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HON. EDITOR : Eng. G. C. Oak

Contents

ISSE FRATERNITY

WELCOME TO NEW MEMBERS

We welcome following new members, who joined after 1- 4 - 2006

M-747 Ramadurgakar Suresh Vishnupanth	M-748 Dawle Rajkumar Madhukarrao
M-749 Shaikh Amin Abdulaziz	M-750 Hasawala Fakhri Abbasbhai
M-751 Chaudheri Ujval Ravindra	M-752 Vaidya Ravikiran Ramesh

WITH THE NEW ADDITIONS, FRATERNITY (AS ON 30.6.2006) IS

MEMBERS : 752 ORGANISATION MEMBERS : 12 JUNIOR MEMBERS : 5

PATRONS : 29 SPONSORS : 8

REVISED STRENGTH : 806

OUR INTENTIONS

1. To restore the desired status to the Structural Engineer in construction industry and to create awareness about the profession.
2. To define Boundaries of Responsibilities of Structural Engineer, commensurate with remuneration.
3. To get easy registration with Governments, Corporations and similar organisations all over India, for our members.
4. To reformulate Certification policies adopted by various authorities, to remove anomalies.
5. To convince all Govt. & Semi Govt. bodies for directly engaging Structural Engineer for his services.
6. To disseminate information in various fields of Structural Engineering, to all members.

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- Construction Technology & Management
- Computer Software
- Geo-Tech & Foundation Engineering
- Materials Technology, Ferrocement
- Environmental Engineering
- Teaching, Research & Development
- Non Destructive Testing
- Rehabilitation of Structures
- Bridge Engineering

& Other related branches

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	TITLE	Amount of Donation
1)	Proceedings of National Conference on - Corrosion Controlled Structure in New Millenium	Rs. 400/-
2)	Design of Reinforced Concrete Structures for Earthquake Resistance	Rs. 600/-
3)	Workshop & Seminars-Seismic Design Book	Rs. 150/-
4)	Proceedings of One Day Course of ISO-9001	Rs. 150/-
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6)	Proceedings of Workshop on Software Tools for Structural Design of Buildings with CD.	Rs. 500/-
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12)	Seminar Papers of “Innovative Repair Materials / Chemicals”	Rs. 200/-

CRANE FOR ERECTION OF LARGE SPAN SHED ABOVE WATER

Eng. A. B. Karnik

Shed admeasuring 41m wide x 140 m long x 30 m high was to be erected ABOVE WATER. This situation was to prevail all through its life time.

Main purpose of this shed with permanent Gantry Crane etc. was for maintaining the SHIPS AFLOAT.

This shed was designed by other Consultants with twin leg columns and built-up rafters together as Portals. One row of columns rested on Jetty and other row of columns rested on 3.80 m wide r.c.c. platform. This platform was supported on twin piles of 1000 mm dia. at 8 m c/c coinciding with column spacing. Clear width of platform available beyond outer column leg was only 500 mm.

Normally, erection of shed on land follows a sequence of erecting columns and maintaining them in plumb vertical position by means of temporary GUYS or MAST.

This methodology was just not possible here over water.

Conventional floating crane for use throughout the erection time of shed was prohibitively costly.

The author has never say die approach. Crane to be designed had difficult task to perform. It had to erect a Shed of above dimensions TOTALLY OVER WATER.

All the structural steel members had to be floated over barge and piece by piece assembled in position.

Innovation lay in the design of tailor made Crane which efficiently erected above shed in record time.

The required crane was erected with floating crane and main shed erection by this crane itself.

Crane dimensions were decided such that main shed erection was an easy affair. Following logic gave best results.

a) Inside to inside of Crane Columns was 43 m to allow clearance of 1 m beyond outer face of Shed Columns.

b) Bottom chord of the crane member connecting side columns was made parallel to the top chord of the shed member with clearance of 500 mm.

c) In side elevation, crane columns were two at 8 m c/c matching exactly with the shed column centre lines.

d) Base of the side columns was further extended by 8 m on either side of these two columns for comfortable stability of the crane while moving on wheels along length.

e) Vertical and top inclined members were designed as open web members with 2500 mm distance between chord members and side width of 2000 mm for rigidity against deflections / displacements. 2000 mm wide x 2500 box was intentionally cre-ated for workers to walk safely within on inclined members and attend to work on shed assembly which was just 500 mm below crane bottom chord.

f) Steel sections used were MC 125, Angles 100 x 100 x 10 and down with total weight of Crane for above dimensions not exceeding 70 T.

g) Lifting tackles were hooked up to the bottom chords of the top inclined box members and the assembly of Shed was done with speed and great ease.

KUDOS TO ENG. KARNIK

Mr. A. B. Karnik have been honoured by ACCE Governing Council for "Innovative Ideas for In-Situ Construction of PS C Box Girder Bridge Span Weighing 1200 T Over Himalayan River." The Award will be presented at the **ACCE ANNUAL CONVENTION 2006** (Annual Day Celebration of ACCE (I) to be held at **Nashik on 11th August 2006**.

MORE ABOUT CORROSION - II

Eng K. L. Savla

C0RROSION TO VERTICAL MEMBERS

In this article we shall discuss corrosion to vertical members. They may be structural steel members, M.S lamp posts or may be R.C.C members Viz column, pardi etc.

CORROSION TO VERTICAL Mild Steel MEMBERS

We shall discuss a case study of corrosion to lamp posts. It is generally noticed that lamp posts are corroded at ground level and wall thickness of pipe or member is drastically reduced. Whenever there is a cyclone or heavy wind (specially prior to monsoon) all the lamp posts will buckle or bend from ground level .New lamp posts shall be placed at the same place which start corroding at the base and getting ready to bend during next cyclone!!!

Fed up with corrosion problems to lamp posts, in one of the cities in Italy, the authorities decided to erect aluminium lamp posts. The authorities were shocked when they noticed that within a few months the lamp post lower portions developed several holes. In due course the lamp posts started bending or buckling. The authorities had not applied suitable coating which could resist dog urine. Dog urine contains chemicals which start eroding aluminium at jet speed. There after authorities decided to apply suitable coating material up to a height of one meter from base level and they found their lamp posts safe from any more corrosion !!!

Recently Railway Authorities noticed that all the M.S posts which support the cantilever structure (which support the roof of platforms) on the western and central railways in Mumbai are corroded up to 70% at base level. Authorities repaired these entire M.S columns on war footing.

In all these three cases one thing is common and that is **corrosion at base level.**

The reasons for the corrosion at base level are as follows:-

1) Moisture Or Water gets accumulated at base level and when any M.S members is in wet region the rate of corrosion is fastest.
2) In a moist medium various bacteria grow which give out various gases as their waste product. These gases accelerate the corrosion.

Solution for above problem is as follows:-

1) At base level Zinc chromate primer shall be applied and followed by suitable coating of paint.
2) The base shall be so designed and constructed that no water shall get accumulated near base level.
3) In case M.S posts or columns are embedded in concrete then silicone base material shall be filled between M.S members and concrete which, will take care of contraction and expansion and prevent accumulation of moisture at base level.
4) Even if corrosion is noticed at base level it canl be controlled by fixing sacrificial Zinc anode (Sacrificial anodes are available in various shapes Viz. ribbon, rod plate, strips etc)

CORROSION TO HORIZONTAL Mild Steel MEMBERS

A heavy electrical company is manufacturing large size transformers for export purpose. In a transformer electrical coil (having 3.5 M.Ton weight) is placed and then suitable oil is filled in the transformer. The roof of the factory consists of M.S fabricated structure. The M.S perlins were corroding as the painting of perlins was not satisfactory. Since it is a large factory, there was enough space for adult pigeons to fly in and out. The pigeons used to sit on the perlins. The resting and flying of the pigeons from and to the perlins resulted in the rust getting disturbed (Due to their wing motions) and this loose rusted metal was falling into the transformers. The company then had to remove the oil soaked heavy coil and filter the oil to remove the rust particles. Company tried several methods to protect transformers including by covering with plastic sheets. But movement of pigeons could not be controlled. I suggested applying zinc rich paint with sacrificial anode at critical areas of the factory to stop corrosion of perlins. This enabled the company in stopping corrosion problem. The movement of pigeons is still continuing so is the company production.

CORROSION TO VERTICAL R.C.C. MEMBERS

In most of the cases we have noticed that R.C.C. columns or R.C.C. pardis have several cracks at base level. In some cases concrete starts spalling and reinforcement is exposed.

In Saudi Arabia high voltage transmission power supply lines were laid having length of about 700 Kms.The lines were supported on M.S towers with concrete pedestals. Authority had decided to apply some coating to concrete pedestal to avoid corrosion to reinforcement and also as protection to concrete. The authority was shocked when they noticed that all the coating was eroded within a two month span. The reason for this loss was due to nature, as in the desert region sand was blasting at a temperature of 54 degree celsius. In summer winds blow at jet speed. The hot air and hot sand had peeled off the coating.

So we conclude that without understanding the environment conditions it is decidedly difficult to control the corrosion. If such towers collapse it will be a serious accident. Such accidents are many times catastrophic in nature.

To avoid corrosion of reinforcement of R.C.C. at base level following care shall be taken:-

1) Reinforcement shall be applied with rust converter at base (Chelating type of rust converter shall be used.)

2) Concrete must be dense with optimum water cement ratio.

3) Vapour phase inhibitor in chemical form shall be mixed in concrete at base level only. Vapour phase inhibitor is a chemical which ultimately forms vapour and arrests the Corrosion.

4) If concrete pedestals are constructed care shall be taken to see its top slopes outward so that water shall not accumulate on top of pedestal.

CONCLUSION & REMARKS

So, I conclude that to arrest the corrosion at base level of any member care shall be taken to avoid accumulation of water or development of dampness and M.S. members shall be protected with flexible material to take care of thermal contraction & expansion , which will prevent accumulation of moisture and growth of bacteria.*

Frequently, the one general question asked is the difference between Rusting & Corrosion.

Corrosion is defined as eating away of parent material.

It is found that corrosion is an electro-chemical process for which moisture or water acts as an electrolyte.The rate of corrosion is very high if dry & wet take conditions alternate.

When nominal moisture level is present and an electro-chemical process uniformly takes place at surface of M.S. metal the process is called **rusting.** Due to rusting uniform passive film is created which may protect further rusting, but this again depends on environmental conditions. Corrosion takes place in the presence of excessive moisture and free oxygen . When excessive corrosion takes place it is called pitting corrosion. Apart from environmental conditions corrosion depends on metallurgical configuration of metal.

Shri. K. L. Savla

B.E. (Civil), is a practicing consulting structural Engineer and Jnt. Secretary of ISSE. He has been providing remedies to corrosion affected structures and provides services of corrosion consultancy. He has been very actively involved in post-quake relief activities in Kutch.

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- Articles bearing on innovative design and construction.
- Articles dealing with challenging construction problems and how they were solved.

Authors of published articles will be felicitated on ISSE Annual Day Function.

REDUNDANCY AND DUCTILITY HELP IN IMPROVING FLEXURAL RESISTANCE AT ULTIMATE LOAD

Eng. Neelkanth D. Joshi

Let us take the case of a fixed beam AB of rectangular cross-section b x d loaded with uniformly distributed load w on the entire span l and made from steel of grade Fe-250 having yield stress 250 N / sq.mm.

The bending moment diagram and deflected shape are shown in **Fig. 1.**

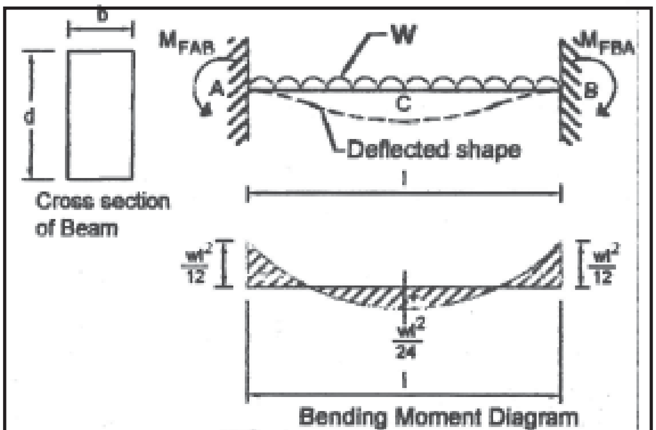


FIG. 1

Stress – Strain characteristics of the steel are shown in **Fig. 2.**

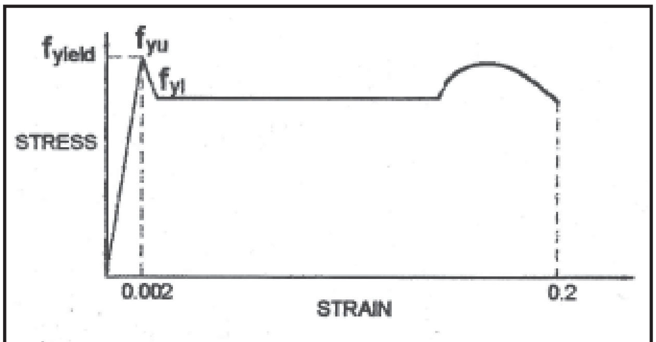


FIG. 2

The beam is statically indeterminate, having three degrees of redundancies. For symmetrical vertical load it has two degrees of redundancies.

If we try to work out simple bending stress from the equation f = M . y / I , for maximum bending stress at the extreme fibers f = M / Z, where the elastic modulus of the section Z = 1/6 (b d^2) for rectangular section. The higher stresses occur, at both the fixed ends A and B, where the value of bending moment is wl^2 / 12, which is hogging in nature. Whereas, the stress at center of span (point C) will be just half that at A or B, since the sagging moment at the center is wl^2 / 24. The stress diagram at A or B is as shown in **Fig. 3(b).**

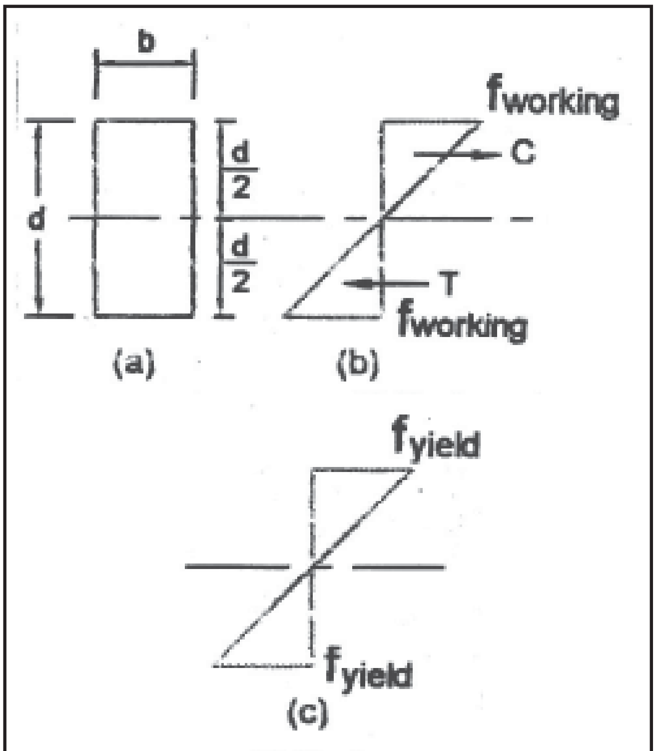


FIG. 3

As we increase the load further, points A and B will reach yield stress level f_{yield} as shown in **Fig. 3(c)** but the point C, will have smaller bending stress at its extreme fibers. The stress at points A and B towards the neutral axes, at this stage, will be smaller than, yield stress f_{yield}. The extreme fibers at top or bottom at point A and B start yielding.

Myield = fyield x 1/6 (b d^2) = fyield x Z , where Z = Elastic Modulus of the section.

With further addition of the load, the fibers from the extreme end, towards neutral axis, start yielding, and the yield stress penetrates the inner core as shown in the **Fig. 4.**

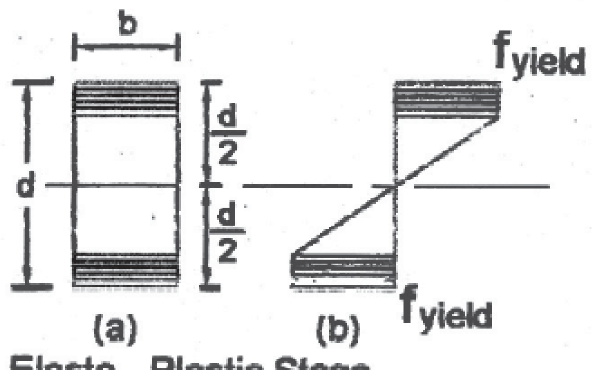


FIG. 4

The affected fibers subjected to yield stress, start flowing (yielding – extending without any increase in load) inducing there by, some rotation at the fixed ends. This stage of state of stress is known as elasto – plastic stage.

With further increase in the load, the yield stress penetrates right up to the neutral axis from both ends, and all the sections from extreme boundaries to the neutral axis from both ends, start flowing (yielding - extending without any increase in load). This stage is known as plastic stage as shown in **Fig. 5**

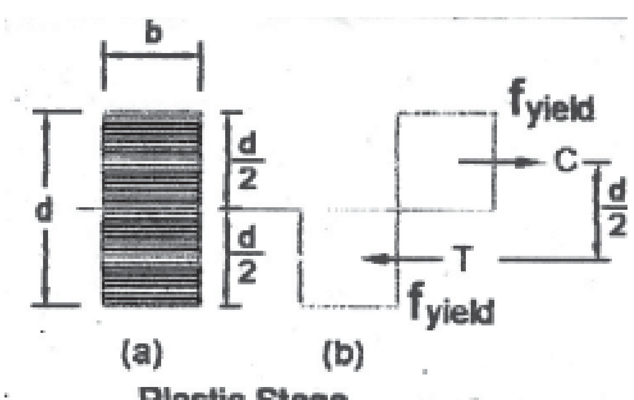


FIG. 5

and the joints at A and B develop plastic hinges and start rotating. The moment present at this stage, at points A and B of fixed beam AB, equals the plastic moment of resistance of section Mp.

Mp = fyield x 1/4 (b.d^2) = fyield x Zp where Zp = Plastic Modulus of the section.

Thus, Mp = 1.5 Myield in this particular case having rectangular cross-section.

Now, let us look at load – deflection diagram of beam AB, shown in **Fig. 6.**

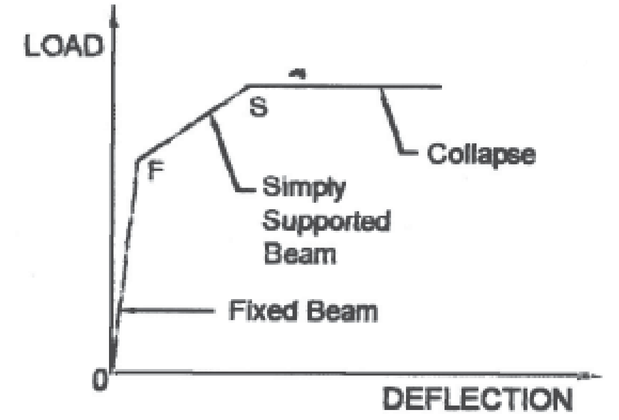


FIG. 6

The deflection at C, as marked in **Fig. 7** will slowly increase, with increase in load, just as the stresses increase till points A and B yield. The yield stress at points A and B, will penetrate deeper inside the section with further increase in the load and the section at A and B goes into elasto – plastic stage. The deflection at point C keeps on increasing. At this stage also the stress at point C does not reach yield stress level. With further increase in the load, the deflection at point C keeps on increasing, till the yield stress penetrates deep in the section up to the neutral axis and plastic hinge forms at the points A and B with moment reaching the value of Mp = fyield x Zp and they start rotating as shown in **Fig. 7.**

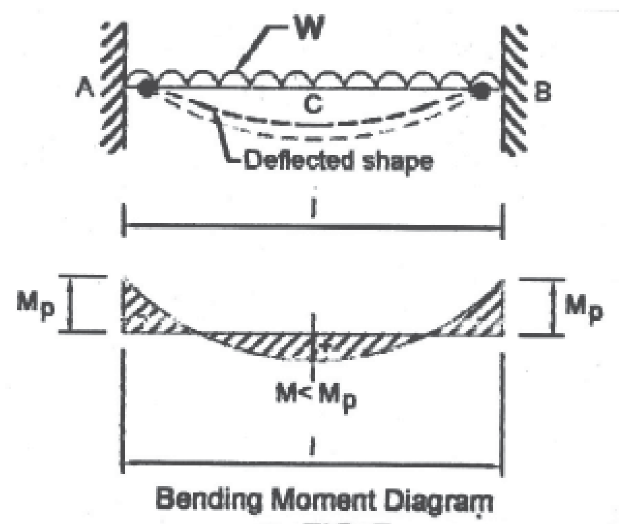


FIG. 7

At this stage, the beam does not fail and collapse, but it loses the redundancy and starts taking further load, as if, it was a simply supported beam. Here, at this stage, the deflection at point C starts increasing at faster rate, in Zone FS, in comparison to the rate in Zone OF of the Load –Deflection diagram, because, points A and B keep on rotating with presence of moment equal to plastic moment of resistance of the section and the beam AB carries further load as if the beam AB has become simply supported beam. With further increase in load, point C deflects further, and the stress at point C increases to fyield. With further increase in load, point C also passes into elasto-plastic stage, and ultimately, the moment Mp equal to plastic moment of the section, develops at C, and plastic hinge forms there. The deflections increase without any addition of the load, and the collapse mechanism sets in as shown in **Fig. 8**

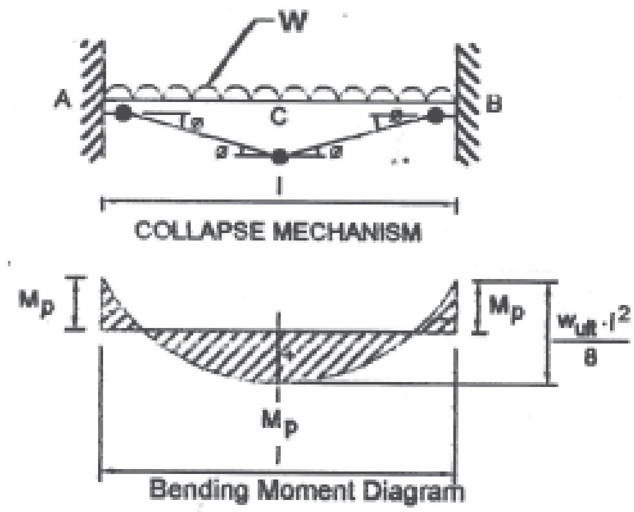


FIG. 8

and the beam fails. The load at this stage is known as ultimate load w_{ult}.

From **Fig. 8**,

1/8 wult . l ^{2} = 2 Mp

or maximum ultimate uniformly distributed load w_{ult} = 16 Mp / l ^{2} can be carried by this fixed beam, which is made of the ductile material, that permits the rotation of plastic hinges, while losing the redundancies before collapse.

Now, let us consider a simply supported beam AB, of span l, shown in **Fig. 9**

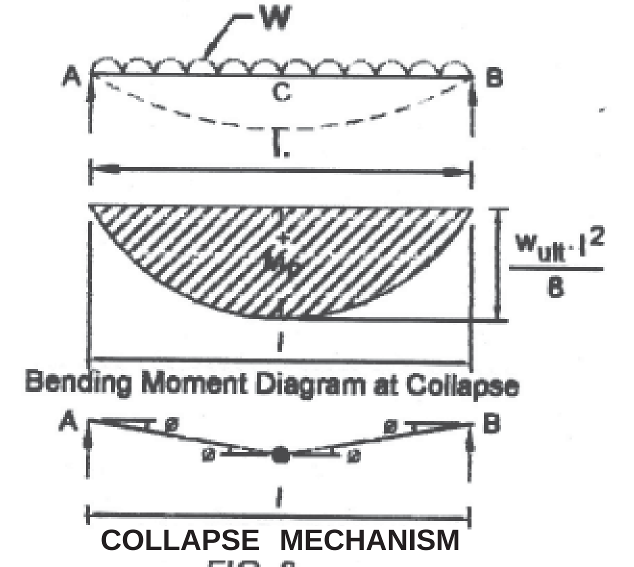


FIG. 9

made of same section and material properties. Since points A and B are simply supported ends, they rotate with the application of the load on simply supported beam AB, and moment at points A and B is zero. At collapse, the stresses equal to fyield, at point C, fully penetrate up to neutral axis, and develop moment equal to Mp-the plastic moment of resistance of the section, and plastic hinge forms at the point C.

Looking to **Fig. 9** Mp = 1/8 wult . l ^{2}.

Therefore, wult = 8 Mp / l ^{2}. Where Mp = fyield x 1/4 (b d^2).

Thus, we can observe that, the fixed beam could carry double the load at ultimate state, when the collapse mechanism is formed. This is because of the ductility of the material of the beam i.e. steel.

If the fixed beam was made of brittle material, the beam would have failed at point **F** only as shown in **Fig. 6**, and it would not have rotated at points A and B.

Thus, for improving the flexural resistance, at ultimate load, it is necessary to have both the redundancies as well as the ductility. Only redundancy will not help in the absence of ductility, and only ductility will not help in the absence of redundancies.

Therefore, it is necessary to increase the number of redundancies and the amount of ductility as far as possible, in the structures, to make them capable to resist seismic forces without collapse.

SECANT PILE WALLS

Subrata Ray

Chief Technical Manager (C & D), Simplex Infrastructures Ltd., Mumbai

I) INTRODUCTION :

The side protection of deep excavations for facilitating construction is still a challenge, technically as well as economically. Different types of retaining structures such as cross-lot / internal bracing, Soldier piles and lagging walls, sheet pile retaining structure, diaphragm walls, Contiguous / Touching piles, Secant piles etc. have been and are being employed since the recent past. Depending upon the prevailing site conditions, depth of excavation, nature of subsurface strata and financial implications, these retaining structures may be anchored or cantilever.

Temporary sheet piles or soldier pile shoring have the disadvantage in that valuable space is wasted. Although for many years sheet piles have provided the commonest way of supporting deep excavations, there are many instances in which for reasons of vibration, or noise thereby causing a possible damage or disturbance to neighbouring structures during driving and extracting, or the sheer difficulty of driving, or because the piles cannot be withdrawn for re-use, the use of sheet piling is less attractive than it might otherwise be.

The other possible practical alternative solutions are to use diaphragm walls, contiguous reinforced concrete bored piles or secant piles. Diaphragm walls avoid these problems but are very expensive.

Contiguous piles are constructed in a line with a clear spacing between the piles of 75 to 100 mm as a rule and, in consequence, cannot easily be used for water retaining structures. Their main use is in clay soils where water inflows are not a problem, though they have also often been used to retain dry granular materials or fills. Clearly, where water is not a problem the spacing of the piles can be adjusted so long as the gap between piles is such as to prevent soil collapse between them.

Secant piles can be used to form a continuous watertight wall or nearly watertight wall. The latter part of this note will concentrate on secant piles, its definition, principle, design aspects, method of construction, construction machine and equipments, advantages and limitations, uses etc..

II) WHAT ARE SECANT PILES?

DEFINITION :

Secant piles may be defined as a series of piles that are installed in a configuration such that they intersect one another.

They are installed at centre-to-centre distances that are smaller than the sum of the radii of the two adjacent piles. In this configuration adjacent piles intersect and therefore interlock.

III) THE PRINCIPLE AND TERMINOLOGY OF SECANT PILING

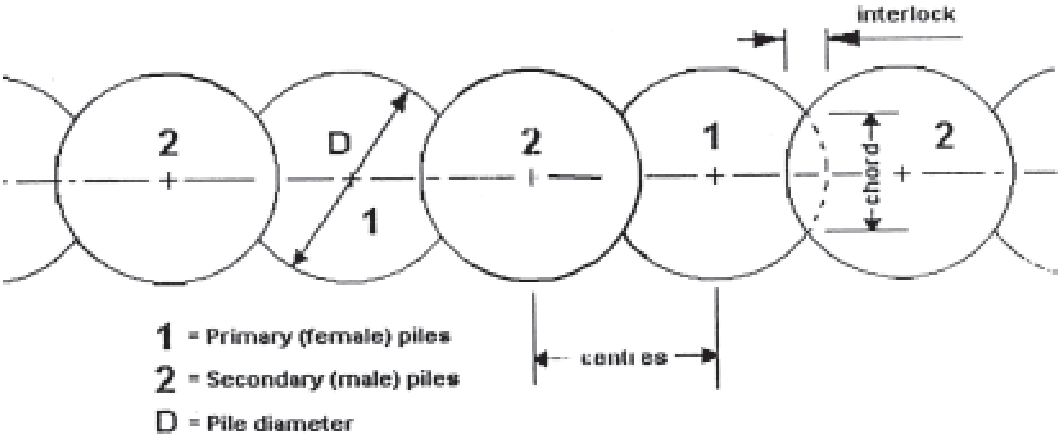


Fig. 1

The application of this method to form reinforced concrete earth retaining structures – otherwise known as Secant Pile walls – in various subsoil conditions is becoming increasingly popular, replacing the more conventional sheet pile or diaphragm wall methods. The method is particularly popular in built up areas where noise, the presence of underground services, vibrations and the effects of excavations on adjacent structures can be detrimental.

Secant pile walls are being used increasingly more frequently also where subsoil conditions are adverse, where soils are soft and excavations are difficult to stabilize and, conversely, where soils are hard and are difficult to penetrate or where they contain boulders or other obstructions. Further, on small sites where access is difficult or headroom is low, small, lightweight machines and small bore drilling techniques can be used to produce substantial secant pile walls.

The other significant advantage of the secant pile wall method is that the individual piles can be excavated using any of the known drilling methods, many of which preclude the use of bentonite or other forms of fluid borehole support. This gives the method number of added bonuses:

- The most suitable drilling methods can be chosen to excavate the specific formations at the site.
- When drilling dry, the absence of mess on site caused by spillage of mud, polymers or other fluid trench support media improves the working environment.
- The costs and problems associated with treating and the disposal of large quantities of drilling mud are eliminated.
- Many of the other obvious advantages associated with drilling and concreting a dry hole are also significant.

IV) DESIGN ASPECTS :

Piles that constitute secant pile walls, when acting as retaining walls are designed to resist horizontal earth and water pressures and where necessary, vertical loads as well. In the design of these structures we analyse the following :

Pile diameter :

Primary and secondary piles can be of different diameters and can be built using different materials to suit the application. This flexibility and the possibility of installing the piles at rake gives the method great versatility of use.

Reinforcement :

The piles are reinforced to resist the applied bending moments and shear forces. The reinforcement requirement is normally calculated by conventional design methods after the applied loading and the geometry of the support systems have been determined.

When evaluating the reinforcement requirement, consideration must be given to the fact that in the circular section of a pile the distance between tension and compression centroids (lever arm) is smaller than in an equivalent rectangular section. The circular section of a secant pile wall therefore usually needs more main reinforcement per unit length of wall to produce a moment of resistance equivalent to that of the constant section of a diaphragm wall. The following figure compares the lever arms of conventionally reinforced piles and a diaphragm wall of thickness equal to the diameter of the piles.

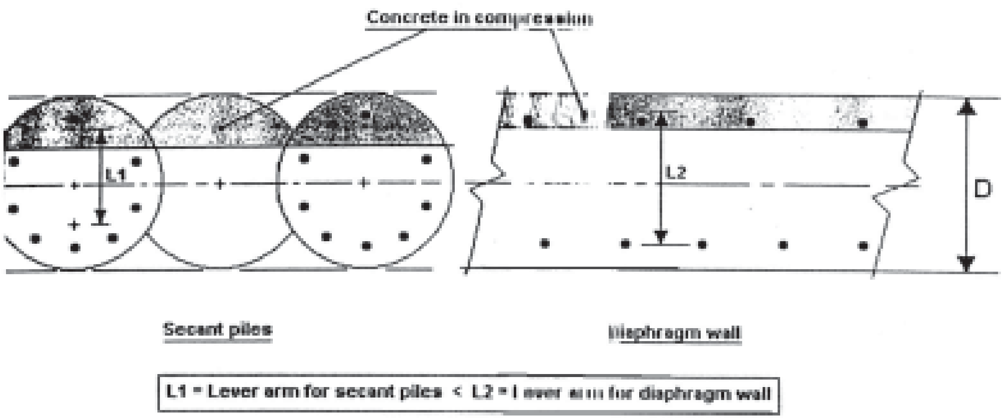
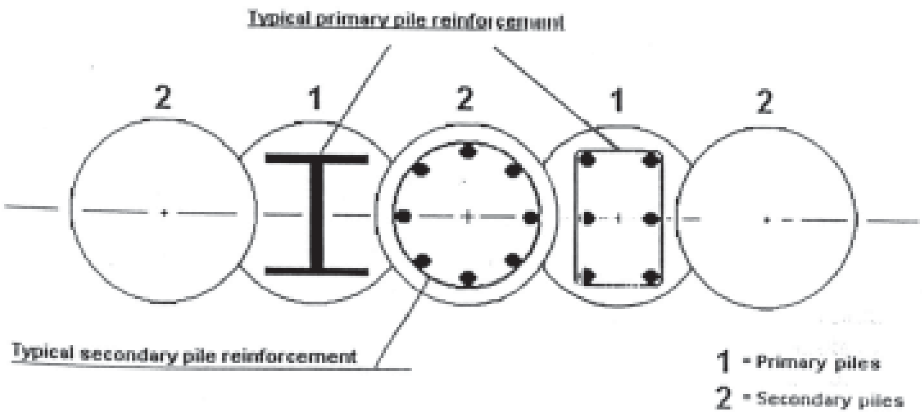


Fig. 2

Under light loading conditions only the secondary piles are normally reinforced, but where the loading dictates so large a number of reinforcing bars that their congestion might hinder the free flow of concrete, it has become common practice to reinforce the primary piles as well; as shown in Fig.3

Reinforcement in both the primary and secondary piles can be provided in the form of a cage or by the use of steel sections such as universal beams or columns (Fig. 3).



DETAILS OF TYPICAL SECANT PILE REINFORCEMENT Fig. 3

Interlock :

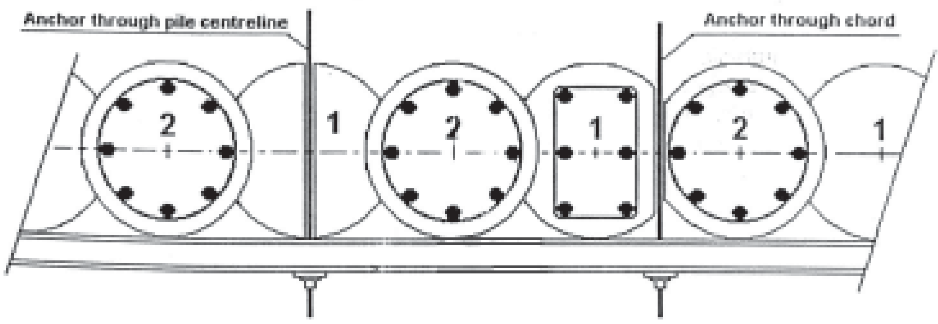
The amount of interlock and consequently the chord length are designed to transfer horizontal loads from one pile to the other and to provide a seal across the joint between adjacent piles. The amount of interlock is also designed as a function of the pile diameters, the length of the piles and the type and quality of machinery and equipment that will be used in their construction.

Clearly, a minimum amount of interlock is required throughout the depth of the wall. Typically this ranges from 100 mm (4") to 250 mm (10"). Whereas the designed interlock is guaranteed at the surface by the guide walls, the amount of interlock at depth is a function of the alignment and verticality of adjacent piles. Modern machinery, when in good state of maintenance, can drill the boreholes within tolerances on alignment of 1:300.

Support :

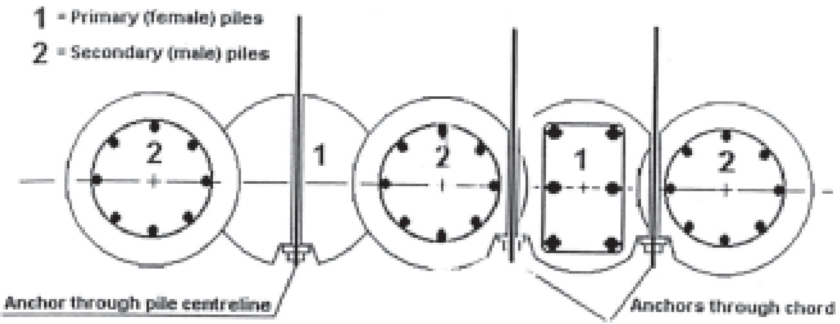
Although it is possible to design freestanding secant pile walls to retain vertical faces, ground anchors or pops are often incorporated in the retaining wall scheme to reduce deflections and the large bending moments and shear forces that develop during the temporary stages of construction, i.e., between excavation and the installation of the final support structures (Figs. 4 & 5).

In order to transfer the anchor load to the piles, waling beams are sometimes used but these occupy significant space (Fig.4).



TYPICAL ARRANGEMENTS OF ANCHORS AND WALER BEAM ON SECANT PILE WALLS **Fig. 4**

Alternatively the interlock between adjacent piles can be used efficiently to transfer the anchor loads to the pile wall (Fig. 5)



TYPICAL ARRANGEMENTS OF ANCHORS THROUGH SECANT PILE WALLS **Fig. 5**

Vertical support :

Where the secant pile wall is designed to carry large vertical loads and where the stiffer formations are well below the excavation level, it is common practice to extend the secondary, load bearing piles, beyond the toe of the primaries, down to the load bearing strata. Alternatively the Secant / Contiguous method may be used, where both the primary and secondary pile boreholes are extended beyond the toe of the casing using extension shafts that are smaller in diameter.

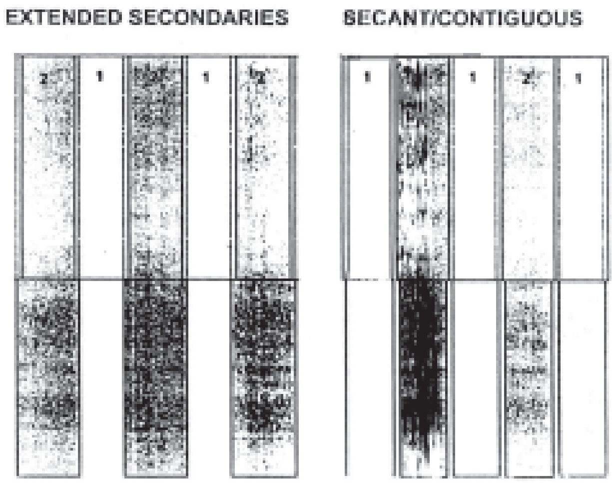
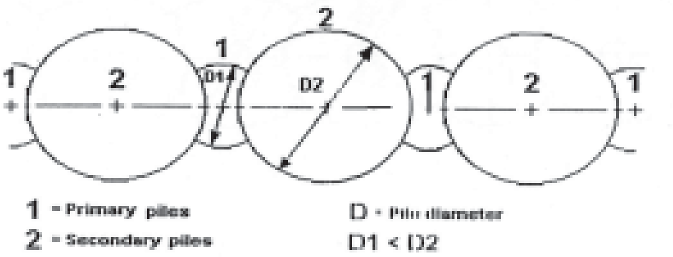


Fig. 6

V) VARIATION IN THE METHOD :

There are a number of variations in the Secant Piling method :

1. Primary and secondary piles can be of different diameter. When a wall of greater stiffness is required, the diameter of the secondary piles, which are easier to reinforce, can be larger than that of the primary piles. For example, 1200 mm (48") or 1600 mm (60") secondaries can be drilled to intersect 600mm (24") or 800 mm (30") primaries (Fig. 7)

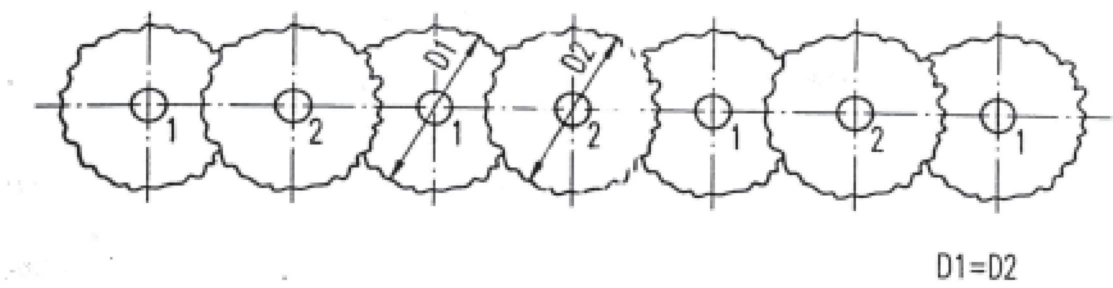


PILES WITH DIFFERENT DIAMETERS Fig. 7

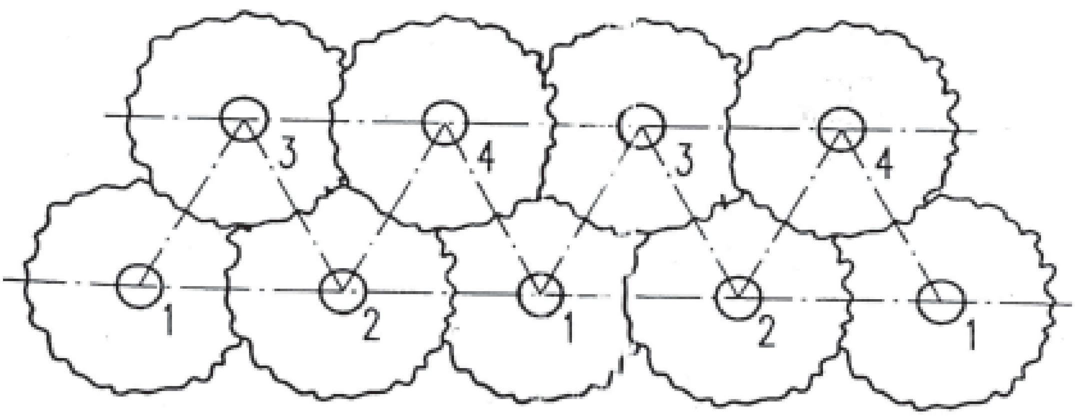
2. When a stiff wall with high resistance is required, both the primary and secondary piles are built using reinforced concrete. This method is commonly known as the "hard/hard" method.
3. When greater wall flexibility is desired and better sealing must be assured between adjacent piles, the primaries may be built using a softer, plastic mix and the secondaries are then constructed with normal reinforced concrete. This method is commonly known as the "hard/soft" method.
4. Where the scope of the barrier is to reduce permeability and where load bearing capacity is not required, both the primary and secondary piles can be built using a plastic mix or, alternatively, by

using the ‘jet grouting’ or ‘soil mixing’ techniques. When the latter methods are used, different degrees of permeability can be obtained by arranging the intersecting columns in different patterns (see figs. 8 & 9). Clearly the larger the degree of intersection of adjacent columns or the greater the number of intersecting rows in the pattern, the lower will be the permeability of the structure. This method is commonly known as the “soft/soft” method

INTERSECTING COLUMNS BY THE "JET GROUTING" OR "SOIL MIXING" METHODS



SINGLE ROW Fig. 8



MULTIPLE ROWS Fig. 9

VI) CONSTRUCTION

Guide Walls :

When installing secant piles, three important criteria must be satisfied in order to guarantee the designed amount of intersection throughout their length :-

- Alignment
- Location
- Verticality

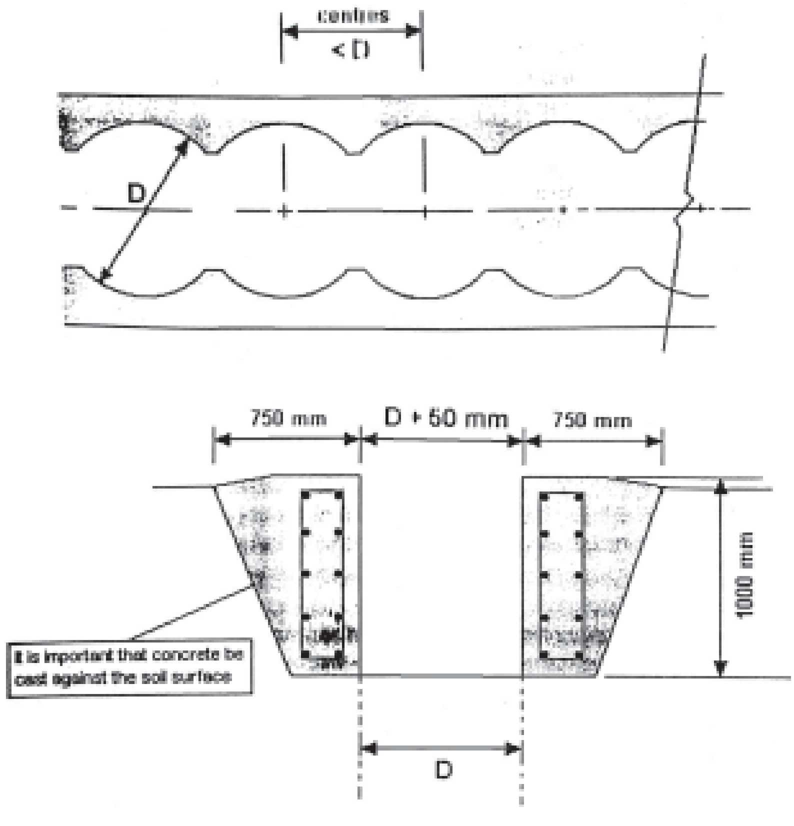
In order to satisfy these it is a good practice to build proper guide walls along with wall alignment before commencing any excavation.

The guide walls serve four main purposes :

1. They guarantee the correct location of every pile, particularly the secondary, intersecting piles in order to ensure the required amount of interlock.
2. They facilitate setting up of the rig, particularly the alignment and verticality of the mast on hydraulic drilling rigs; or the verticality of the Kelly bar when mechanical drilling rigs are used.
3. They support the reinforcing cage or steel section and assist in its correct vertical location.
4. They provide support for the casing oscillator or extractor when these are used to extract the casings.

<u>DETAILS OF TYPICAL GUIDE WALLS</u>

PLAN



Section Fig. 10

<u>Drilling and installation of the Primary Piles :</u>

A series of primary piles are installed first using any of the conventional drilling methods such as the Kelly bar driven auger, or the continuous flight auger (CFA); or, when using small bore drilling methods, the drag bit, the tricone roller bit or the down the hole hammer.

In soft soils, or where there is a presence of water, but generally, where the borehole can be unstable and support systems are needed, a fluid such as water, bentonite or polymers can be used to support the sides of the excavation. In many instances however, this would defeat the choice of the secant piling method to produce an earth retaining structure.

In most cases therefore a temporary steel casing is used to support the borehole while excavation is carried out in the 'dry' with an auger, bucket, or other suitable tool.

In difficult soils or where there is a presence of boulders or where soft soil strata are intercalated with layers of very hard or cemented materials, the use of a temporary casing also offers the advantage of reducing the amount of overbreak and will produce a relatively uniform finish to the pile. More significantly, in all formations the use of a temporary casing will reduce the amount of deformation of the soils surrounding the pile with the consequential benefit of reducing settlements and their adverse effects on nearby structures and services.

Once the borehole has been drilled and properly cleaned out, reinforcement, if required by the design, is inserted and properly located. The borehole is then concreted using the accepted practice for cast-in-situ bored piles i.e., by placing the concrete directly into the pile shaft through a short trunking and hopper when the shaft is dry, or by the tremmie method when the shaft is full of water or bentonite.

Immediately after concreting, the temporary casing, when this is used, is extracted using the drilling machine, a casing oscillator or casing extractors. Care must be taken during this operation, to ensure that withdrawal or oscillation of the casing commences before the concrete starts to set. This is particularly important in deep bore holes or those of large diameter or when there is a delay in pouring successive batches of concrete due to breakdown of machinery. Generally, special attention must be paid in all those instances where there is a risk that the first concrete poured will start to set before the concreting operation is completed.

As an alternative to the above, in certain soils and for special applications, primary piles can be built using the "jet grouting" or "soil mixing" methods.

Drilling and installation of the Secondary piles :

The secondary piles are drilled in between two adjacent primaries so as to intersect these and to cut into their shafts.

For this operation to be successful, a fourth criteria – timing – becomes of critical importance as the strength gain of the primary pile concrete, which is to be cut to form the interlock, is related to time, temperature and the mix design.

Ideally, before drilling the secondary piles, the strength of the primary pile concrete should be high enough to prevent it from slumping or cracking, but it should be low enough to offer minimum resistance to the action of the cutting crown.

The secondary, intersecting piles, are drilled using conventional drilling methods as described above with the exception that a temporary casing is now used in almost all circumstances, principally to mount the special cutting crown needed to cut through the primary pile shafts, but also to drive the bore hole support.

Drilling the secondary piles proceeds with care; special attention being paid to maintaining verticality in order to ensure that the minimum designed amount of intersection is obtained throughout the length of the shaft particularly at depth.

Once the shaft has been drilled and cleaned out, the reinforcement is inserted and properly located. Concreting and extraction of the temporary casing is then carried out as described above for the primary piles.

In soft cohesive soils and particularly when the "hard/hard" method is used, contamination of the joint between two adjacent piles can occur when soft soil is drawn into the joint by the cutting crown teeth as they rotate and is deposited onto the newly cut concrete surface. During the concreting phase particular care must be taken therefore to ensure that the concrete has optimum slump so that, together with the cleaning action of the withdrawing cutting crown teeth, it will displace the contaminating material and produce a good joint.

VII) MACHINE AND EQUIPMENT

A major contributing factor to the increase in popularity of the secant pile method has been the development of new tools and of powerful, hydraulic drilling machines designed to speed up the installation process. Manufacturers have dedicated significant effort to the development of new machines and systems that make application of the method more efficient and economical.

IN the past, casting for both the primary and secondary piles were installed using casing oscillators. Whereas, these machines were very effective in driving the casing and even more effective in their extraction, they were slow to use. Also, their use made it difficult to obtain good verticality and therefore good interlock between adjacent piles.

New, powerful, hydraulic rotary heads are now available which, when fitted to long robust masts, will drive casings deep into the ground with extreme accuracy. Automatic vertically control systems are now also fitted to most drilling machines, these ensure that the masts and tools are kept vertical at all times thereby assisting the operators to drill properly aligned holes.

Rotary heads with torque capacities in excess of 500 kNm (400 000 ft. lbs) will drive and extract up to 14 m (45 ft.) lengths of casing at a time, using crowd and extraction forces in excess of 40 tons (88000 lbs).

The same, high speed, rotary heads will also drive the large augers or buckets, applying high crowd forces through interlocking Kelly bars, to speed up the drilling process through virtually any type of soil.

Whereas these machines will enable the contractor to install most secant pile walls rapidly and economically, casing oscillators are still required on certain projects. They are needed to extract casings when these are of large diameter – greater than 1000 mm (40”) – or when they are installed at great depth – deeper than 20 m (65 ft.)

For work in rock or hard soils, down-the-hole hammer manufacturers have developed large diameter (up to 1000 mm (40”), direct and reverse circulation hammers that will drill rapidly through these formations. Further, the development of eccentric and, more recently, special concentric bits make it possible now to install large diameter casings easily through formations which once would have been prohibitive using traditional methods of excavation.

Special, quick coupling joints have also been developed to speed up the process of making and breaking the joint between successive lengths of casing. It is now possible, using limited personnel, to make and to break a casing joint in a few minutes. In the past lengths of casing would be welded together during the installation phase and would have to be cut during extraction; both arduous, time consuming processes.

Developments in the design of cutting crowns fitted with a variety of teeth, mounted in different patterns, have facilitated cutting through formations of different consistencies when drilling the primary piles and through different concrete mixes when installing the secondary piles.

All the above have led to making the method more efficient, cheaper to apply and therefore more attractive.

VIII) ADVANTAGES AND DISADVANTAGES

The following are some of the advantages inherent in the use of the secant piling method :

- Secant pile walls can be constructed effectively in all soils; their use becomes particularly attractive when soils are difficult to drill and where boreholes are difficult to support. For example in loose or poor quality fills or where soils contain obstructions such as boulders or where the formations are very hard.

- Secant pile walls are constructed by excavating alternate, primary piles first. These are allowed to gain some strength before the intersecting secondary piles are drilled. This method of operating together with the use of temporary casings to support the boreholes reduces significantly the deformation of soils surrounding the wall, thereby reducing settlements and their adverse effects on nearby structures and services
- In built up areas and on confined sites where retaining walls need to be constructed close to adjacent structures it is possible because of the use of a mechanically supported borehole to chisel or to drill through an obstruction with minimum risk of damage or disturbance to the structure nearby. Whereas with sheet piling or diaphragm walling such conditions can present a much more difficult problem particularly where there is a risk of loss of drilling mud, a serious event inherent with the diaphragm wall method.
- Secant piles are load-bearing structures and can be incorporated to form an integral part of the main structure.
- There is great flexibility in the choice of pile diameter and different combinations of hard and soft piles can be used to produce a wall apt for the purpose for which it is designed.
- Secant piles can be constructed at an inclination to the vertical thus alleviating the required moment of resistance. Also, in urban areas, or where there are obstructions, this feature gives the method added flexibility and makes it possible to maximize basement areas and excavations.
- Secant piles are built using rigid casings. The stiffness and inertia inherent in these makes it easy to produce well aligned columns.
- The quality of finish on secant pile walls is usually very good and the formation of bulges or protrusions is rare. This eliminates the high cost of chipping and making good which is usually required on diaphragm walls particularly when they are built in difficult, loose or stratified soils.

Like all techniques, secant piling has its disadvantages in certain situations :

- Where the soils, the site and the contractual arrangements are such that both secant piles and diaphragm walls can be built equally effectively, the speed of construction of secant pile walls can be slower than that of diaphragm walls. This may make the Secant Pile method more expensive.
- Secant pile walls produce more joints than the diaphragm wall method; in water-bearing ground therefore, more care needs be taken to ensure that they are of good quality.
- Generally the circular section of bored piles requires heavier reinforcement to produce a moment of resistance equivalent to that of the constant section of diaphragm wall.

IX) TYPICAL USES OF SECANT PILE WALLS

The technique is well suited to a wide range of applications which include load bearing and earth retaining structures for deep or shallow basements, cut and cover tunnels, underground stations, Docks, pump-houses, underpasses; particularly when these structures have to be built in difficult ground in congested urban areas.

The technique is applicable to the construction of vertical shafts of large and small diameter. When installed in a circular pattern they can be designed to develop hoop compression stresses and therefore to be self-supporting.

In Dams, weirs or reservoirs, when the structure is built over adverse rock or where piling phenomena have developed through the core of the dam the technique is well suited to the construction of effective cut-off curtain walls.

NDT FOR HARDENED CONCRETE

ENG. S. H. JAIN M.E. (Civil) FIE, MISSE

Testing of concrete is done to ascertain the compressive strength of concrete. In normal course 7 day / 14 day / 28 day Concrete Cube are tested to ascertain the grade of concrete in use. Non Destructive Testing are desirable in following cases :

1) Due to improper sampling or not maintaining cubes in proper condition the test result of cubes are irrelevant.
2) Samples are not available for testing.
3) Some times Concrete Compressive strength is to be assessed for old Concrete which is required for
   i. Structural repairs.
   ii. Extn. of Structure
   iii. Addition / alteration of structure.

In above cases it is advisable to take help of following Non Destructive Test which is

A) U. S. P. V. test
B) Hammer test

These tests are nowadays becoming very popular because of simplicity and less expenditure. These tests are to be done by equipment of high repute and the person handling must be well qualified, experienced Engineer, otherwise we are likely to land in deep trouble.

A) ULTRASONIC PULSE VELOCITY :

The ultrasonic pulse velocity technique is based on the ability to measure the propagation velocity of a pulse of vibrational energy which has passed through a concrete medium. Knowing the direct path length between the transducers, and the time of travel, the pulse velocity through the concrete can be obtained.

From the physics of elastic wave propagation it can be shown that pulse velocity is proportional to the square root of the elastic modulus and inversely proportional to the square root of the mass density of the concrete. However, it has been found that when the relationship between pulse velocity and strength is determined by calibration tests the best predictions of compressive strength can be achieved.

Ultrasonic pulse velocity measurement techniques are totally non-destructive and have the advantage that they are quick and easy to perform. Also, because of the nature of the test, all of the concrete between the transmitter and the receiver affects the measured property. Therefore, if the test is performed by an experienced operator, then a considerable amount of useful information can be gained about the interior of a concrete member.

Factors which may affect the transmission of the pulse are,

1) Location of steel reinforcement
2) Cracks and voids in the concrete.
3) The moisture condition of the concrete

This is especially troublesome when reinforcing bars are orientated parallel to the pulse-propagation direction. Failure to take account of these factors can lead to erroneous predictions of concrete strength.

B) HAMMER TEST

Tests in the 1930's were based on impacting the concrete surface with a specified mass and measuring the resulting surface indentation. Subsequently, the Schmidt hammer was developed commercially, in the last 1940's, in Switzerland. In the modern - days systems are based on this basic principle.

Whilst a rebound hammer is easy to use, in practice it is important to realise, from a fundamental point of view, this particular test is a complex combination of impact loading and stress - wave propagation. On account of this, it is recommended that an empirical relationship between rebound number and cube compressive strength should established. However, there are two main limitations.

Firstly, during a particular test the equipment assesses only a small surface layer of concrete approximately 30 mm deep. If any test locations correspond to local variations, then these can have quite a dramatic effect on the measured rebound number and ultimately the assessed concrete strength.

These tests are very easy but following precautions must be taken before tests :

1. The concrete surface must be dry.
2. The calibration of USPV machine shall be checked at regular interval.
3. Concrete surface shall be prepared properly failing which results are likely to be erratic.
4. In case of plastered concrete plaster shall be removed.

MUMBAI BUILDING REPAIR & RECONSTRUCTION BOARD

EMPANELMENT OF CIVIL / STRUCTURAL ENGINEERS / ARCHITECTS

Mumbai Building Repairs & Reconstruction Board, a unit of MHADA invites applications for empanelment of Civil / Structural Engineers / Architects for carrying out works relating to Survey, Inspection, Safety analysis as per IIT format, Estimation and Supervision of Structural Repair work etc. of the cessed buildings. MHADA, in partnership with IIT, Mumbai, has evolved a scientific system of analysis of old dilapidated cessed buildings to decide the vulnerability and repairs of structures. To undertake this work, it is intended to establish a panel of Civil / Structural Engineers / Architects who have adequate experience in such related works. The panel will included 4 categories of Civil / Structural Engineers / Architects as shown below.

CATEGORY - I :

Engineers' Emeritus - Under this panel eminent engineers will be pre-qualified based on their rich experience. These engineers need not submit applications in usual format. Based on their rich experience, they will be invited to join the panel of Emeritus Structural Engineers. Those engineers, who have exceptional experience over 25 years in the field of civil engineering, or Engineers who have obtained doctorate degree in subject related to Civil Engineering and possess at least 5 years relevant experience thereafter, will be considered. Also, Engineers who have Master's degree in civil engineering and at least 15 years experience thereafter can be considered. Engineers who fulfill these criteria may send their bio-data either by post or by fax in the name of Chief Engineer-II, MHADA, Mumbai 400 051 on Fax No. 022-26592058. This empanelment will be used for carrying out investigative work in case of any mishap of dilapidated buildings.

CATEGORY - II :

Engineers who possess BE (Civil) or equivalent degree and related experience of at least 10 years in the building construction and / or repairs will be qualified under this category; either Graduate or Diploma holder Engineers with relevant experience, retired from Government / Public Sector Undertakings can also apply. They may be considered on merits. This empanelment will be used for field survey, assessment of conditions of the buildings as per proforma devised by IIT / MHADA and for estimation and supervision of structural repair works.

CATEGORY - III :

Fresh Engineers possessing Civil Engineering Degree or equivalent, or diploma in Civil Engineering or equivalent with minimum 3 years experience will be eligible. This empanelment will be used for actual field survey, assessment of condition of building as per proforma devised by IIT / MHADA and for estimation, supervision of structural repair works.

CATEGORY - IV :

Practicing architects who have specialized knowledge of building construction or building repair works for at least 10 years may also apply. The architects need to have an association with qualified Structural Engineers for undertaking specified works. This empanelment will be used for actual survey, assessment of condition of buildings as per proforma devised by IIT / MHADA and for estimation, supervision of structural repair works.

Even though the scope of work defined under category II, III and IV are identical, the quantum of work to be allotted to higher categories will be more than that for lower category. The exact quantum or

Cont. Page 23

Congratulation to

Mr. Karkhane

Member of ISSE

The noted structural engineer (RCC consultant), Mr. N. G. Karkhane, has been appointed 'structural design checking authority' on the Maharashtra Jeevan Pradhikaran here recently.

Works to the tune of crores of rupees are in progress under the government's tanker-free scheme. The contractors have to submit all these works with design and have to get it checked through the IIT, VJTI or the Government Engineering College. After the process is completed, the Pradhikaran gives permission to the contractors for construction work. However, due to workload the process gets delayed in the colleges. Due to which the Pradhikaran chose well-known engineers who were in private practice.

Accordingly, the government appointed Mr. Karkhane as structural design checking authority. His appointment would help the Marathwada contractors.

Mr. Karkhane obtained B.E.(Civil) from the BITS, Pilani University. After that he obtained M.Tech. degree in structural Engineering from IIT, Pawai. For the last 10 years, Mr. Karkhane has been in the private practice.

work to be awarded shall be decided based on work available with department and number of civil / structural engineers / Architects empaneled in the list. The decision of department in this regard shall be final and binding on the consultant.

The civil / structural engineers / Architects enlisted on the existing panel of Mumbai Building Repair and Reconstruction Board, who fulfill above conditions need to apply afresh as the scope of the work is now changed. For all the above categories, the upper age limit will be 65 years.

A booklet containing application form priced at Rs. 100/- can be purchased from Resident Executive Engineer, Room No. 408, Griha Nirman Bhavan, Bandra (East), Mumbai - 400 051, Telephone No. 56405385 during 11.9.2006 to 22.9.2006 up to 3.00 p.m. The completed application forms should be submitted before 30.9.2006 up to 3.00 p.m. The empanelment will be a continuous process, and hence sale and receipt of forms will be again resumed after 5.10.2006. For more information one may please contact Shri. R. G. Karkhanis, Deputy Chief Engineer (south), 89-95, Rajni Mahal, Tardeo, Opp. Air-condition Market, Mumbai. on telephone No. 24925305 / 24948423

OBITUARY

We regret to inform our members that one of the active members of ISSE, **Shri. Ashok G. Bapat** passed away in the unfortunate incidents of Bomb Blasts in Local Trains, on 11th July, 2006.

He was 61 years old. He was in service with N.T.C. and after retirement he was a consultant with N.T.C. He gave fruitful guidance to ISSE in the matter of formulating the requirement for making structural audit mandatory by Co-op. Housing Society federation. He was actively involved in efforts to get it implemented.

He was a workoholic and was always involved in productive activities. In his spare time he used to take lectures in Colleges where his services were actively sought.

He is survived by his wife and two children. He leaves in his wake a shattered family and our hearts go out to them in their hour of grief. May his Soul Rest in Peace.