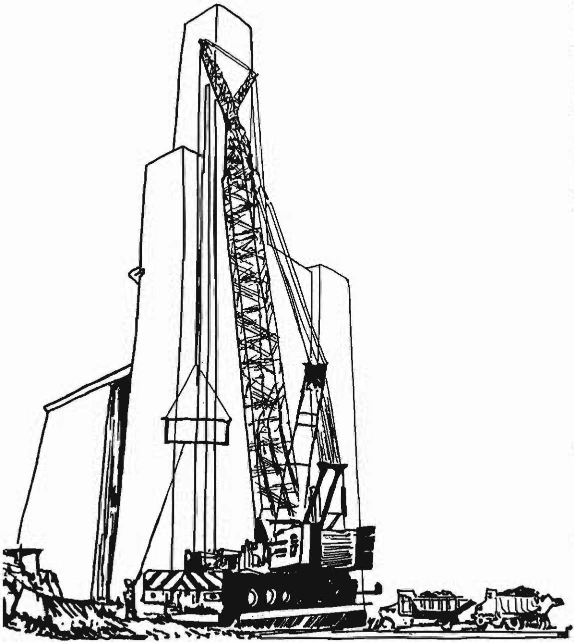
contour



A MESSAGE FROM THE HEAD OF THE DEPARTMENT

I am happy to note that another issue of CONTOUR is being brought out by the Editorial Committee. On this occasion, I wish to share a few thoughts of mine with the students of our Department.

We are now living in a period of "Computer Revolution". While the capabilities of the computer like speed, memory etc. are being considerably enhanced, their prices are being continuously slashed down. It appears that the time is not far off when you can have a P.C. with the capabilities of CRAY on your table. These developments have changed the attitude and approach to work in all walks of life, particularly in the field of l planning, analysis and design in Civil Engineering. Faster, better and more economical solutions even to problems hitherto unattempted are in sight. I am happy to note that many of our students have realised these potentialities and are striving to equip themselves with the latest in this area.

While I commend this trend towards computer, I cannot help pointing out another not so desirable trend on the part of our students. More and more of them are drifting towards analysis and theory oriented projects <u>only</u>. Their interest in experimental and practical oriented projects is declining. With the help of West German Government and Universities, we have established laboratories comparable to any of the best in the world. Indian Institute of Technology, Madras is known for its strength in experimental research. Continued efforts are being made to add latest equipments and modernise the laboratories under special funds. Good knowledge and training in practical oriented projects

....2

will be quite necessary to solve the basic problems of life such as provision of shelter for masses, drinking water etc. which are yet to be solved by Civil Engineers of our country. The students should therefore take interest in experimental and practical projects also during their stay here.

Further I would request the students to reactivate our Civil Engineering Association which is dormant for quite some time now. Needless to point out that this is the only forum through which our young students can come in contact with all faculties together and also with senior engineers in the profession and benefit from their experience and expertise.

Lastly I wish all the students success in their ensuing examinations and good luck in their professional career later on.

T P Ganesan

PROF.T.P.GANESAN

CONTENTS

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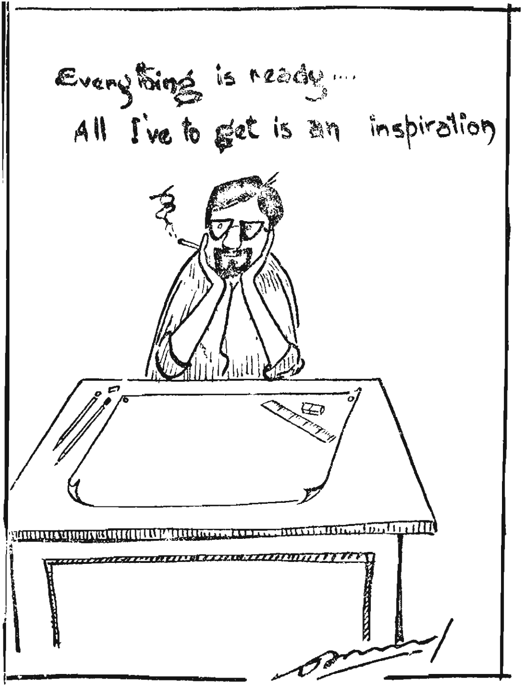
COVER DESIGN: AMALAN


Everything is ready....
All I've to get is an inspiration

From the Editors....

Hi folks! It is nice to be back with you with another issue of 'CONTOUR'. This issue features an interview with Prof. Johnson Victor, an article on residential building construction by Mr. S. Rajeev, several interesting articles from students and much, much more. Before you proceed further we will give you a brief update of the happenings in our Civil Engg community.

The job prospects for us Civil Engineers, we feel, are brightening with many more companies coming for placement this year. Although the number of B.Techs who have got jobs remains more or less the same as last year, it looks as if there will be an increase in the demand for Civil Engineers in the coming years. This probably coincides with the present trend of many major companies going in for expansion in a big way.

It is really too early to comment on the ''aid scene" - anyway, only a handful of students have received the 'good news' from the U.S. till now.

The GATE results this year have proved yet again that practically no B.Tech student is interested in pursuing higher studies in India.

Now a word about CEA activities - after 8 months of hibernation CEA has woken up at last - the first meeting of this academic year was held in the end of March. Prof. Santha Kumar of Anna Univ. gave a very interesting lecture about Tall Structures on the occasion. There was even a good student turnout!!! We hope that the faculty and the students will continue to work together in their endeavour in bringing back the lost glory of CEA.

While bringing out this issue we were faced with a dearth of articles, as usual, although we received promises for many more.

And finally, it is our pleasant duty to introduce to you the new set of Editors - Raghu, Vivek, Suresh and Kumar. We wish them all the best.

PLEASANT READING!!!

JOJU M. MICHEL	DINESH A.GOPINATH
RAGHU KAUSHIK	KURINJI, S

++++ Please bear with us for any typographical error ++++

PROF-FILE

In this issue, the spot-light is on Prof. D. Johnson Victor, who is one of the seniormost professors in our department and the head of Transportation Engineering Division. 'CONTOUR' had a very enlightening discussion with him which covered various topics of interest to all of us. Here are the highlights....

CONTOUR: Can you briefly tell us about your educational background and professional experience?

PROF.J.V: I graduated with B.E. in Civil Engineering from College of Engineering, Guindy in 1953.

I joined the then Madras State Highways Department as Junior Engineer in January 1954. My first posting was in South Kanara District, where I constructed one bridge and did field surveys for 25 miles of West Coast Road (now NH 17). Later I was transferred to Chief Engineer's Office in Madras. I did my M.Tech. in Structural Engineering at IIT, Kharagpur during 1957-58.

I joined IIT, Madras on 1st August 1960 as (the first) Lecturer in Civil Engineering. During 1963-66, I studied at the University of Texas at Austin, Texas and earned my Ph.D. in 1966.

Having joined IIT almost at its inception, I have had the privilege of participating in various facets of the development of the Institute in general and the Civil Engineering Department in particular. I served as Professor-in-charge, Engineering Unit during 1973-77 and as Head of Civil Engineering Department during 1979-82.

I have successfully guided eight scholars to Ph.D. and seven scholars to M.S., besides many M.Tech. theses.

My publications include one text book on Bridge Engineering and over 58 papers in Journals and conferences in India and abroad.

I served on invitation as a Professor at a National University in Japan for one year during 1987-88.

CONTOUR: Why did you choose 'Transportation Engineering' as your field of study?

PROF.J.V: My early practical experience was in Bridge Construction and in Highways. Based partly on my field experience, I have written a text book on 'Bridge Engineering', which is now in Third Edition and is followed in most Universities in India.

By 1972, I felt convinced that IIT Madras should have a post-graduate programme in the emerging area of Transportation Engineering. So I contributed towards the development of a M.Tech. course in this field, which was the first programme in Transportation Engineering in the IIT system.

CONTOUR: What is the scope of 'Transportation Engineering' abroad and in India at present? What are your predictions for the future in the Indian context?

PROF.J.V: Transportation Planning is a relatively new field, not only in India but abroad also. Government of India have rightly recognised this as an 'Emerging Area of Technology', and, during the past 2 years, have allotted Rs.20 lakhs for developing infrastructure for better training in this area at IIT Madras. Similar grants are given to many other institutions also.

There is adequate scope for study in Transportation Engineering in India and also in USA, Europe and Japan.

Developed countries have recognised the need for good transportation many years back and are thus able to sustain an industralised status.

In India, attention given to transportation in the past has been inadequate to meet the demands for various reasons. Currently, the awareness of the importance of transportation is increasing. So in the near future, I expect that engineers well trained in Transportation Engineering will have bright prospects for fruitful employment.

CONTOUR: What are your current research interests? How about consultancy?

PROF.J.V: My current research interests include: Urban transportation planning, bus transit, and traffic safety, with special emphasis on developing countries. My latest publication is an invited paper on 'Road accidents in India' published in February 1989 issue of IATSS Research from Tokyo.

My past consultancy projects included development of specialised transport equipment and inspection of construction. While there are not many consultancy projects forthcoming in my areas of current research, I have been invited to serve on many technical oommittees. The latest such assignment is Membership in the Expert Group on Water Transport in India constituted by the Science Advisory Council to the Prime Minister.

CONTOUR: What is your opinion about students going abroad, especially those going for 'Transportation Engineering'?

PROF.J.V: Having studied and taught abroad, I would like to encourage students who wish to go abroad for higher studies. But I would advise that students, who seriously try for admission to graduate programmes in Transportation Engineering abroad, would do well to take a few elective courses and projects in this area at IIT Madras. This will be of much help to them in gaining an orientation.

Secondly, students should keep in mind that the techniques that they study in USA or other industralised country cannot be directly transported to India. They should learn to adapt the methodology of advanced countries to the conditions prevailing in India.

CONTOUR: As a senior Professor, what are your expectations from students?

PROF.J.V: The students are well motivated to study at IIT Madras. They have the best of facilities here, and I am sure they will have the necessary training to take up leadership roles in the development of the country.

CONTOUR: How do you feel about the available facilities in Transportation Engineering?

PROF.J.V: The physical facilities available are reasonably adequate for the current emphasis on transportation system planning. However, we may need a few more faculty and research scholars to take up academic work in certain areas, e.g. transportation economics, air transportation and rail transportation.

CONTOUR: You have a long association with this Institute. Are you satisfied with its performance as an Institution of higher learning?

PROF. J.V: As I indicated earlier, I am at IIT Madras since August 1960. I am quite satisfied with the progress made, particularly in Civil Engineering Department. There is still scope for improvement. For example, I would like to see more sponsored research projects than at present. The available potential for experimental research could be more intensely utilised.

CONTOUR: We hear that you will be retiring soon. What are your plans after retirement?

PROF.J.V: I am due for retirment in February 1991. I am keeping my options open. I am sure that I will be usefully employed as a Professor even after my retirement from IIT Madras.

Closure:

PROF.J.V: Finally, I thank you for your interest in my work at IIT Madras and I wish you and through you the readers of 'CONTOUR' success in career and health and happiness in life.

CONTOUR: Thank you, Sir!

OPTIMIZATION OF COST IN RESIDENTIAL BUILDINGS - A case study

Mr. S. Rajiv.

Optimising cost in the construction of residential buildings is essentially a very important topic that civil engineers can contribute to a lot . It is generally seen that the engineering aspects of the construction of residential buildings are mostly being managed by non technical contractors. The public has also got a feeling that there is practically engineering involved in house construction and if any at all the head mason or the contractor (mostly non-engineer) are more than sufficient for that.

Both in the case of flats as well as bungalow type of residential buildings, it seems like the industry has standardised almost all the activities. Architects are being called upon to plan flats. These plans may be functionally efficient, but may not be cost effective. Also, most of them follow the conventional technology in construction.

As the factors affecting the cost of construction are many, proper thought has to be given to each one of them, to minimize the cost. Proper utilization of advancement of technology in planning, structural forms and their design and construction techniques will bring down the cost of construction by a great extent. I would like to share some of my thoughts and experiences in this area. Recently, about 6 months back, I have completed the construction of my own house, where I tried some ideas, which are not generally practiced here. The experiemmt proved to be successful so far, both from the performance of the building and the cost of construction point of view.

Masonry wall and reinforced concrete roof are the two load bearing structural components in any residential buildings. These are the two major items, which consume a big percentage of the total cost. Quite a lot of research activities are being carried out on structural and functional aspects of wall and foof components of residential buildings in many research laboratories academic institutions in the country. Different bonds are being considered for masonry walls and different structural forms for floors/roofs. I tried the ''rat-trap masonry'' for walls and funicular shell for roofs. Rat-trap masonry has been successfully used by the famous architect BAKER in the places where the duration of monsoon is quite long. Many research papers are available in Indian as well as International journals on structural strength and durability of roof system made up of funicular shells.

The shells are to be cast on ground and then assembled in position. As the size of the room decides the size of the shell, it is necessary to have a minimum number of different sizes of shells. Many different shell configurations can be adopted as shown in figure 1. As the number of joints is more in the configurations 1(a) and 1(b), the one shown in figure 1(c) is adopted. In this the length of each shell unit is 50 mm more than the width of the room. The longitudinal and cross-sections of one shell unit adopted is shown in figure 2. To minimize the number of moulds to be prepared to cast the shells, it was decided to use shells with same dimensions for the whole building. This put a dimensional constraint on planning, i.e., one dimension of all the rooms has to be kept same, and the other dimension an integer multiple of one shell unit. The structural action of the roof system is such that, the loads from the roof are transferred

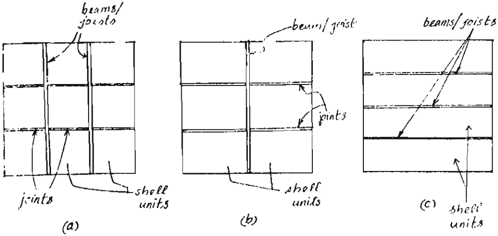


FIG. 1

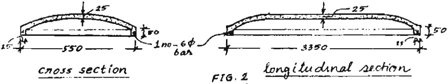


FIG. 2

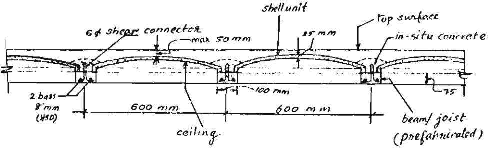


FIG. 3 CROSS SECTION OF ROOF/FLOOR SYSTEM

only to the opposite walls. This in turn brings down the number of load bearing walls in the building. As only external walls and the internal load bearing walls need the foundation, the reduction in the total length of load bearing wall results in reducing the foundation cost. Other walls to divide the rooms are constructed as partition walls, which requires only a nominal foundation - i.e., thickening the floor concrete below it.

The moment we think of a shell, the first thing that comes to mind is the mould. To cast the shells with the required curvature, moulds are to be prepared. The definition of the funicular shell is that the shape of the shell is derived from its dead weight. The mould is designed by taking this theory into account. No mould with curved surface is used to cast the shells. A tightly fixed thin gunny bag (known as jute canvas) gives the necessary curvature to the shells. The same gunny bag was used to cast about 8 to 10 shells. Only the edge beam of the shell carry reinforcement. All the technical papers available on the topic describe shells with thick edge beams around it. One such shell unit with present dimensions will weigh about 240 kg. and special lifting arrangements are necessary to lift and place them in position. Hence, the design was modified to reduce the weight of a single piece to be lifted, which in turn reduces the manpower required for the erection of the roof system. The modification carried out in the design was the removal of the edge beam from the shell unit and combining the edge beams of two adjacent shells to form a joist. Figure 3 shows the details of joists and the shell units after erection. The thickness of the shell used is 25 mm with only a 6 mm mild steel bar around it as reinforcement as shown in figure. The edges of the shells are flattened to get a proper seating on the joists. The reinforcement in the joists is to be designed for its span. Two 8 mm HSD bars are used as main refinforcement and shear connectors are provided projecting out, so that the joist acts as a single unit togerther with the in-situ concrete placed after assembling the foof system. A concrete mix of 1:2:4 is adopted with 12 mm coarse aggregate. Only three moulds are made and the quantity of concrete required to cast these is not much. Hence the mix was prepared manually. A mason and two helpers took half a day to cast three shells. The shells were demoulded on the third day . After demoulding, the gunny bag fixed on the mould was tightened so that next set of shells could be cast.

To have uniformity in the structural forms in the building, funicular shells are used as sunshades. With this, the conventional formwork and centering was totally avoided except for the staircase. Complete prefabrication of lintel beams and sunshade units accelerated the speed of construction work, along with considerable reduction in cost. The details of a typical sunshade are shown in figure 4.

Casting of joists, shell units for sunshades and roof were carried out in parallel with the construction of walls. The lintel beams, sunshade shells and necessary brackets were ready after curing by the time the wall construction reached the lintel level. Similarly all the shells and the joists were ready when the walls reached roof level. Erection of whole roof system consisting of joists and the shells was completed in a day. [The group of workers were really afraid to walk over the roof after erection as the body of the shell is only 25 mm thick and did not have any reinforcement. It is quite understandable that they are only used to 100 to 120 mm thick slab with 8 to 10 mm HSD bars running across as reinforcement.]

Assembly of the roof system is completed as shown in figure 3. The shear connectors provided ensures the monolithic action of the roof system with precast and in-situ concrete elements. The usual weathering course with brick pieces in lime mortar was used to level the top of the roof. (The design details of the roof system and casting sequence of the shells are not included in this article). These types of roofs are not restricted to one floor only. As the strength of the roof system is as good as the conventional one, additional floors can be constructed. The overall savings in cost over the conventional roofing system was worked out to about 30%. Morethan this, the ceiling looks different and better(maybe because it is different from the conventional one.)

Wall system

Now coming to the load bearing walls, one of the most important constraint one should consider while designing is its structural strength. i.e., its ability to bear the loads of at least two storeys and possibly one more later. Hence optimization in cost means reducing the materials required for construction (i.e., bricks and cement) without compromising its strength. As the present roof is light compared to the conventional slab type, the loads on the walls are reduced. Onebrick thick wall (9 inches or 230 mm thick) was used for load bearing walls and the details of the bond used to construct the wall is shown in figure 5.

Figures 5(a) and 5(b) shows the plan of two successive layers and 5(c), the elevation. The size of the country brick that is available in Madras is approximately 9'' X 4.5''X 3'' (i.e., 230 mm X 115 mm X 75 mm). The bricks are placed on edge, which is not a common practice. Extensive research

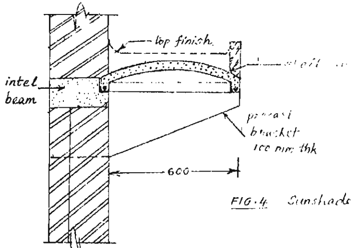


FIG. 4 Sunshade Details

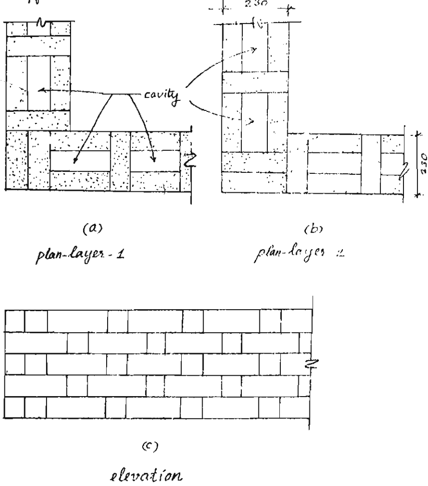


FIG. 5 Rat-trap masonry

has been carried out by the central Building Research Institute, Roorkee on this type of masonry and the results show that the load carrying capacity of walls with this bond with the chamber - burnt country bricks is quite sufficient upto three floors, in residential buildings. The famous architect Baker has used such masonry years back and proved it to be successful. He calls this kind of masonry ''rat-trap''. The only difficult was to train the generally reluctant masons to construct such walls. Initially the speed of construction was quite slow, but later it picked up as the masons started really getting into it. The overall reduction achieved in materials was about 35% and in cost approximately 30%. This was due to slightly more labour requirements.

Functionally, the walls with the cavity inside provide a very high insulation property. The thermal comfort in the rooms has increased considerably and the rooms were quite warm during this winter. It is also expected that they will be quite cool during the summer. The cavity in the walls was closed at three levels by a continuous layer of bricks placed on edge. At the window sill level, lintel level and roof level the cavities are closed. 1:6 cement mortar was used for the construction of walls.

Ofcourse, a close supervision is very much required to control the quality of construction. The joints between the shells and the joist, joints between the wall and the lintel and sunshades etc. are to be sealed properly with cement mortar. During the last monsoon, damp patches were observed on inside walls at the joints between wall and sunshades. It disappeared after repair. There was no dampness anywhere on the ceiling.

The above discussion shows that proper planning, selection of structural form and its design for roof system and sunshades and selection of proper bond for load bearing walls considerably reduces the cost of construction of residential buildings without compromising safety, strength and comfort aspects. Improvements are possible in other building components also which can optimize the cost of construction. It very much shows that <u>there is engineering in construction of residential buildings</u> and the engineering judgement of technical personnel in every aspect of planning, design and construction not only improves the quality of the building, but also reduces the cost of construction. As housing is one of the major industry in our country, there is lot of scope for entrepreneurs with engineering background. Especially among the middle class citizens of our country, constructing a house is the major investment. Cost optminization can not only bring down the pinch on their pockets, but we can also keep our (civil engineering community's) committment to the nation by producing cost effective designs and thus reducing the national wastage to minimum. Let us contribute to make everyone's ''house'' really a ''dream-house''.

TENSILE STRUCTURES

JOJU.M.MICHEL
4/4 B.TECH.

When H.G. Wells, in the novel 'When the Sleeper Wakes' looks into the twentysecond century, he writes of the city of London covered by a transluscent membrane spanning to cables that arch across the city. Giant wind mills are seen outside the city generating power on the inhabitants. He seems to describe a time when fossil fuels are gone and the city is encapsulated so as to give a controlled environment. Is it possible that this is the direction in which technology is taking us? Considering the history of tensile structures over the last few decades, we can similarly expect the future will be so shaped.

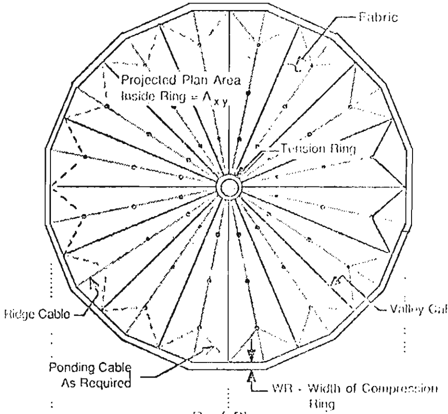
People on the move have used lightweight tensile structures in the form of tents for many thousands of years, the oldest made of branches and animal skins - going 20,000 to 30,000 years back. Medieval armies had tents of impressive size and shape. The large circus tent is one of the more recent applications.

The main advantage of the above type of structures was the very light weight of the root, and hence its ability to cover very large area with minimum construction cost. But the construction of a tent structure with a comparatively long life period was impossible with the building materials available in those times. Then the arrival of steel cables began to make an impact in this field.

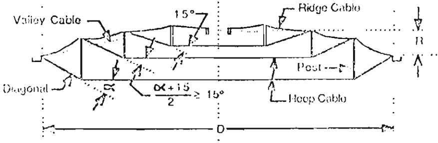
Although the first recorded evidence for a structure made of steel cables dates back to 1620, the idea of using steel cables as structural elements in a building however, is very recent. One example is the tensile root used in International Agriculbural exhibition in Madrid (1953). Roofing was cable net + light weight concrete. Water-fightness was achieved by a tectined cloth, painted with bitumen applied to the external surface. Exterior was painted with aluminium paint. The root had to be repaired every two years for impermeability.

But now that the structure could no longer be considered temporary or portable, what was needed was membrane material that would allow for the construction of a 'Permanent Structure'. Although in 1964 a new membrane material was introduced - polyester reinforced with plastic fibre - it was not entirely satisfactory. The task was finally assigned to Gieger Berger Associates (in New York) by Educational Facilities Laboratory. Working with various other agencies they developed the permanent solution - Teflon Coated Fibre Glass Fabric. This membrane is - transluscent, abrasion resistant and non combustible. This achievement immediately started showing the result.

Till the late sixties, tensile structures were constructed as 'Prestressed' systems. But by the completion of the U.S. Pavalion in Expo '70 in Osaka (Japan), a new structural system was introduced - 'Air Supported' system. In these type of structures the pressure inside the structure acts as a pseudogravity which keep the comparatively light roof of cables and membrane in tension and hence in proper shape. The new experiment was an immediate success - in the brief period from 1974 to 1984 a total of seven air supported stadia were built, the largest being Pontiac Stadium in Michigan which covers more than 10 acres of unobstructed space.



Roof Plan



Roof Section

CABLE (TENSEGRETY) DOME

The reason for this wide spread interest is because of several reasons. Since the roof is transluscent, artificial lighting is not required in the daytime. It also gives a controlled environment that gives a feeling of being outdoors - A desirable feature for sport structures and which cannot be achieved by other structures.

In 1983 Buckminster Fuller proposed another novel idea - The Tensegrity Dome. This type of structure doesn't need air pressurization inside. This inspired Gieger Associates to design the Gymnastic Hall for Koream Olympics with a system very much similar to tensegrity dome - Cable Dome - rivaling low profile air strutrures in Economy and appearance. (The plan and the truss details are shown in the prv. page). It is envisioned that the cable Domes will over the next ten years impact the design of long span roots, particularly for sports facilities, as the low profile air structures have in the last ten.

The development in compression structures will be always constrained by considerations of buckling which is controlled by the geometry of cross section. Freudenthal and others (in 1950) have shown however that, for a particular material the modulus of elasticity is a constant, but on the other hand the ultimate strength can be made to increase by reducing or idealy eliminating the imperfections in grain boundaries. We now know that grain boundaries can be climinated by growing metallic whiskers in a gravity free environment as in outerspace. These whiskers would have a strength thousands of times greater than materials now produced on the earth, Similarly it is possible to postulate one molecule thick glass having no imperfections and brittle characteristics that could function as an ideal transparent membrane. Considering the present rate of development in this field we have every reason to believe that Tensile Structures are the structures of the future - That which the genius of H.G. Wells had foreseen right back in the nineteenth century.

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SOURCE : VARIUS I.A.S.S. JOURNALS.

FORM AND SPACE

''We put thirty spokes together and call it a wheel
But it is on the space where there is nothing that
the utility of the wheel depends.
We turn clay to make a vessel;
But it is on the space where there is nothing
that the utility of the vessel depends.
We pierce doors and windows to make a house;
and it is on these spaces where there is
nothing that the utility of the house depends.
Therefore, just as we take advantage of what is,
we should recognize the utility of what is not.''

— LAO TSE

THE KINEMATIC INTERPRETATION OF THE CANTILEVER APPROACH IN THE CALCULATION OF DEFLECTIONS

BENNY RAPHAEL
3/4 B.TECH.

In the last issue of contour, we found that the deflections on cantilevers and simply supported beams can be written down directly by inspection treating each part of the structure as a cantilever. The results were based on the moment area theoreme. In this article we will go into an interesting exercise, the kinematic interpretation of these results.

First let us take the case of cantilevers.

It can be seen that the fictitious cantilever deflections in the cantilever method are nothing but the deflections on the actual structure measured from an inclined base. (See Fig. - 1).

Coming to simply supported beams (Fig. - 2A)

If the end A of the beam were fixed and the end B free to move due to the action of external forces and the force equivalent to to the external reaction applied at B. The elastic curve will take a shape shown in Fig. - 2B. The deflection at B, $\Delta B'$ is nothing but the fictitious cantilever displacement we have computed. The chord A 'B' is at an inclination $\theta A' = \Delta B'/l$.

In order to restore the kinematic conditions of the actual beam rotate the entire figure about A' by an angle $\theta A' = \Delta B'/l$, so that the chord A 'B' becomes horizontal.

The deflectione measured in this position would give the actual deflections on the simply supported beam. Hence the actual rotation at $\angle A = \theta'_A = \Delta B'/l$.

And the actual rotation at any point on the beam will be equal to the fictitious cantilever rotation minus θ'_A.

In order to calculate the deflections at any point on the simply supported beam, we considered the point as the fixed end of two fictitious cantilevers on either side (Fig. - 3B). The reactions were replaced by equivalent forces. The delfected shape under this condition is given in Fig. - 3C. The points B' and A' are at different elevations. The difference in elevations of these two points is $\Delta A' - \Delta' B$

Hence the chord A'B' is inclined to the horizontal by an angle $\theta = (\Delta A' - \Delta B')/l$

In order to bring the chord A'B' to a horizontal position rotate the diagram by θ

In this position the beam is kinematically equivalent to the actual simply supported beam, and the deflections measured about the Line A'B' give the true deflections. Hence the actual rotation at the point C:

$\theta\ C = (\Delta A' - \Delta B')/l.$

It is a simple geometric exercise to prove that the distance of C' from the line A'B' is $\Delta A' \times b/l + \Delta' B \times a/l$. which is the actual displacement At C.

INDETERMINATE STRUCTURES

We were able to write down the actual deflections from the

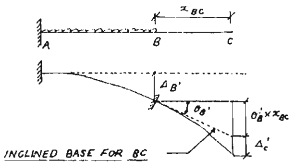

FIG 1A

FIG 1B

THE DEFLECTION OF A CANTILEVER

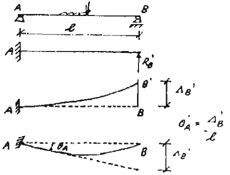

FIG 2A

FIG 2B

FIG 2C

FIG 2D

THE CANTILEVER METHOD FOR SSB

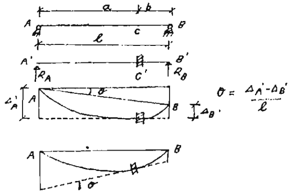

FIG 3A

FIG 3B

FIG 3C

FIG 3D

deflections of individual parts because the structure was determinate. It should be noted that in the case of indeterminate structures, We can not apply these kinematic Principles. Due to the presence of reduntant reactions any rotation or translation would induce forces in the members which would further change the deflections. However it can be seen that based on these principles , an exact method of analysis of indeterminate structures could be evolved which does not require the solution of simultaneous equations. This we will see in the next issue of Contour.

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PAMBAN BRIDGE

V.Suresh
3/4 Civil

The inauguration of the Anna IndiraGandhi Bridge by the Prime Minister - Mr.Rajiv Gandhi on the 2nd of October, has brought to a fruition this colossal attempt to bridge the sea.

The 20 crore bridge, the only road bridge across the sea in India, connects the island of Rameshwaram with the mainland/The bridge is at the junction of the Palk Strait and the Gulf of Manuar between Pamban and Mandapam in Ramanathapuram District of Tamil Nadu. Standing on 74 open foundations of which 64 are in the sea, and covering a distance of 2,345 m, it is 52 m south of a rail bridge already providing the link.

Rameshwaram has the famous 17th century Ramnathswamy temple with its carved granite pillars and artistic corridors. About 30 lakh pilgrims and tourists visit Rameshwaram every year. Hitherto, facilities for travel to and from the island have been inadequate and subject to interruption during bad weather.

The foundation stone for the road bridge was laid by the then Prime Minister - Mrs.Indira Gandhi, as early as in 1974 but the progress was unsteady. The contract which was originally awarded to Neelakandal and Brothers (Madras), was finally completed by Gammon India Ltd., 14 years after the laying of the foundation stone at a cost of Rs.20 crore, up from the originally estimated Rs.5 crore.

The road bridge has 79 spans of 27.13 m each, a navigation span of 115.21 m and two anchor spans of 68.5 m on either side of the navigation span. To facilitate ship traffic, a vertical clearance of 17.68 m has been given above the high tide level at the navigation span. The bridge has a gradient of 1 in 100 on the Mandapam side and 2 in 100 on the Pamban side. There are two traffic lanes, each 7.5 m wide and two footpaths each 1.5 m wide.

The challenges involved in the project mainly arose from the fact that it was in area of cyclonic disturbances and in a severely corrosive environment.

The open foundation method was employed since the founding stratum available at the shallow depths were strong enough to bear the load. To lay the pillars, divers cut out of the sea bed a circular trench 1 m wide and 0.3 m deep with an internal diameter of 12 m. The depth varied depending .. on the undulation of the bed. While the trench cutting was in progress, a circle platform was erected along the periphery of the trench on either side. The two platforms were connected by rail over which the coffer dams were assembled. The coffer dam - a twin walled cellular steel structure with 1.5x1.5m curved shutters was lowered into the trench after the two layers of shutters were assembled and lifted slightly above the circle platform with found 10 - tonne chain blocks mounted on a tripod and after removing supporting rails of the platform.

After the coffer dam was lowered, concrete was laid underwater in its cellular portion to a depth of 30 cm. After the concrete had set, sand was spread over it to a height of 1.5 m to provide deadweight to the Coffer Dam. At this stage, dewatering was begun and the bed exposed. The usual foundation laying was then begun.

4,000 tonnes of mild, tensile and structural steel, 30,000 Cum of crushed stones, 15,000 Cu-m of sand besides 12,500 tonnes of sulphate resistant cement, 8,000 tonnes of high strength cement have gone into the making this engineering marvel. The 14 years wait has been worth it.

ARTIFICIAL INTELLIGENCE AND THEIR APPLICATIONS IN CIVIL ENGINEERING.

P.GIRISHKUMAR
4/4 B.TECH.

Artificial Intelligence (AI) is the mystery topic which has taken the world and particularly engineering subjects by storm. AI endeavors to make computers intelligent.

Why at all should an engineer be interested in AI?

The answer is ---- to make the computers more useful for getting the best possible solution. Computers should check design rules, recall precedent designs, offer suggestions and help create new designs. Also computers should act as superbooks for engineers.

As an introduction it is necessary for us to have a look at varioue fields of AI.

+ Knowledge based systems + Robotics
+ Logic and Theorem proving + Natural language processing
+ Voice recognition + Image recognition
+ Concept and learning computers

Almost all Civil Engineering problems can be calssified in the areas of knowledge. Based systems to Robotics. In fact most of the other problem areas are responding better to the 'neural network' approach.

The development of Expert Systems (ES) on knowledge based systems started in the 70's.

An E S is a software which solves problems in the domain area of the expert. An E S building process is called knowledge Engineering. The knowledge engineer (who builds the E S) interacts with the domain expert's and extracts knowledge in the form of strategies, rules of thumb etc. This is the most challenging part of an E S. The term domain expert can also refer to books and journals. A tool builder creates a friendly atmosphere (an E S building shell) for building an E S. This shell is used by the knowledge engineers to build an E S.

Finally we have the end user who makes use of the E S to solve these problems. In CE the end user can use E S s in to following areas.

+ Design of multistoreyed RC buildings
+ Concrete and steel bridges
+ Steel industrial structures
+ Transportation Engg.
+ Geotechnical Engg.
+ Trouble shooting defects in buildings
+ Water resources systems etc.

One of the most successful E S's in Civil Engg. has been PROSPECTOR which helps geologists locate ore deposits.

The hallmark of E S is that the problem domain (knowledge base) is separated from the systems other knowledge (inference engine). In E S's branching is the rule rather than exception; as in conventional algorithms. Sensitivity Analysis (If X is changed how is Soln. affected?) can be carried out in E S's. In E S's knowledge is applied using shortcuts and tricks. E S's have a permanent record of the best strategies used by experts in the field.

E S's Invaded the world often the phenomenal success of :

XCON - Configures VAX computers - developed by DEC, USA
MYCIN - helps physiciansdiagnose and treat infections
flood diseases - developed by Standard University.

REPRESENTATION OF KNOWLEDGE

Rule Based Reasoning:

Knowledge is represented in the form of IF - THEN rules. These rules represent processes driven by a complex and rapidly changing environment. A set of rules specify how the program should react to the changing data without requiring detailed information about the flow of control. These rules adaptively determine the best sequence of rules to execute. Conclusions can be explained by retracting the steps. If an antecedent (IF ---) is satisifed then so is the consequent. If the consequent (Then ---) defines an action then the action is scheduled for execution else a conclusion is inferred.

Inference Methods:

Forward Chaining: An inference method in which rules are matched with facts to establish new facts.

Backward Chaining: An inference method in which system starts with what it wants to prove and tries to establish the facts it needs to prove its assumption.

Frame Based Reasoning: This is a structured knowledge representation technique which associates features with nodes representing concepts on objects. The features are described in terms of their attributes (called slots) and their values. One frame may represent a concrete beam and another a whole class of beams ie each class can be described as a specialisation of a more general class. Frames can be used to partition index and organise a systems production rules.

Semantic nets are a network of nodes standing for concepts on objects connected by arcs which describe relations between nodes.

OBJECT ORIENTED PROGRAMMING

In object oriented programming all the action comes from sending messages between objects. Objects combine the properties of procedures and data since they perform computations and save local state. Instead of naming a procedure to perform an operation on an object one sends the object a message. The selection in a message specifies the kind of operation. Objects respond to messages using their own procedures for performing operations. Message sending and specialisation (Class inheritance is used) form important concepts in object oriented programming, specialisation helps to avoid storing redundant information and simplifies updating to modifications.

BLACKBOARD ARCHITECTURE

This is a sophisticated architecture E S's of the future. Modules of knowledge communicate via a central blackboard. In a blackboard system the solution space is organised in to one on more application dependent hierarchies. The domain knowledge is partitioned into independent modules of knowledge that transforms information at one level possibly using information at other levels of hierarchy in to information on the same or other levels. The choice of the knowledge module is based on the latest additions and modifications to the data structures . At each step either forward or backward chaining can be applied.

Such a system will be particularly useful in finite element method application.

ROBOTICS

Robotics has started playing an important role in Structural Engg. Laboratories throughout the world.

Robotics involves the following:

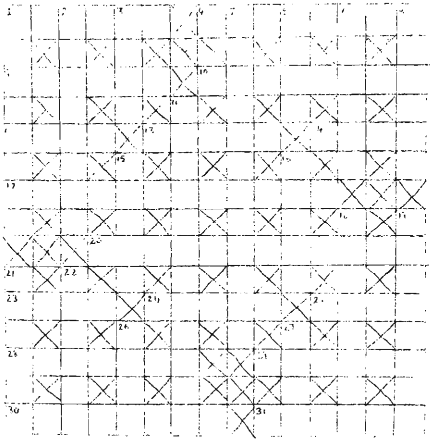
+ Sensor and Sensor Understanding :Vision, Force and touch capabilities
+ Manipulations and manipulation control: Robot arms should be capable of fast accurate motion and should be capable of graping all objects.
+ Object and Space Oriented Problem Solving:

Robots have to visualise how things fit together. They should move around without bumping into objects, Robots need the mathematical principles and both kinematics and dynamics. Relations between manipulation position, orientation and joined angles as also between point motions and required motion torque have been derived. Robots need mixed position and hence controls as also spatial reasoning.

Once the research in robotics has yielded good results, Civil Engineers will find a lot of use with them.

Expert systems and Robotics have come to stay in the area of Civil Engineering. Hence the research in thes areas are of great importance to future Civil Engineers.

CROSSWORD



CLUES

ACROSS

1) Point to a loud fair and get exhausted(6)

4) Influenced and made a show of (8)

9) Deals with right inside udders(6)

10) Storminess without a start is mildness (8)

12) Maybe bent, scar (4)

13) Steal a bit (5)

14) Sharp but eke out a point (4)

DOWN

1) Charm the gate (8)

2) Plundering sheep clothing may be (8)

3) To the back street children (4)

5) Extract in fat with charge honouring (12)

6) She 's a girl among them may be (4)

7) Offer to nurse (6)

8) Deans with Japanese dough in Data Operating Systems (6)

11) Completely devoted but with one brain only (6,6)

FINISHING LINE — TOMMY

ACROSS

17) Go on creating for the gathering (12)
20) Yield Les on the sly without a gap (12)
23) Combine bat (4)
24) Scheme about a flier (5)
25) Number a silent stroke (4)
28) Exaggerated drive with do (6)
29) How to have a couple of pounds with nothing but a cavity (6)
30) Delays and hangs (8)
31) First of the month when in danger (3,3)

DOWN

15) Concise element of wear (5)
16) Bay to the North of thirteen witches (5)
18) The nitwit suffered on being attacked (8)
19) Incidentally seen on the roadside (2,3,3)
21) Bill with hills can emote (6)
22) Constraint of rude ship (6)
23) Lied that he was lazy (4)
27) Ten thank a bit (4)

ANSWERS To CROSSWORD

ACROSS

1. EFFETE 4. AFFECTED 9. TREATS 10. CLEMENCY 12. ARCS

13. PINCH 14. KEEN 17. CONGREGATION 20. RELENTLESSLY

23. CLUB 24. PILOT 25. LASH 28. OVERDID

29) HOLLOW 30. SUSPENDS 31. MAY - DAY

DOWN

1. ENTRANCE 2. FLEECING 3. TOTS 5. FELICITATION 6. EMMA

7. TENDER 8. OYENS 11. SINGLE MINDED 15. BRIEF 16. COVEN

18. ASSAILED 19. BY THE WAY 21. ACTORS 22. DURESS 23. IDLE

27. IOTA

VERY SPECIAL THANKS TO THOMMY FOR CARTOONS

AND TO
THE DEPARTMENT OFFICE
THE TRANSPORTATION ENGG. OFFICE
THE BUILDING TECHNOLOGY OFFICE
THE GEOTECHNICAL ENGG. OFFICE, AND
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