Monthly E-Magazine January 2016 Edition

ABES

Estd. 2000

Department of Civil Engineering

THE COLONNADE

STAMBH

Always DEDICATED and DEVOTED

A Note from Director

It gives me immense pleasure to pen a few words as prologue to "The Colonnade", a student's monthly e-magazine of Civil Engineering Department.

At ABES Engineering College, we always strive for the holistic development of the students and this e-magazine is one example of such. I am confident that this magazine would be helpful in disseminating the various activities held in the department, current technological developments along with the faculty and students achievements.

I congratulate the student's team along with the faculty mentor who are instrumental and all the contributors for bringing out such a beautiful magazine.

Dr. Surendra Kumar
Director
ABES Engineering College

A Note from Patron

The Department of Civil Engineering is one of the youngest department of ABES Engineering College. The greatest asset of the department is its highly motivated and learned faculty. The available diversity of expertise of the faculty with the support of the other staff prepares the students to work in global multicultural environment and holistic development of the student as a professional engineer.

The Online magazine "The Colonnade" is an e magazine initiated by the students of second and third year which would be showcasing the achievement of faculty and students along with the various departmental activities such as industry visits, guest lectures, skill development trailing etc. The first issue of it would be release in the month of January.

I wish all the students who are instrumental in bringing this magazine best wishes and wish their endeavor's my very best.

Patron
Dr. T. Visalakshi
(Head of Civil department)

Unturning a Stone.....

The Civil Engineering Department of ABES Engineering College, Ghaziabad, in the prime of time, has introduced a new club in its very own department named as "Stambh" which is all in good faith ready to make a history.

It aims at rather not only strengthening the journey of upcoming engineers promising by providing a platform to showcase their talents and skills but even would help them groom and brush up their personalities in accordance with their career aspects.

The team "Stambh" has sown the seeds in the soil of Civil Department and aspire to have best harvest, having putting in all its hard work and endeavours. The initiative has been taken up keeping in care to stabilise the young minds to which way they should take in order to enhance their technical knowledge and practical skills. The club will organise various activities related to our core engineering where students can come up presenting their wit and intelligence. The students are expected as well to rise to the occasion and participate whole heartedly in all the events that will be held by the club, as to bring laurels and name is what everyone desire for.

In addition, it is a matter of great pleasure that the department is hereby to launch a magazine "The Colonnade". "The Colonnade" is an ambitious venture that is accomplished as it is and it is a culmination of efforts taken up the department. This initiative has been taken up with a keenness to keep the readers updated with ongoing developments and inventions in technology related to Civil Engineering, facts regarding historical monuments, modern structures and other concepts. Also, the magazine has a column which makes the avid and avaricious readers aware about various researches going on in nooks and corners of the world. The magazine ensures to imbibe the qualitative knowledge among readers with all meaningful, thoughtful and useful logics and reasons of the content provided in it. Hope that "The Colonnade" is indeed going to be worth reading for you all!

In the end, with open arms, we look forward for the appreciative works to set a milestone to create a history so that we can come on with flying colours in the sky.
Best wishes!

By
Kruti Agrawal
(Creative Director)

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GENERO'15

UNRAVEL THE ENIGMA

Genero is the Annual Techno cum Cultural Fest of ABES Engineering College hosted every year to celebrate the blend of technology and culture.

In genero'15, various events of civil engineering were organised under the name "constructo".

Head of Constructo

Faculty Head	Student Head	Chief Co-Ordinator
Mr.Ayush Kumar & Mr.Amit Bajaj	Ms. Saumya Singh & Mr. Sunil Sharma	Ms . Urja Singh

Events under Constructo

- BOB THE BUILDER
- TERRAMIND
- BEAT-D-EUCLID
- EXHIBITION
- ARCHIPEDIA
- CARTE-DE-PALAIS

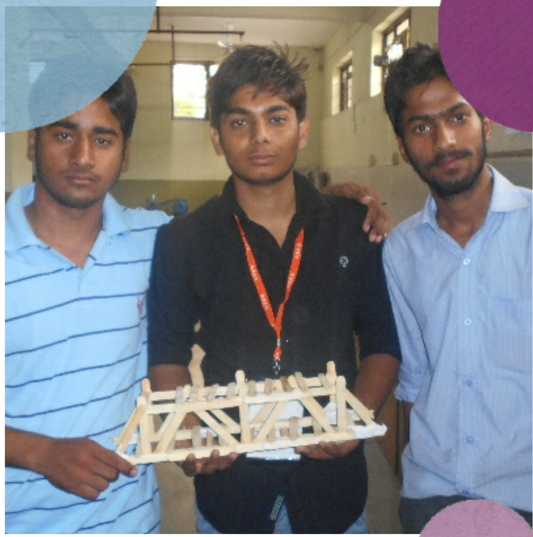
Bridge of Dreams

“we called aspiring engineers to substantiate the bridge of their dreams. They Made bridge using icream sticks and fevicol. The load bearing capacity and stabiltiy of bridges were checked.”

BOB THE BUILDER

Judged By

Mr. Amit Bajaj
&
Mr. Uzair Khan



Winners

Mr. Sanjay
&
Mr. Shashank

BOB THE BUIDER TEAM WITH PARTICIPANTS

Imagine out

"It was the on spot event which tested the modelling abilities of the participants. A given 3-d structure was to be visualized as a 2-d structure using auto-cad software."

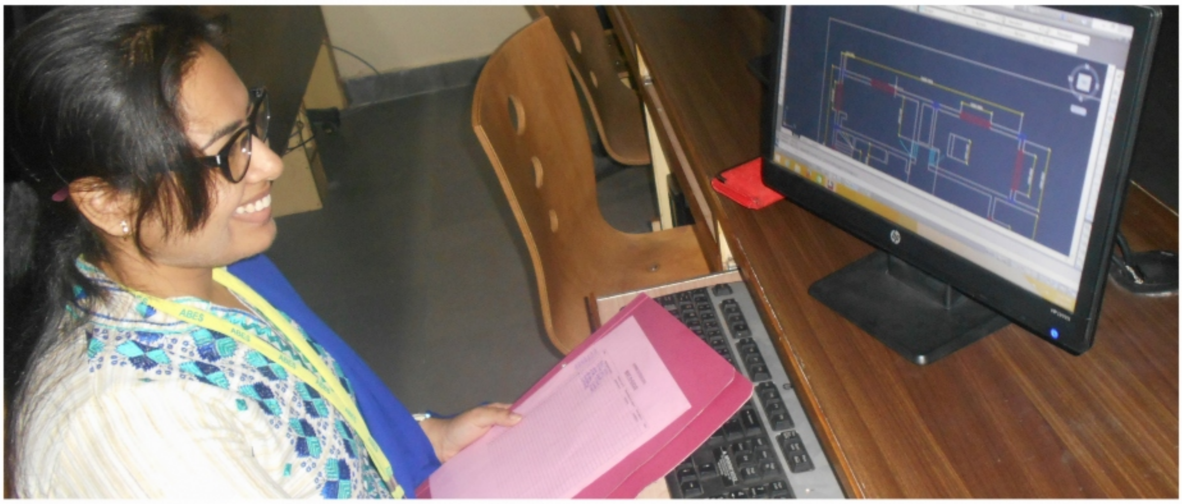
BEAT-D-EUCLID

Judged By

Ms. Hina Gupta

Mr. Ranjeesh R

Mr. Ayush Kumar



Judges Checking after the event

Winners

Mr. Akshay Kumar

Into The Past

"The participants gave the presentations on various historical monuments specifying their special features related to stability, and structural design."

ARCHIPEDIA

Judged By

Mr. Nikhlesh Kumar

Mr. Shailesh

Winners

Mr. Yogendra Kumar

Core Team Of Archipedia With Judges And Faculties

Test Of Knowledge

"It is a civil engineering quiz event testing the knowledge of participants in a wide range of fields namely environmental engineering, Geo-technical, structural and various other subjects of civil engineering."

TERRAMIND

Judged By

Mr. Ranjeesh R

Mr. Abhinav Singh

Winners

Mr. Himanshu Bharadwaja

"The event was introduced first time in constructo'15. Various models were presented by the participants which demonstrated the concepts of civil engineering."

EXHIBITION

Judged By

Ms. Hina Gupta

Mr. Shailesh Kumar

Participant Of Exhibition

Winners

Ms. Kajal Singh
&
Mr. Ankit Gautam

Core Team Of Exhibition

House Of Cards

“This event is to Check the imagination of the participants and their insight into the field of architecture and design . Here the participants have to make A civil structure with the help of 52 playing cards.”

CARTE-DE-PALAIS

Winners

Mr. Sarthak Garg
&
Mr. Nishant

Judged By

Mr. Ayush Vashistha

Mr. Rakesh Srivastava

Mr. Sandeep Goyal

Like us at

STAMBHviaCIVILABES

Bridge of Ambition: Centennial Bridge

Edited by: Abhishek Kumar Ray

1 Introduction

The Panama Canal represents one of the greatest engineering achievements by man. **Puente de Las Americas** (Bridge of the Americas) represented a four lane bridge crossing that was sufficient for the volumes of traffic for that time. However, with the construction of the new Pan American Highway and the continued expansion of Panama City, traffic volumes reached 35000 vehicles per day in 2004 in contrast to 9500 vehicles per day when the bridge first opened in 1962. Subsequently, the bridge could not cope with the increased traffic demands. The Panamanian Government recognised the problem and proposed a second crossing for the Panama Canal that would be called Puente Centenario (Centennial Bridge) to represent 100 years of Panamanian independence from Columbia. The construction of the bridge, in conjunction with the new freeway connecting Araijan (west) to Cero Patacon (east), was hoped to alleviate the traffic congestion observed around the existing bridge and to facilitate the development of the western side of Panama.

The Panamanian government specified a set of criteria for the design of the new bridge that included a 6 lane traffic capacity, central pedestrian walkway and 100 year expected service. However, there were two central considerations for the design and construction of the Centennial Bridge. First, canal traffic could not be interrupted at any point during the construction or completion of the bridge. Also, the bridge had to have sufficient navigational clearance (80m high and 110 m wide) to allow the large crane Titan, which is used for canal lock maintenance, to pass below the bridge. To provide the required navigational clearance an innovative and large structural design had to be formulated and the construction methods had to be selected and planned carefully. Secondly, were the challenges presented by the varied founding conditions discovered along the bridge and also the prevalent history of seismic activity in the area.

The bridge was **designed by Guatemalan architect Miguel Rosales**, who developed a single plane cable-stayed bridge with a cast in place concrete box girder that would become the longest and highest cable stayed bridge over a water way in the western hemisphere *(Figure 1)*. The bridge forms a very large structure with a main central span of 420m and a total length of approximately 1052m (*figure 2*).

Figure 1: The Centennial Bridge

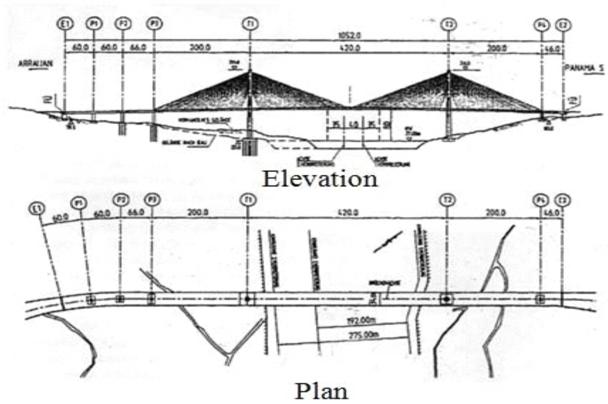


Figure 2: Plan and elevation of the Centennial Bridge

The Centennial Bridge is located 15km north of the Bridge of the Americas, 22km from Panama City close to the Pedro Miguel locks. The bridge was financed by the Panama Ministry of Public Works (MOP) who awarded the design contract to **TY Lin International**, the construction contract to **Bilfinger Berger**, the detailed design contract to **Leonhardt, Andrau und Partner (LAP)** and the project management contract to international consulting group **COWI**. The bridge was inaugurated by the Panamanian President on 15th August 2004 and was opened to traffic on 1st September 2005 subsequent to the completion of the two approach roads.

Aesthetic analyses of the Centennial Bridge

Leonhardt suggests that, primarily, a bridge should fulfil its purpose, by showing clearly how it works in order to create a sense of stability and safety. The bridge should highlight its structure in a pure, clear and simplistic manner to achieve this. Cable-stayed bridges are a particular bridge load bearing system that conveys it function through its pure structural simplicity. More specifically, the Centennial Bridge reveals its structural form through a single plane, single pole cable-stayed bridge that has three main structural elements: box girder bridge deck, towers and cable stays. The structural system is easily interpreted where the deck loads are carried directly in tension in the stay cables back to the towers which then transfer the loads down through the two towers in the foundations. The structural system should also be visible from the view of the traffic moving across the bridge to allow bridge users to experience the aesthetic of the bridge and also ensure that confidence in the stability of the structure is achieved. Generally, to achieve this bridge designer's use two planes of cables that create an envelope for the traffic to move through to increase the feeling of safety. However, for the centennial bridge there is a central single plane of cables and, therefore, the traffic moves along either side of the cable on the cantilevered bridge deck (*figure 3*). Although this may suggest an area where the bridge design does not convey its function through stability it provides a complex variation to the otherwise simple structure that can offer aesthetic improvements to the structure. This underlines Leonhardt's guideline of complexity where he

Figure 3: View for vehicles travelling over the bridge suggests that a small amount of complexity can be Pleasing, but, it should be kept to a minimum

The proportions of a bridge e.g. height width and breadth, masses and voids, closed surfaces and, and light and dark have also been highlighted in Leonhardt' s bridge aesthetic guidelines. Leonhardt suggests that harmonious dimensions must be achieved in order to design a beautiful structure. Due to the 80m navigational requirements for the Centennial Bridge, the large distance that the bridge had to cross and the wide deck required for 6 lanes of highway traffic the design of the proportions of the structure and its individual elements was of paramount concern. The towers, as one of the major structural components, were required to be proportioned very carefully. Using a single pole tower system (*figure 3*) it was crucial that the towers were not too slender as this could give of an impression of weakness and would look incorrect in relation to the large length and breadth dimensions of the concrete box girder. *Figure 4* conveys that the proportion of the towers appear correct and conveys an image of strength. The large navigational clearance required meant that the overall bridge height would have to be proportioned similarly. The top of the towers reach a height of +211m (184m above the +27m water level) which conveys harmony between the voids below and above the deck. The piers have also been shaped to harmonise with the tower sections.

Figure 4: Elevation of the Centennial Bridge showing the relative proportions of the towers and the bridge deck

Leonhardt underlined that order within the bridge was also required to improve the aesthetic. He underlined that bridges should convey order in their lines and edges. This is a particularly important consideration for the Centennial Bridge due to the cables stays. Many stay cable arrangements used for this type of load bearing system convey crossing of the lines of the cables from oblique views. However, the Centennial Bridge uses a single plane semi harp design which has the advantage that the cables will never cross when viewed from different angles. This reveals a clear ordered arrangement of the cables enhancing the aesthetic appearance. Another example of good order in the bridge is that has a continuous box girder element that does not change throughout the length for the structure. Symmetry and repetition of the structure also provides good order for the bridge. The main section of the bridge consists of three spans, the central span of 420m and mirrored spans of 200m either side (*figure 2*). The cable two towers are geometrically identical and they also support matching cable stay arrangements (*figure 2*). Similarly, the piers that support the viaduct to the east and west of the main section have the same plan sections; however, they vary in height due to the changes in topography beneath the bridge. Despite this, the piers convey repletion of similar structural elements. The symmetry and repetition observed in the Centennial Bridge provide rhythm in the visual appearance of the structure, which creates satisfaction for the viewer.

Leonhardt describes how refinements can be used to improve the aesthetic quality of a bridge. The Centennial Bridge portrays a number of refinements in its structure. Some of these refinements are linked to the optical illusions that are created by using large structural elements with straight edges. To prevent this optical illusion forming for the towers, where straight edges would result in the towers appearing wider at the top when viewed from below, the towers are tapered towards the top. Another optical illusion that was prevented was the sagging that would have been perceived if a straight deck was used for the long spans on the Centennial Bridge. To achieve this, a centred 600m section was given a slight camber, 10,000m vertical radius to ensure that the long bridge deck is viewed as straight from a distance (*figure 5*). The spans of the viaduct highlight a further refinement of the bridge where the spans decrease as they approach the slopes on either side of the bridge. Refinements have also been performed to consider the effects of light and shadow on the structure where the wide cantilever deck casts a shadow over much of the box girder giving the deck the desired light and slender appearance. A final refinement that can be observed by the traffic and pedestrians using the bridge is provided by the view of the anchorage system on the front face of the towers (*figure 6*). These anchorages are emphasised by a groove that is extended beyond the anchorage zone which draws attention to the structural purpose of the cables. A suggested further refinement that could improve the aesthetic of the bridge could be to provide a smooth finish on the bottom of the continuous box girder as this forms one of the most important views of the bridge for freight traffic using the canal. This was probably not attempted due to the cost of providing a smooth finish for the box girder that stretches over 1km.

Figure 5: Visual effects of the bridge deck camber

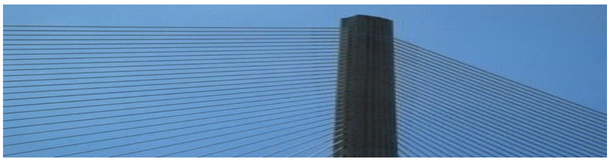
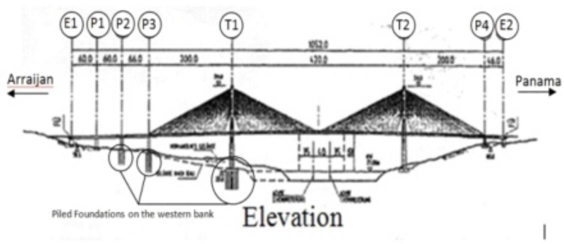


Figure 6: Anchorages emphasised by a groove extended beyond the anchorage zone

Leonhardt underlines the importance of the integration into the environment of bridges and this particular guideline has been considered the most important by many other authors. Cable-stayed bridges in general provide an excellent load bearing system that offers sufficient flexibility for integrating the structure into its environment through its range of configurations of deck, tower and cables. The Centennial Bridge spans a



Large valley that the Panama Canal flows through and due to the flexibility of cable-stayed bridge design this structural system was a very appropriate choice to ensure good integration into the environment.

The required scale of the bridge also meant that integration into the environment was going to be essential for producing an aesthetically pleasing structure. First the most significant feature of the surrounding environment is the Panama Canal. The canal itself is a large engineering project and also has a significant scale and, therefore, the bridge that crosses it should relate well to this. Consequently, this explains why such a large structure can blend seamlessly in with the surrounding environment. In addition to this, the single semi harp cable arrangement and the relatively slender proportioned continuous deck and towers create an elegant and transparent structure that is unobtrusive to the surrounding environment. The successful integration into the environment can be summarised by a “surreal feeling that towers and stay formations are those of sailboats that hover over the canal. The landscape of the area where the bridge stands is mainly that of rainforest. With this picturesque background, the beautiful Centennial Bridge is a welcome addition that adds glamour to the scenery with its sleek and graceful appearance”.

The choice of material, surface texture and colour provide additional considerations that can facilitate the integration of the bridge into its surrounding environment. The Centennial Bridge has a concrete deck and abutments. These structural elements appear to have a rough finish which is advised by Leonhardt. The concrete is not coloured, but, reflects a beautiful white colour during the day (*figure 4*). The concrete deck also has fascia beams that have a smooth finish which emphasizes the location of the bridge deck. The colour of the cable is an important consideration because it impacts upon the appearance of light on the bridge. The Centennial Bridge has white cables. White cables reflect the light of any colour and, therefore, the appearance is constantly changing depending on the colour of light being reflected by the cables.

The character of the Centennial Bridge was absolutely paramount to the success of the bridge as an aesthetic structure. The Panama Canal is symbolic of The Republic of Panama and subsequently the Centennial Bridge had to be worthy of crossing it. The sheer scale of the bridge provides character in abundance, however, it is the way in which this large structure is delivered in a light and transparent form that builds the character for the Centennial Bridge and renders it worthy to provide the second crossing of the Panama Canal.

Leonhardt’s final guideline is that a consideration of nature can improve the aesthetic. The centennial bridge design does not appear to have incorporated nature into the design in any specific way. This was possibly due to the often complex organic forms that are observed in structures that use nature to drive design. This would contrast the criteria specified for this bridges where it was important to keep the structure as simple as possible.

Structural arrangement

The Centennial Bridge has a structure consisting of a single pole single plane cable-stayed arrangement. A continuous box girder carries the traffic across the 1052m distance between abutments E1 and E2. The deck is supported along its length by the two towers T1 and T2 as well as the secondary support provided by piers P1, P2, P3 and P4 located on the east and west sides of the canal. In addition to the support provided by the towers and piers the deck is supported by a single plane cable stay configuration suspended from the two towers.

The design of the layout of the stays for cable stayed bridges represents one of the most important considerations in the design of cable-stayed bridges. There are a number of options available to bridge designers most notably the harp and fan arrangements. The harp pattern represents the most aesthetically sound arrangement where there is no crossing of the cables from oblique views; however, from an economic and structural; point of view it is not the most efficient configuration. The fan pattern theoretically brings all the cables together at the top of the pylon, which has a number of advantages including the decreased horizontal force induced by the cable in the deck. Although it has been suggested that the crossing of cables often found in fan patterns for bridges is not a problem for large span bridges like the Centennial Bridge, there remains a specific limitation of using this pattern. This problem is that it is not practically possible to bring all the cables together at the same point at the top of the pylon and, therefore, spreading of the anchorage zones creates a highly stressed region at the top of the pylon. This zone subsequently requires complicated and costly methods of construction that also detract from the elegance of the structure and, therefore, explains why the fan pattern would not have been selected for the centennial bridge.

The cable stays are arranged in a semi-harp configuration. This arrangement does not provide the most efficient structural arrangement; however, for the aesthetic purposes underlined in the aesthetic analyses it is reasonable to specify this cable stay arrangement to improve the visual appearance of the bridge. The semi harp pattern represents an arrangement that combines the layouts of the harp and fan systems. It combines many of the advantages of both these patterns whilst also eradicating many of the disadvantages. The decision to use the semi-harp pattern for the centennial bridge allowed the stays to be spread out in the upper region of the pylons, which would greatly facilitate the good design of the anchorage details without decreasing the depth and integrity of the pylon structure. Another advantage that the semi-harp pattern introduced was that the cables near the top of the pylon are at a greater inclination, which facilitates the reduction in the required stiffness of the connection between the pylons and the deck.

The first modern cable-stayed bridges only had a small number of stays, which created large distances between the elastic supports. This meant that very stiff bridge decks were required. As this bridge configuration has developed multiple-stay bridges have been introduced, which decrease the distance between the elastic supports and subsequently facilitate the use of decks with reduced stiffness. This allows for more slender decks to be used, which have obvious aesthetic and structural advantages linked to the lightness.

The Centennial Bridge was designed with a multiple-stay configuration to utilize these specific advantages. The cable stays are closely spaced (*figure 3*) and subsequently the bending in the deck is greatly reduced. This reduction in bending allows the bridge deck to be more slender. However, as a consequence, of using the single plane cable-stayed arrangement and the large width required (34m) for the six lane capacity road surface, the bridge deck had to have sufficient torsional stiffness to support the weights of the cantilevered bridge deck and the loads that it carries. Generally, to achieve high torsional stiffness box sections provide a good option. The Centennial Bridge utilizes a box girder to achieve this torsional stiffness that is supported on transverse beams at 6m centres to increase the stiffness of the deck. The design decision to use a single plane arrangement represents an inefficient structural strategy because of the additional stiffness required in the deck. However, as described in the aesthetic analyses of the Centennial Bridge the single plane arrangement provides aesthetic qualities for the bridge and, therefore, the inefficient design of the stiff box girder can be justified.

To provide sufficient torsional stiffness in the deck careful detailing of the pier-deck connection was crucial. The torsional stiffness and lateral restraint was achieved by fixing the towers longitudinally to the deck, which produced a uniform structural frame. The box girder is supported vertically at all the piers and the two abutments by multi-directional pot bearings. These pot bearings accommodate the estimated deck movements of 16 inches and also limit the ingress of water because of the rubber seal commonly used for this type of bearing. P3 and P4 also have hold down cables that connect to the foot of the piers. Horizontally the box girder is supported by transversally fixed supports at P1, P3 and P4. This is achieved by using a shear key that penetrates through from the girder diaphragm into the pier top. In the longitudinal direction all the supports are equipped with moveable bearings. Expansion joints, which allow horizontal movement to occur within the plane of the deck, are used only at abutments E1 and E2. This is probably because expansion joints often fill up with debris, and, therefore, the uniform fixed connection between the towers and the deck offers a better solution. This structural arrangement is effective because it reduces the restraint forces caused by wind loading and seismic effects. This is achieved by the proportional distribution of the transverse, seismic and wind loads to the towers fixed supports to the deck and the shear keys that are located at the top of P1, P3 and P4.

Loading

The most important loadings that need to be considered for the design are dead, superimposed dead, and live loads. For the centennial bridge seismic effects also represent an important consideration in addition to the generic loading conditions required for bridge design.

1) Dead and super-imposed dead loads

The dead load for the bridge deck was calculated to be 416MN over the 820m length supported by the cable stays. The superimposed dead load, assuming a 120mm thick layer of asphalt was calculated to be 77.3MN. For dead loads, as specified by BS5400 partial factors are applied to these loads. γ_{fl}=1.05 for ultimate limit state (ULS) and γ_{fl}=1 at service limit state (SLS). Super-imposed dead loads are factored at γ_{fl}=1.75 for ULS and γ_{fl}=1.20 for SLS. The super-imposed partial factors are considerably larger than those for dead loads because it is certain that super-imposed loads will be replaced in the lifetime of the bridge and, therefore, it is probable that the bridge will be subjected to a different super-imposed load.

2) Live loads

Eurocode design suggests that the first consideration for live loads is to define the number of notional lanes. The carriageway had an overall width of 34m with a central pedestrian walkway of 5.5m and, therefore, the number of notional lanes was found to be 8. The lane width was therefore calculated to be 3.56m.

3) HA loading

HA loading represents uniformly-distributed load acting over a notional lane in combination with a knife-edges load (KEL) located at the adverse position within the notional lane. This loading considers the effects of fast moving traffic. The loaded length considered for the design of the bridge would vary because different scenarios need to be analyzed to identify the most onerous load case. For the Centennial Bridge the most onerous load cases are likely to be observed when the length between P3 and T1 is fully loaded and the rest is not loaded and secondly when the length between T1 and T2 is fully loaded and the sides remain unloaded. For the first case the loaded length was 200m and therefore the load is 12kN/m or 3.37kN/m^2 for the 34.1m wide deck used for the Centennial Bridge. For the second case the load is 9kN/m which subsequently renders a load of 2.5kN.m2 for the full width of the Centennial Bridge. For each of these cases a KEL of 120kN would be considered at the central location of the loaded length.

4) Seismic loads

The location of the Centennial Bridge meant that the bridge would have to withstand the effects of seismic activity. The seismic design of the bridge considered two different scenarios. A 1 in 500 year as well a 1 in 2500 year earthquake event were considered to ensure that the bridge had sufficient stability to withstand such events. The bridge was carefully tuned to reduce the effects of the loads produced in earthquake events.

Serviceability

There is very little literature on the serviceability methods used for the Centennial Bridge. However, it is likely that a network of sensors are used to monitor the moments, axial stresses, foundation settlements, deflections in the deck and stresses in the pre-stressed cables. This would allow the serviceability of the bridge to be continually monitored and provide current data on the condition of the bridge.

Construction

The Centennial Bridge was constructed using a fast track process in order to ensure that the bridge was completed in time to commemorate 100 years of Panamanian independence from Columbia. As well as the tight schedule the construction team faced major challenges from the founding conditions and seismic activity present in the area. The concrete structures that comprise the cable-stayed bridge were predominantly constructed from local material. The concrete used for the bridge was designed for the specific strength demands of the individual structural components, e.g. piles constructed using 30MPa, foundations using 35MPa, piers and towers using 45Mpa and finally the superstructure using 50MPa.

The construction process began with a pile investigation of the ground conditions at tower T1 and subsequently at piers P2 and P3. The results conveyed that there were variable ground conditions along the length of the bridge where a block of basalt was found on the east bank that would provide supporting stratum that could directly support the bridge. In contrast, along the west bank, a soft formation of clay shale constituting of sandstone, basalt and ash was revealed and presented the possibility of landslides and, therefore, could not provide direct support for the bridge. Due to the varying founding conditions different foundation methods were required for the abutments, piers and towers along the length of the bridge. There were two different foundation methods used for to support the bridge. Direct foundations were used for abutment E1 and E2, piers P1 and P4, and tower T2 as there was sufficient supporting stratum in these locations. In contrast deep piled foundations were used for piers P2 and P3 and tower T1 to provide sufficient support in these unstable locations. Both types of foundations were constructed using conventional methods.

The towers, approach structure and piers were all built at the same time to ensure a quick construction period for the bridge. The towers are identical apart from the foundations and were cast in place using climbing formwork (figure 8). The formwork used was flexible so that it could facilitate the changes in geometry of the towers as they tapered towards the top. The tower shaft was divided into 48 segments with a standard height of 4m; however, where the towers deck intersected the segment heights were decreased because they had to be adjusted to facilitate the anchorage points of the stay cables. A four day cycle was used to produce each individual segment; however, at the areas where anchorage points were present the process was more time consuming because of the pre-stressing operations required and the reduced accessibility. This four day cycle facilitated the fast track construction process required to produce the bridge on time. The towers were constructed on either side of the canal to avoid having to construct deep water foundations, which are costly and it was also important to provide enough space for freight traffic to pass between the towers. Steel formers were used to cast the pier shafts in place and when an individual segment had hardened they would be moved to a higher level to cast the next section. As mentioned previously a shear key is used at piers P1, P3 and P4. To transfer the horizontal forces from the shear key into the pier shaft the pier tables were pre-stressed transversally. These tables took three months to construct. The approach viaduct began with construction on the east side P4-E2 and subsequently the west side viaduct was built in three stages from E1-P3. The box girder deck for the approach viaduct was constructed using custom built formwork, which was lifted into place to cast the deck.

Figure 8: Tower construction using climbing formwork

The superstructure was constructed using a cast in place free cantilevering construction method. Cablestayed bridges have the advantage that they have permanent towers that can be used for the cantilever construction, which represents a very cost effective construction method as it does not require temporary structures to be built to support the bridge. It is probable that this was one of the main reasons this method was used; however, the main advantage that this construction method provides is that it would not disrupt the flow of traffic along the canal during the construction process, which was one of the main specifications underlined at the beginning of the projects. The deck was cast in place using 4 form travellers, 2 for each tower. 128 cables were used to suspend the deck using this method of construction. The cantilever construction of the deck began shortly after the towers exceeded the height of the deck and work was continually carried out on both sides to once again ensure an efficient construction process.

GREEN ROOFS FOR HEALTHY CITIES

Edited by: Urja Singh

A **green roof** (also known as **living roof or vegetated roof**) is a type roof of a building that is either partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It might include some additional layers such as a root barrier and drainage and irrigation systems. The container gardens are, generally, not considered to be true green roofs.

Green roof concept is not new. These have been in use for centuries as an effective thermal insulator, energy efficient, ecologically-sensitive technology.

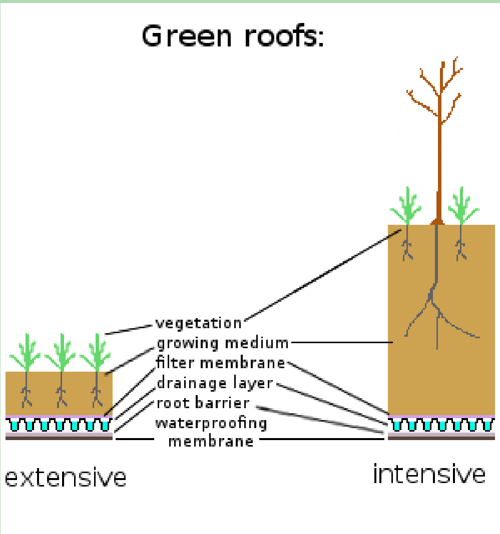
There are two types of green roof:

INTENSIVE ROOFS:-

These are thicker, having a minimum depth of 12.8 cm, and can support a wider variety of plants. These are heavier, require more maintenance and support 80-150 pounds of vegetation per square foot (390–730 kg/m^2)

EXTENSIVE ROOFS:-

These are shallow, depth ranges from 2 cm to 12.7 cm. These are lighter than intensive green roofs, require minimal maintenance and traditionally support 10-25 pounds of vegetation per sq. foot (50–120 kg/m^2).



WHAT DOES GREEN ROOF DO?

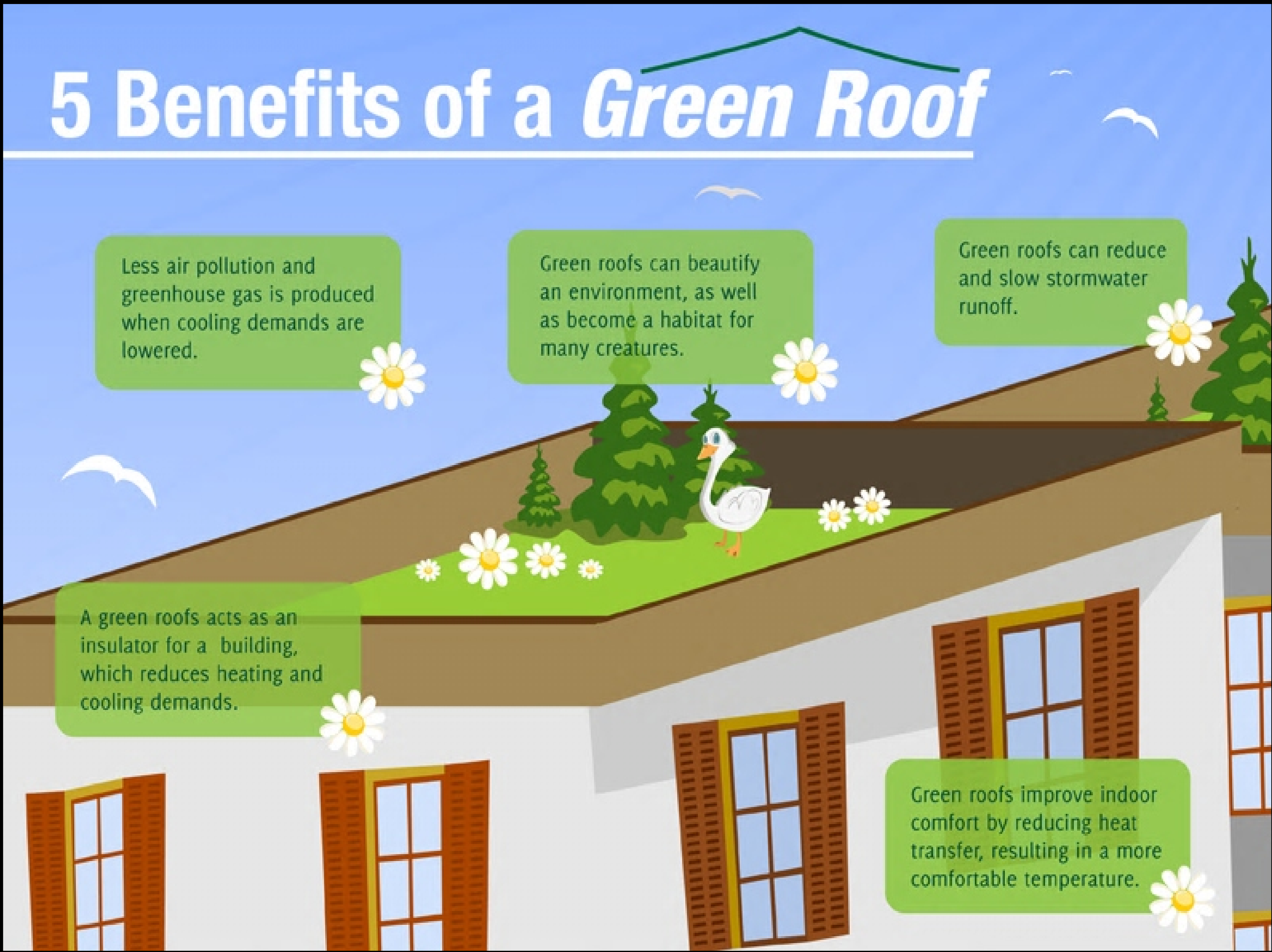
Several purposes are served by these roofs for a building, which includes absorbing rainwater, creating a habitat for wildlife, increasing benevolence and diminishing stress of the people around the roof by providing a more aesthetically pleasant landscape, and also helping in lowering urban air temperatures and lessen the heat island effect.

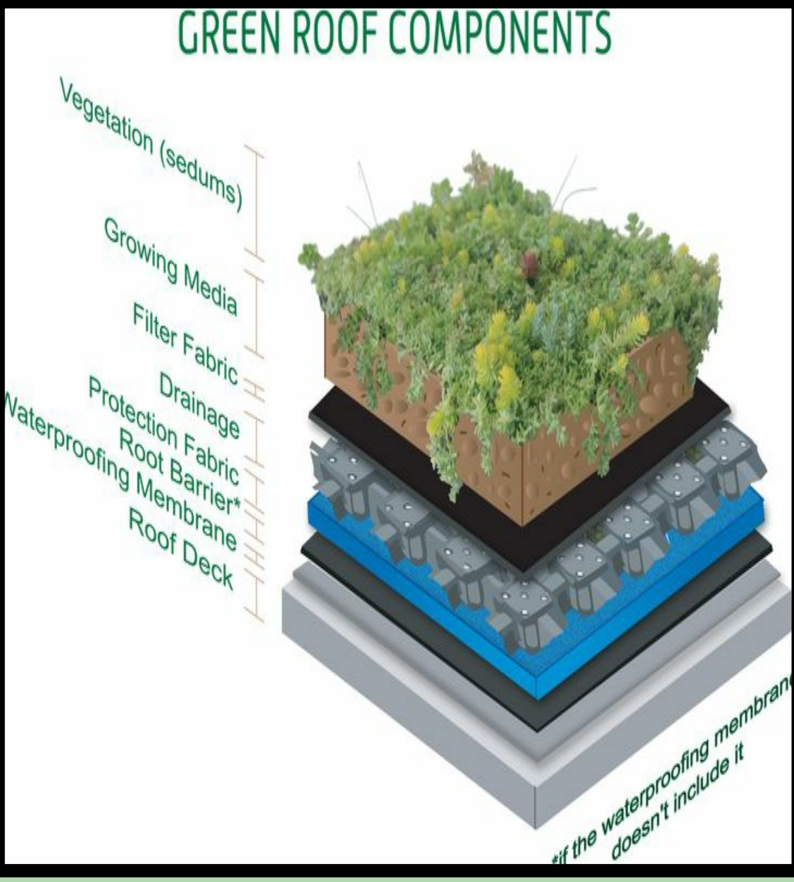
Since green roofs protect the roof membrane from harsh weather and ultraviolet (UV) radiation, they can last twice as long as traditional roofs. They have a fairly stable surface temperature, remaining at air temperature or cooler while traditional rooftops can soar up to 90º F (32º C) above air temperature. The extra growing medium and vegetation insulates the building from intense temperatures and minimizes the heat gain. According to a Canadian study, by even a six-inch extensive green roof, there can be reduction of summer energy demands by 75 percent.

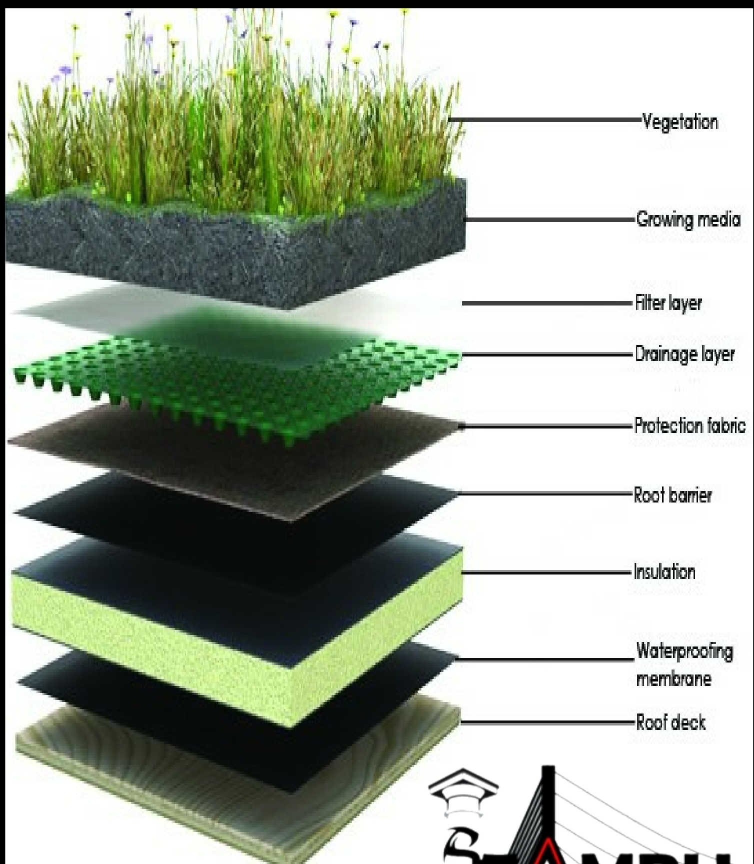
Evapo-transpiration and the shading provided by plants, help counteract the Urban Heat Island Effect brought about by an excess of reflective and impermeable surfaces in cities and suburbs. Because Urban Heat Islands increase temperatures in urban and suburban areas, they amplify the demand for air conditioning and launch a cycle of energy consumption that contributes to global warming. If green roofs become a common building initiative, cities can reduce the uncomfortable effects of Urban Heat Islands to a greater extent.

GREENER MATERIAL SPECIFICATIONS

With the purpose of sustaining living plants, the planted roof must have soil and the soil must contain nutrients along with proper aeration and water. The construction materials selected for such a system must, therefore, be able to resist exposure to soil chemistry and fertilizers, physical abrasion from tilling, and contact with insects, animals, roots and soil, and to the constant presence of moisture.


5 Benefits of a Green Roof
Less air pollution and greenhouse gas is produced when cooling demands are lowered.
Green roofs can beautify an environment, as well as become a habitat for many creatures.
Green roofs can reduce and slow stormwater runoff.
A green roofs acts as an insulator for a building, which reduces heating and cooling demands.
Green roofs improve indoor comfort by reducing heat transfer, resulting in a more comfortable temperature.


GREEN ROOF COMPONENTS
Vegetation (sedums)
Growing Media
Filter Fabric
Drainage
Protection Fabric
Root Barrier*
Waterproofing Membrane
Roof Deck


Vegetation
Growing media
Filter layer
Drainage layer
Protection fabric
Root barrier
Insulation
Waterproofing membrane
Roof deck

Most of the traditional roofing materials are not formulated for constant contact with soil chemistry, and thus, are designed to shed moisture and spend at least part of their life cycle in a dry, well ventilated state. Membranes, drains, insulation and containment supports should then be selected based on zero maintenance, below grade specifications such as those used beneath pavements, foundations, and patios as opposed to standard roofing criteria.

STRUCTURAL LOADS - WEIGHT OF GREEN ROOFTOPS

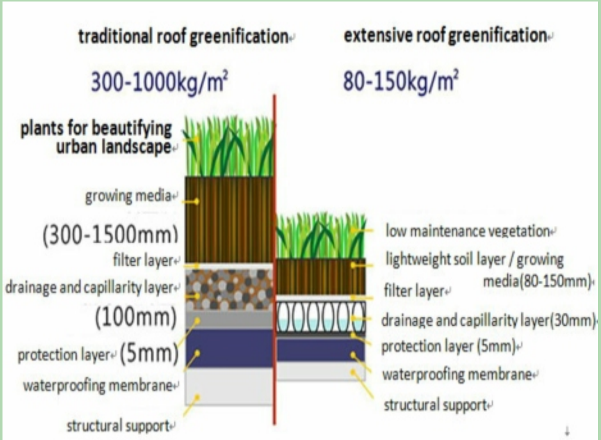
One cubic foot of dry, agricultural dirt or loam which is typically used for a "green" roof weighs between 75 and 81 pounds. When saturated with water, the increment in weight can be as much as 35%, i.e. to around 100 to 110 pounds per cubic foot. This means 100 square feet of planted roof containing soil 6 inches deep can add over 5000 pounds of dead load to the roof structure, roughly 50 p.s.f. or more.

Four discrete planter boxes or containers, which are 6 feet long, 2 feet wide and are 1 foot deep in soil, applies a similar load. Add a blocked water drain and the weight starts adding up at the rate of 5 p.s.f per inch of standing water. Add a conservative snow load allowance for flat roofs of 15 p.s.f., and the design criteria can easily exceed 70 p.s.f. dead load. For a modest building using 2500 sq.ft. of living roof construction, this could translate to 175,000 pounds of dead load on the roof top. Constructed in a seismic zone, this can become an unpredictable live load directly above the heads of the building occupants.

Finally, if the planting is intended to be a tended garden additional live loads will be incurred by equipment, gardeners, and visitors if applicable. Whether for new construction or for retrofitting existing roofs, structural engineering design is required for anything more than a few square feet of planted roof area.

WATERING AND DRAINAGE

There is requirement of water by live plants not only to maintain growth, but to prevent disease and rot, adequate drainage is required. Drainage is also required to prevent a flood event, which could have disastrous consequences at rooftop level. Again, drains designed for below grade applications with constant soil contact and zero maintenance are required as opposed to conventional roof drainage systems. A layer of agricultural lightweight aggregate or pea gravel covered with a suitable filter fabric is usually adequate. There are also proprietary formed drain systems available, such as synthetic fiber mats and cellular matrices, which are thinner, lighter, and can increase drainage rates but usually at higher cost. Additionally the drainage design should incorporate several collection points serving a given area in case one drain becomes clogged. Finally, active irrigation needs to be closely monitored to avoid excess water weight as mentioned previously.



ENVIRONMENTAL BENEFITS

- ⇒ Reduces heat in buildings by adding thermal mass and resistance to the roof membrane and reduces heat loss and energy use in winters
- ⇒ Reduces cooling loads on buildings by 50 to 90%
- ⇒ Reduces temp. fluctuations on roof top daily, seasonally and yearly
- ⇒ In urban areas, Heat Island Effect (cities are hotter than surrounding areas due to impervious surfaces) is minimized to greater extent
- ⇒ Green roof slow down the velocity of direct runoff, thus reducing the erosion of stream and river banks
- ⇒ Creates natural habitat and promotes biodiversity
- ⇒ Filter pollutants and CO_2 , thus improving air quality which in turn helps in lowering the rates of diseases such as asthma
- ⇒ Serves as a sound damper, insulating a building for noise reduction; soil block lower frequencies and plants blocks higher frequencies
- ⇒ Contribute in achieving various points in LEED credit categories:- Sustainable site, Water efficiency, Material Resources, Environmental Quality, etc.

SOCIAL BENEFITS

- ⇒ Asthetic value
  - ➢ Improves morale and productivity
  - ➢ More visually appealing than conventional roofs
- ⇒ Amenity value
  - ➢ Desire for more green space in cities fulfilled
  - ➢ Increase marketability of properties; green rooftop buildings command higher least rates and selling prices
- ⇒ Recreational Value
  - ➢ Rooftop terrace for residents
  - ➢ Space for playgrounds for urban schools and childcare facilities

ENERGY AND COST SAVING

Green roofs save energy, which means they save energy costs. There are real savings (10-30%) for homeowners, commercial building owners, the agents who manage properties; and in urban communities, there are savings for local governments that maintain the built infrastructure.

- reduces heating demand in colder seasons, and cooling demand in warmer weather
- dramatically reduces the temperature fluctuations on the rooftop daily, seasonally and yearly:
  - o lower air temperatures near the roof surface mean HVAC equipment is operating less and with greater efficiency, saving on maintenance and replacement costs
  - o in fact, green roofs on neighboring buildings in densely-built communities contribute in a small way to reducing one's own energy bills, especially in warm summer weather; this is known asthe Heat Island Effect

DISADVANTAGE

The main disadvantage of green roofs is that the initial cost of installing a green roof can be double that of a normal roof. The additional mass of the soil substrate and retained water places a large strain on the structural support of a building. This makes it unlikely for intensive green roofs to become widely implemented due to a lack of buildings that are able to support such a large amount of added weight as well as the added cost of reinforcing buildings to be able to support such weight.

Some types of green roofs do have more demanding structural standards especially in seismic regions of the world. Some existing buildings cannot be retrofitted with certain kinds of green roof because of the weight load of the substrate and vegetation exceeds permitted static loading. Another disadvantage is that the wildlife they attract may include pest insects which could easily infiltrate a residential building through open windows.

CONCLUSION

Green roofs extend the life of the roof membrane 2 to 3x, or 30 to 60 years; this is a huge savings on roof replacement costs that typically run $10-30 per square foot, depending on size, for each replacement. With these construction considerations in mind, a properly designed and executed living roof can be an excellent choice for building construction. Some estimates indicate more than 20 LEED points can be obtained from such a system, not to mention the purely aesthetic improvements that can be achieved

RESEARCH PAPER

EFFECT OF USING RECYCLED AGGREGATES ALONG WITH FIBERS AS REINFORCEMENT ON THE MECHANICAL PROPERTIES OF CONCRETE

Talakokula Visalakshi, Rafiya Majeed Khan

ABES Engineering College, Ghaziabad, India

ABSTRACT. The increase in urbanization has led to increase in the infrastructural needs ultimately leading to the depletion of natural resources; therefore the research community has focused on utilization of alternative construction materials. The use of recycled aggregates from construction and demolition wastes is one among which is showing prospective application in construction as alternative to primary (natural) aggregates. On the other hand fiber reinforced concrete (FRC) is one of the fastest growing segments in the concrete industry to supply their reinforcing needs in concrete applications. Even though lot of research has been done in their respective areas, but seldom can be found on their combination. This paper presents the results of the experiments performed on recycled aggregate in different percentage replacements of natural aggregates in fiber reinforced concrete. The compression, tensile, and flexural strength parameters were studied and the optimum proportion of recycled aggregate with fibers is presented.

Keywords: Recycled Construction & demolition waste, recycled aggregates, fiber reinforced concrete.

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INTRODUCTION

Construction industries produce millions of tonnes of construction and demolition waste (CDW) each year which contain lot of renewable materials, if properly not managed will become a burden to the society. Recycling turns the otherwise waste materials into usable products which help in sustainable development. Environmental protection agency defines Construction & Debris as the waste material produced in the process of construction, renovation or demolition of structures (both buildings and roads). In addition, it includes the materials generated as a result of natural disasters.

Recycled aggregates are the aggregates obtained from recycling of CDW. The CDW consists of cement concrete, bricks, cement plaster as major components while the minor component include steel components (Galvanised iron pipes/iron pipes), electrical fixtures, panels, glass etc. For producing good quality recycled aggregates cement concrete is used. The recycled aggregates obtained from cement plaster and bricks cannot be used for structural applications

NEED FOR RECYCLING CD WASTE

Stringent anti-pollution and environmental regulation acts have been passed by the state and central government for conservation of natural resources and dumping of demolition waste. It is estimated that construction industry in India generates about 10-12 million tonnes of waste annually (2010 reports by Indian Concrete Institute and Central Public Works Department). In recent survey, the CDW generation jumped to 14.7 million tones of which 50% are concrete and brick waste, need to be dumped. The dumping of waste requires large landfills and dumping sites, but unfortunately there has been considerable decline in the availability of dumping sites in India as well as in other parts of the world. Considerable decline in the availability of good quality natural aggregate in the vicinity of construction and easy availability of recycling technology has laid obligations on mankind to recycle the construction and demolition waste.

The technology involved in converting CDW into useful aggregates consists of three stages:

- Collection
- Processing
- Manufacturing

First the CDW is collected from the construction or demolition site after which the foreign matter including metal straps, electric fixtures, plastic materials etc. are sorted out from it by hand picking or by using magnetic separation and then the remaining material is broken into pieces with the help of jaw crusher or hammer. The aggregates are then sieved through IS sieves of 26.5 mm and 12.5 mm and 4.75 mm to remove higher and finer materials. The higher size is broken again and then it is sieved through 4.75 mm IS sieve. Fines left out are used as filler in the plinth of buildings or highway embankments.

The present research focus on utilization of recycled aggregate in different percentage replacements of natural aggregates in fiber reinforced concrete (FRC). Experiments were performed to study its effect on the strength parameters.

METHODS

Ordinary Portland cement (OPC) of 43 grade was used to for the experiments, whose properties are listed in table 1. Water used for concrete mixing pH 6.5. Natural river sand of zone II was used as fine aggregate. The recycled aggregates were produced by hammering/jaw crushing the concrete blocks obtained as a demolished waste from residential building. The maximum size of aggregates was limited to 12.5 mm.

Table 1: Properties of cement

Property	Range of Values
Normal consistency	33%
Initial setting time	30 minutes
Final setting time	6 hours
Specific gravity	3.65

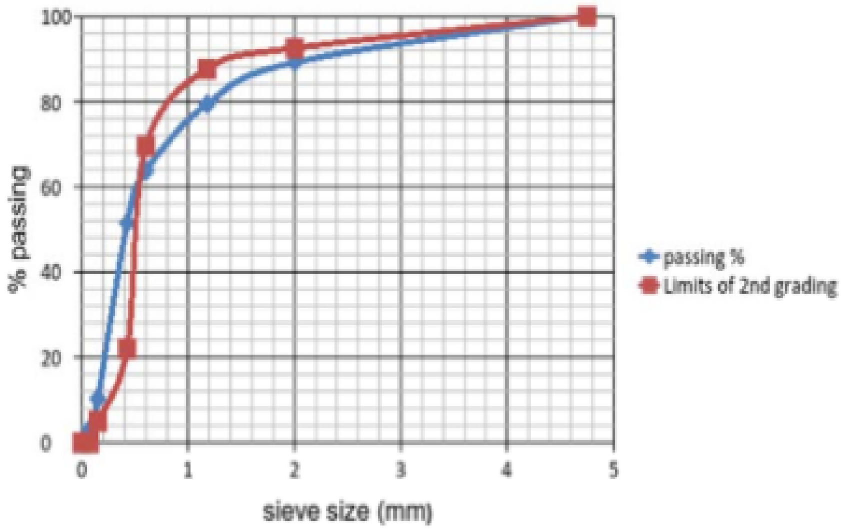

Figure 1 Grading of Sand (Zone II)

For experimental work seven mixes of concrete were made. The preliminary mix design was carried out for target strength of 30 MPA. In the first mix only normal aggregates were used. In the next three mixes 25% (by weight) of the normal aggregates were replaced by recycled aggregates and polypropylene fibers in the fraction of 0.25%, 0.5%, and 1% were also used respectively. Similarly three more mixes were made by replacing 50% (by weight) of normal aggregates with recycled aggregates and using polypropylene fibers in the fraction of 0.25%, 0.5%, and 1% respectively. The composition of design mixes is shown in table 2.
The recycled aggregates obtained from a 35 year old residential building were tested for various properties. The test results are tabulated in table 3.

The slump value and compaction factor ratio of the concrete mixes was tested to check the workability and self compactibility of the concrete. The slump value was found out to be 100 mm for the mix containing only normal aggregates while for the mixes containing 25% recycled aggregates and 50% recycled aggregates, slump value was found out to be 96 mm and 90 mm respectively. The compacting factor ratio for the mixes was found out to be between 0.75- to -0.85. The concrete mixes developed were tested for compressive strength at 7 and 28 days. To perform the compressive strength concrete cubes of size 15x15x15 cm were used. The comparison of compressive strengths for different mixes is shown in Fig. 2.

Table 2: Details of Mix deign

Mix	Replace ment (%)	Cement (kg/m^3)	Sand (kg/m^3)	Natural Aggregate (kg/m^3)	Recycled Aggregate (kg/m^3)	Fiber (kg/m^3)	W/C Ratio
Mix 1	0	500	570.5	1062.2	-	-	0.4
Mix 2	25	500	570.5	769.65	265.55	2.65	0.4
Mix 3	25	500	570.5	769.65	265.55	5.31	0.4
Mix 4	25	500	570.5	769.65	265.55	10.62	0.4
Mix 5	50	500	570.5	531.10	531.10	2.65	0.4
Mix 6	50	500	570.5	531.10	531.10	5.31	0.4
Mix 7	50	500	570.5	531.10	531.10	10.62	0.4

Table 3: Specification of Recycled Aggregates

Property	Range of values
Specific gravity	2.62
Water absorption	5.35%
Crushing strength	27.85%

From the figure it can be seen that with the increase in replacement ratio of natural aggregate the compressive strength decreased, the effect of fiber was not much appreciable from the results. Mix 2 compressive strength was comparable with the control mix with a mere above 3% decrease, hence from the results it can be concluded that about 25% replacement of natural aggregate with recycled one would have a comparable compressive strength.

To perform flexural test beams were cast and tested at 7 and 28 days, the results are shown in Fig. 3. The effect of addition of fibers can be clearly seen in the flexural strength, out of the percentages used 0.5% yielded maximum flexural strength, 0.25% strength was comparable with the control mix specimens and 1% gave the least strength. Hence from the results it can be concluded that 0.5% fiber addition is optimum with reference to the flexural strength

Table 4: Compressive and Tensile strength results

Mix details	Compressive strength (N/mm^2)			Tensile strength (N/mm^2)		
	7 days	28 days	%	7 days	28 days	% change
Mix 1	23.84	32.86	100	3.44	4.82	100
Mix 2	22.23	31.8	96.8	3.62	5.14	107
Mix 3	21.22	30.31	92.2	3.72	5.43	112.7
Mix 4	20.84	30.0	91.3	3.25	4.51	93.6
Mix 5	16.78	22.98	70	3.32	4.69	97.3
Mix 6	16.5	22.91	69.72	3.6	4.76	98.75
Mix 7	15.8	22.87	69.6	2.69	3.58	74.27

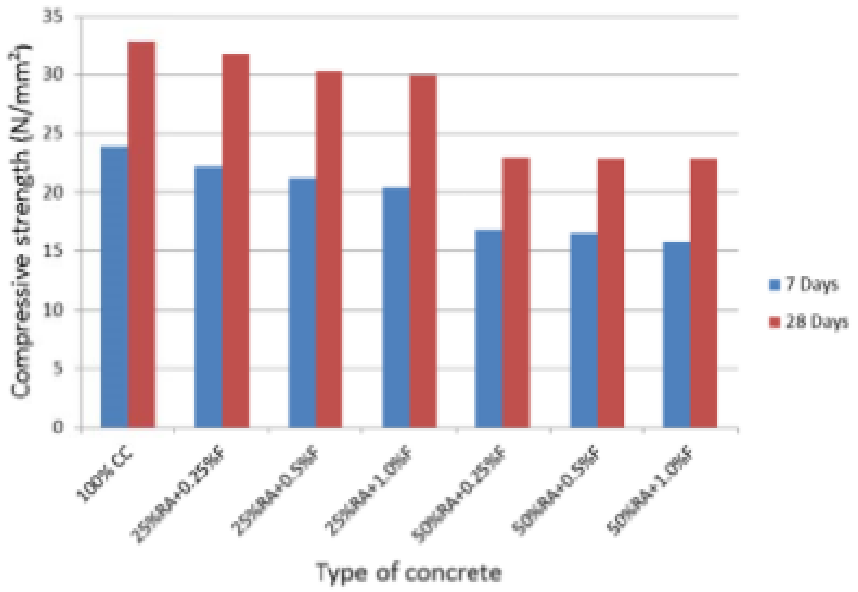

Figure 2 Compressive Strength Results

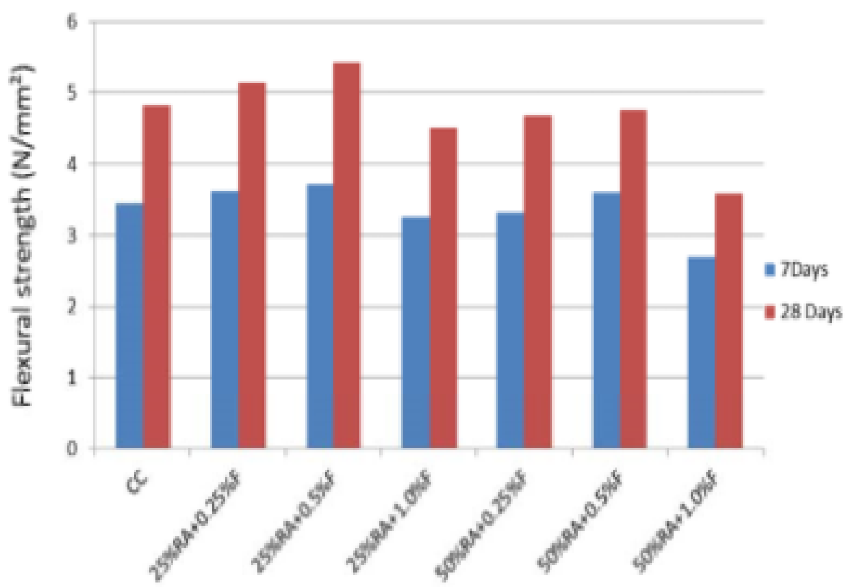

Figure 3 Flexural Strength Results

CONCLUSION

Following conclusions can be made from the experiments performed

- The water absorption of recycled aggregates was more as compared to normal aggregates, thus workability of concrete mixes containing recycled aggregates was less as compared to the concrete mixes containing normal aggregates only.
- The compressive strength of the concrete mixes containing recycled aggregates was found out be lesser as compared to concrete containing normal aggregates, 25% being comparable.
- Unlike the flexural tensile strength, there was decrement in the compressive strength of all mixes with the introduction of fibers.
- The flexural strength was found out to be maximum for the mix containing 25% recycled aggregates and 0.5% polypropylene fibers.

REFRENCES

1. MARTA,K.K, MATEUSZ, G. Recycled Aggregate Concrete As a Material For Reinforced Concrete Structures, Journal of Sustainable Architecture & Civil Engineering 2014.No.2(7)
2. AJDUKIEVICZ, A., KLISZCZEWICZ, A. 2002, Influence Of Recycled Aggregates On Mechanical Properties of HS/HPC, Cement & Concrete Composite, 24, 269-279
3. BALENDRA, R.V., ZHOU,F.P.,NADEEM,A.,LEUNG,A.Y.T,2002, Influence of Steel Fibers On Strength & Ductility Of Normal and Light weight High Strength Concrete
4. CAEREIRO, J.A, LIMA, P.R.L., LIETE, M.B., FIEKO, R.D.T 2014, Compressive Stress Strain Behaviour Of Steel Fiber Reinforcement- Recycled Aggregate Concrete Cement And Concrete Components
5. BCSJ.1977. Proposed Standard for "Use of Recycled Aggregate And Recycled Aggregate Concrete''. Building Constructors Society of Japan Committee on Disposal and Reuse Of Construction Waste
6. DIN 4226-100. 2000. Mineral Aggregate for Concrete and Mortar part 100: Recycled Aggregates
7. IS: 10262 (2009), Guidelines for concrete mix design.
8. IS: 383 (1970), Specifications for coarse and fine aggregates

Use of demolished waste as an aggregate in the construction of flexible pavement.

Introduction:

Roads and highways play very important role in development of community. Most of the highways and roads in our country are made up by Hot Mix Asphalt Bitumen which is very costly and uneconomical. As the materials costs are increasing day by day engineers are looking for an alternative to overcome this problem.

Now a days, The wide production of construction and demolition waste and its illegal deposition is also a serious current problems in developing and developed countries.

As demolition waste is generated in large amount in medium and large sizes. demolition waste has a great tendency to be reused as aggregate material in road construction .the aggregate from demolished waste is an attractive alternative for bases and sub-bases due to its high resistance and non-expansive behavior.

These material can be used as aggregate in low volume roads like village roads an d other district roads.

Objective:

The purpose of this project is to evaluate the feasible use of demolished waste as aggregate in pavement construction process.

Problem Statement:

As per previous data in the production of one tonne of cement, .9 tonnes of carbon dioxide is evolved out in production process of cement.
In the formation of aggregates, the blasting of rocks also produces carbon content which degrade the environment and affect the life of sorroundings.

Materials:

Demolition waste is a mixture of ceramic, concrete bricks, mortar, reinforced concrete, steel, plastics, asbestos cement and wood.
These materials so as to obtain as a aggregate which requires a well-planned procedure in which size reduction and sieving are important steps to complete this process.

Methodology:

These materials are characterized under standard laboratory test and evaluated by repeated load triaxial test. It also carries water absorbtion test , grain size distribution, grain shape, CBR test.

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Student Achievements

Subham Agrahari

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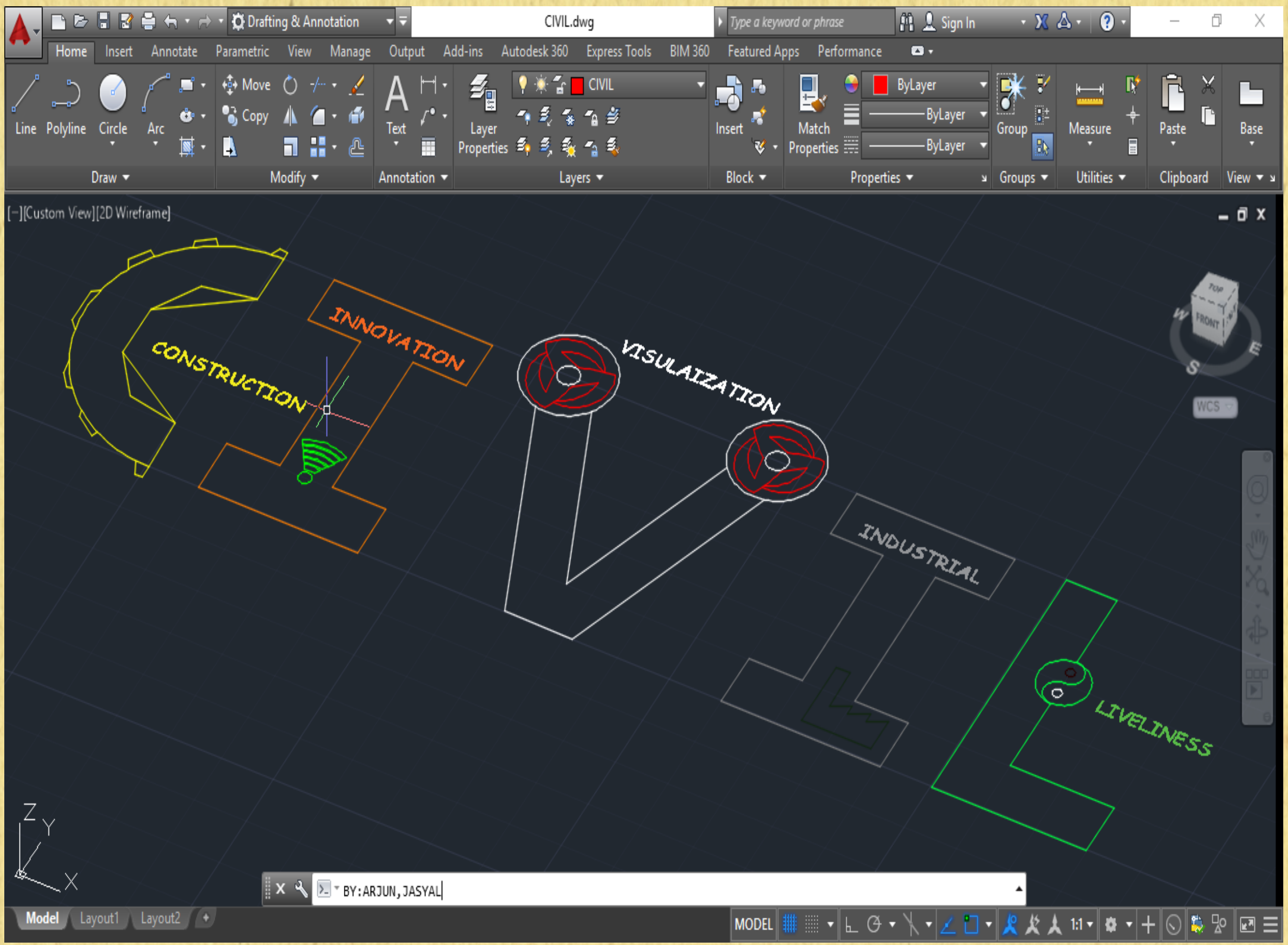
on 29th-30th October, 2015



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