzyme, nearly 50% of the roof of the buildings had the terrace gardens (16). These terrace gardens gave insulation to the building and reduced the requirement of the air-conditioners. By having these terrace gardens the building was able to conserve nearly about 36% of the buildings electricity requirements (13). The air-conditioning units would shut off automatically if the windows were opened. The windows on the outer façade were operable so that the employees could open the windows when the climate was pleasant outside and the load on the air-conditioners would be reduced (14). The company policies stressed on the mass transportation of its employees as it gives its employees free passes of common transportation means available, thereby contributing to the ecosystem by reducing the consumption of petroleum and of pollution. Further the corporation decided to purchase electricity from constellation. Constellation is an energy producing company that provides electricity from the sustainable materials (18). Thus the policies of the company were also aimed towards enhancing sustainability into the lives of its employees; just the same way they had done for the building. Further, Photo sensors and occupancy sensors were employed to

save the electrical consumption. The electricity produced from the photo volcanic sensors was used to lighten up the fire escape routes. The photo volcanic cells were spread over an area of 1650 square feet with an output of 20 KW. The energy requirement was further reduced by ambient natural daylight which reduced the artificial lighting requirements of the building to the minimalist requirement. In addition to this the consultants designed the air-conditioning system in such a way that they could use the steam from the neighboring plant for heating and cooling of the building which reduced the consumption of the electricity considerably.

On the other hand we have observed above as to how the CII – Godrej GBC was able to conserve the energy. They also had used nearly the same techniques except the use of steam from neighboring plant which was a creative use of skills and resources by the consultants of Genzyme. Further the CII – Godrej GBC purchased energy from the state government. The companies in India do not have the freedom to buy energy from any company they want, because the government has not privatized the energy sector and its still in the hands of the government. Therefore, the companies are bound to buy the electricity from the government irrespective of the way the electricity is produced if they want to. The Genzyme initiated policies that gave incentives to employees who practiced mass transportation whereas the CII – Godrej GBC failed to come with such sound plan or policy. The major reason that can be ascertained to the difference in the policies could be the economical disparity between the two companies where the former company is very economically stable than the latter. However smaller initiatives could surely have made a difference, but by how much, it would have been an interesting question to be observed.

Material & Resources:

In Genzyme, the main breakthrough the building achieved was through the use of Filigree Slab. This was a pre-cast slab and with the use of this slab the client was able to save nearly 2552 cubic yards cement, 250,000 square feet of plywood for shuttering along with 386 tones of reinforcing steel (14). Thus with this feat on the part of the civil engineering team, the building was able to reduce 25% of its load and hence resulting in the lighter foundations (14). Further the building was able to have constant temperature with the use of this type of slab. In addition to the slab, the client decided to use all wood products that were FSC certified and made with recycled contents. Glass was enveloped along the building to have the transparency and was recyclable. 40% of the building had a double facade to maintain thermal tapping. IRMA spread over 50% of the roof to maintain thermal transfer. 46% of the building façade had the single façade(13). The loggia in the double glazed faced was able to provide the thermal benefits. It provided a tampered space by using solar radiation and the ventilation flaps and absorbed or reflected the daylights as per their own needs. 75% of the material used could be recycled, aluminum tiles and drywalls. The steel rebar's used had 100% post consumer waste recycled content. Further steel railing with fabrication had 70% recycled content and gypsum panels had 70-80% recycled content. 50% of the materials used came

from the local resources. Further the paints, carpets and flooring had no-VOC content. Water based polyurethane finish was applied on the wood floor and Milliken carpet tiles in the area of high traffic.

This is one area where we see lot of differences in the techniques and materials that were used to attain the desired goals. CII – Godrej GBC stressed more on the use of concrete, fly-ash bricks and ceramic tiles in contrast to the glass used in Genzyme. The main reason that can be ascertained to the use of concrete and such materials in the CII – Godrej GBC is the availability of cheap labor and further, the installation of concrete proves to be economical in comparison to the installation of the glass. Even the pre-cast concrete has not been used in CII – Godrej GBC because this particular phenomenon is very nascent in India and it gets expensive to use such techniques. The architect has used carpets inside the structure but it is not clear for the real reason of having the carpet except for the LEED points. The main reason for this doubt is because the concept of having a carpet inside the built environment in India is very new and has very rarely been used because there is lot of dusty environment and generally carpets hardly withstand the rough use in the Indian context. So the real reason still is yet to be deciphered.

Indoor Environment Quality:

In Genzyme, the indoor environmental quality is enhanced by the air monitoring devices. Further to enhance the environment there is ambient light which enhances the work environment. In addition to this all the heights of the furniture were adjustable and so it became user friendly. 75% of the total employees were able to receive 2% of the daily sunlight(13). Sensors were placed in most of the corners so that if the rooms became too stuffy the air-conditioners would automatically switch on in that particular area to remove that effect. With all these techniques implemented, nearly 58% of the people working believed that they were more productive, meaning more profit for the company and less leaves by the employees. Thus this process had now started to be give and take where the company starts to be sustainable and in return the efficiency of the people is enhanced considerably along with the profit.

The methods that were used to achieve the indoor environmental quality are the same between the Genzyme & the CII – Godrej GBC. In India, most of the structures lack the indoor environment quality and this is a totally new concept.

Waste Management:

It is an important aspect to see as to how much the building is generating the waste and as to how much the waste has been recycled. Recycling is a common practice unlike in India. The Genzyme authorities were able to reuse 93% of waste by weight which is an impressive figure. The main reason of this enormous figure could be that the client recycled most of the heavier materials which summed up to the 93% (13).

Conclusion:

Sustainability in construction is neither a procedure nor a method used in construction, but a concept which with innovation and creativity can do wonders. This is what we have observed here in the report where two architectural firms from two different ends of the globe facing totally different socio-economic problems were successfully able to achieve sustainability within their buildings. Further, we also observed as to how these varying socio-economic conditions could lead to the change in the concept and the methodologies used to achieve the idea of sustainability. However the standards of measuring sustainability in a building surely came into question because different areas faced different problems and the points should have been allocated according to the seriousness of the issues that were addressed, whereas in actuality the points that were distributed were on a same scale irrespective of the location or the technique used.

CONTEXT.	GENZYME CENTER.	CII SOHRABJI GODREJ GREEN BUILDING CENTER.
Location	▪ Boston - U.S.A	▪ Hyderabad - India.
Leeds category	▪ Platinum.	▪ Platinum.
Leeds points	▪ 52 points. (Maximum :69)	▪ 56 points. (Maximum :69)
Project Conceived	▪ Lyme Properties & Genzyme.	▪ CII, Govt. of Andhra Pradesh, USAID, Pirosha Godrej Foundation
Architect	▪ Benisch Benisch & partners. ▪ Local architects-Next phase studio ▪ The house & Robertson architects.	▪ Architect Karan Grover.
Previous experience of architect for sustainable projects.	Yes.	▪ No.
Contractors	▪ Turner Contractors of Boston, MA	▪ N.A
Type of Project	▪ Invitation Competition with previous experience was added benefit.	▪ The architect gave his services for the particular cause.
Site location.	▪ Urban setting	▪ Bit off the urban setting.
Built up area.	▪ 32,000 square meters.	▪ 20,000 sq ft. spread over the plot area of 5 Acres.
Starting & Commencing Dates.	▪ The project began in June 2001 and commenced on November 2003.	▪ The project began on March 2000 and Commenced on July 2004.
Budget	▪ Total cost of the project: 140 million dollars. ▪ Cost for Construction: 107 million dollars. ▪ Cost for Sustainable Techniques: 107 million dollars.	▪ N.A
Climate.	▪ Harsh Winters & Hot summers.	▪ Cold winters and hot summer.
Concept of the design.	▪ Sustainability along with the reflection of working style of the organization.	▪ The main concept was based on efficiency of natural resources and use ancient Historical techniques.
Site location.	▪ Urban context.	New site on the fringes of the city.
Site History	▪ Brownfield Site. (coal gasification plant)	▪ A vacant new plot.
Access to mass Transportation.	▪ Close to the substation which propagated the mass transportation	▪ Close to the railway and main road lines
Site Conservation.	▪ Decontamination of the whole site done as per the specification.	▪ Extensive erosion & sedimentation plans incorporated.

Innovation & Design.	▪ U-shaped blinds used. ▪ 768 glass prism in the atrium. ▪ Movable heliostats. ▪ Operable windows. ▪ 18 terrace gardens. ▪ Huge 13 floored atrium. ▪ Exhaust fans at the skylight. ▪ Reflective ceiling panels. ▪ Walls of polished aluminum strips. Computer controlled perforated blinds aligned according to the sun path. ▪ The blinds close at night to prevent the light pollution in the neighborhood. ▪ Water feature on the first floor. ▪ Steam from the neighboring plant was used for the heating and cooling of the structure.	▪ Maximum glazing placed on the northern side. ▪ Operable windows were used. ▪ Two 45' tall wind towers constructed to suck the blowing winds. ▪ Courtyards were built to act as a light well. ▪ Screened walls were constructed ▪ The whole building was declared as no smoking zone. ▪ Pond was built on the lowest end of the site and remaining storm water was directed to it.
Water Efficiency.	▪ 32% usage of less water. ▪ 50% of the building roof had gardens. ▪ Low water used fixtures, waterless urinals and dual flush toilets were used. ▪ Drip water irrigation used. ▪ Water sensors used. ▪ Arid landscape used. ▪ Parking was done in the basement which avoided the rainwater runoff.	▪ The building used 36% less water. ▪ Root zone enhancement used. ▪ 55% of the building roof had gardens. ▪ 100% recycling of the grey water. ▪ High efficiency drip irrigation. ▪ Low water fixtures and waterless flush ▪ were used to conserve water
Energy efficiency.	▪ 50% of the building roof had gardens -36% reduction in the electricity consumption. ▪ Air conditioners in the building used the fan coils. ▪ Minimum ventilation to each space but can be increased. ▪ The company policies stress towards the mass transportation.	▪ 55% of the building roof had gardens. ▪ 88% reduction in the lighting consumption. ▪ Double glazing glass with the thermal properties used. ▪ 20% of the building requirements were met by the photo volcanic cell having a capacity of 23.5 KW. ▪ Air conditioning systems used as per ASHRAE 90.1-2001
Material and Resources.	▪ Use of glass on the outer façade. ▪ 75% of the recyclable material used. ▪ Low VOC or VOC free materials used in paints, adhesive, carpets. ▪ 50% of the materials came from the local sources. ▪ Filigree wide slab used for the construction. ▪ Weight of the structure was reduced by 25%. ▪ All wood products used were FSC certified. ▪ Double glass curtain wall used.	▪ Pervious blocks used in parking area. ▪ 80% of the materials used were recycled. ▪ Furniture was made out of composite wood. ▪ U value of roof 0.052 with the use of R-15 insulation. ▪ U value of walls is 0.1 Btu/hr FT2 F ▪ Use of LPD, CFL & high efficiency blaster. ▪ Use of autoclave aerated concrete blocks. ▪ Use of daylight dimmer controls. ▪ Use of energy efficient cooling towers.

	▪ 40% of the building had a double façade. ▪ IRMA spread over 50% of the roof. ▪ Photo sensors and occupancy sensors. ▪ Electricity is purchased from the constellation group. ▪ 1650 sq ft. of area is covered with the photo volcanic cells. ▪ Water based polyurethane finish applied and Milliken carpet tiles in the area of high traffic. ▪ 46% of the building has a single facade.	▪ Fly ash based aero-con blocks used. ▪ Local Bettum Cherta Stone used. ▪ 66% of the materials used were in the radius of 50 miles. ▪ 95% of the material was harvested.
Indoor Environmental qualities	▪ Sophisticated air monitoring system. ▪ 58% people believe that it resulted in more production. ▪ 75% employees have exterior view. ▪ All furniture's are adjustable according to the height. ▪ 75% of the workers get 2% of the daily sunlight.	▪ Carbon-di-oxide sensors used throughout the buildings. ▪ Good natural ventilation, open serene exterior view, circulation. ▪ 75% people believe that they are more productive.
Waste Management	▪ 93% of the waste by weight was reused.	▪ Recycling of 96% of the construction waste. ▪ 96% of the material used was extracted.

Appendix:

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