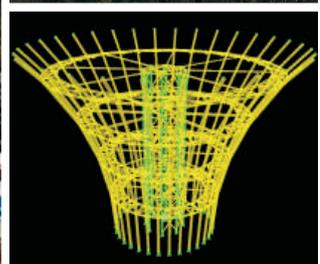


# STERLING

ENGINEERING CONSULTANCY SERVICES PRIVATE LIMITED

Quarterly Newsletter | March 2011 | Issue: 4



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## Sunshine Tower - The Tallest Commercial Steel-framed building in India



### Introduction:

Until recently, developers in India were rather skeptical about using structural steel on a large scale for their projects and RCC was the preferred choice. However, due to availability of suitable structural steel sections manufactured to international standards and advancement in fabrication / erection facilities, steel-framed buildings are emerging as viable alternatives to RCC structures. One recent example is the construction of Sunshine Tower, the tallest commercial steel-framed building in India – located on Tulsipipe Road, Dadar, Mumbai.

### Architectural Planning:

The plot of land available for construction is about 3000sq. mts of which 15% area is consumed by the narrow approach road itself. The overall dimensions of the tower in plan are 21 m x 27 m with a total height of 161m above the ground and 5 m below. Hence, construction of a very tall and slim building was inevitable. Considering these space constraints, it was decided to minimize “in-situ” work and fabricate most of the building components away from the site. This led to selection of steel-framed building covered with structural glazing and aluminum composite panels. The service core comprises of elevators, fire escape staircases, toilets and air-handling units.

The tower comprises of a basement, Entrance Lobby at the Ground Floor, 5 parking floors and 35 office floors including refuge floors at different levels. The office space, measuring 21 m x 16 m, is completely column free. All the services are accommodated in the basement along with a mechanical car parking facility. The car parking floors above are accessed by a 6 m wide ramp. The entire parking block is designed as an RCC structure, attached to the tower block.

### Structural Scheme:

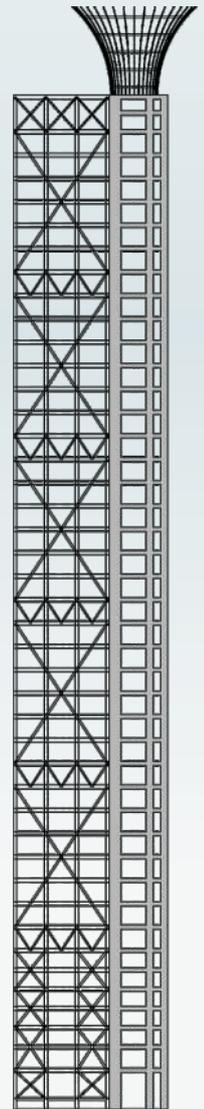
The structural scheme comprises of RCC slabs supported on steel beams which in turn span 15.6m from the service core to the peripheral columns. The depth of these beams is restricted to 686mm and they are designed as composite sections utilizing the compressive strength of the concrete slabs. The beams are directly supported on square hollow steel columns (measuring 500mm x 500mm). The plate thicknesses of these sections vary from 36mm at the bottom to 16mm at the top.

Traditionally, the lateral loads due to earthquake and winds are resisted by providing a strong, centrally located service core. However, in this case, the plan dimensions of the RCC core were restricted to 11 m x 21 m only and the core was eccentrically placed. It was too weak to provide lateral stability for this 180m tall building. Hence it was decided to utilize the strength of the steel columns on the periphery of the building. Although 500mm x 500mm steel columns can carry large axial loads, they have very low stiffness to resist lateral loads. Hence, lateral deflections could be brought under control only after the introduction of diagonal bracings. The bracings used are rectangular hollow steel sections of size 500mm x 300mm. The concept of having bracings also appealed to the Architects for its aesthetic advantages and honesty of expressing the structural concept. The six storey high diagonal bracings resist significantly large tensile forces and reduce lateral deflections. Besides, the steel columns are filled with concrete to increase their stiffness as well as to improve their resistance to fire.

In addition to this, the structural framing system at every service floor is specially designed to function as a “Floor Deep” Spandrel Truss along the periphery of the building. Its major contribution is to utilize the axial load carrying capacity of the steel columns on the periphery and further reduce the lateral deflections at the top.

As per the geo-technical report, a suitable strata (offering a Safe Bearing Capacity of 150 T/Sq mt.), was available at a depth of 7 to 8 meters below the natural ground level. As only one basement was required in the building, the option of using Pile Foundation was ruled out. Hence shore piles were provided to facilitate deep excavation without endangering the adjoining buildings.

The roof of the lift-machine room rises more than 6 m above the terrace level. A steel truss of the same height, along the periphery of the building, conceals the façade cleaning system mounted on rails as well as the lift machine room and staircases.



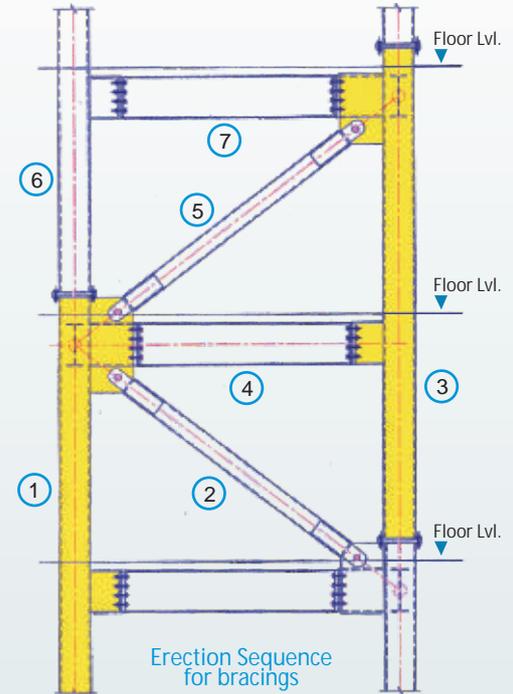
West Elevation

A specially designed architectural feature – resembling a fountain – is supported above the roof of the lift-machine room. This feature is expected to be illuminated at night. This feature is over 15m tall with an upper and lower diameter of 16m and 6m respectively. It was modeled using ETABS software. This feature along with an access ladder and maintenance walkways is fabricated using MS tubular sections. So optimized is the design that the total weight of the whole unit is less than 25 tons.

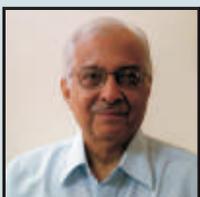
### Construction Sequence:

While the contractors were busy excavating for the basement in the restricted plot area, the owners imported all the special steel sections sourced through CORUS from Japan, Taiwan and UK, since they were not rolled in India. These sections were transported directly to Pratibha Industry's modern fabrication facilities in Wada 90 Kms away from Mumbai. The fabrication was carried out with utmost care and accuracy. As soon as the raft foundation was concreted, the lowest sections of the steel columns (complete with 100 mm thick base plates) were brought to the site by special trailers. A heavy duty crane – capable of lifting 5 metric tons at 185 mts was erected in the north east corner of the tower block. Similarly, to expedite construction of the concrete core, pre engineered aluminium formwork was used. This ensured dimensional accuracy as well as speed.

It must be noted that all the diagonal steel bracings in the tower block are installed in the same plane as the peripheral columns and beams. Thus, eccentric connections were avoided. However, the erection sequence of the columns, beams and diagonal bracings had to be worked out very carefully to avoid delays. The accompanying diagram shows the erection sequence adopted successfully. It can be seen that the junction of columns was staggered specifically to simplify erection and the bolted connections between columns and beams were moved away from the main grids. The diagonals were connected by using single pins and all other joints were “bolted” connections. Thus, welding at site was practically eliminated for obvious reasons.



### ➤ Sterling Team at Sunshine Towers:



S. B. Malekar



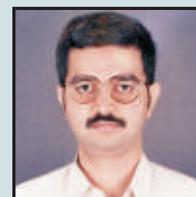
Vinayak Nayak



Kundan Ghogre



Chetan Shinde



Ganesh Sahani



Rahul Thakur

## Some Of The Interesting Projects Under Construction



Saifee Park - Mazgaon, Mumbai

Saifee Park, is a high rise residential building being constructed in Mazgaon, South Mumbai. The building comprises of two stilt levels, five parking floors and twenty four residential floors. There are four refuge floors at different levels. The building stands 141m tall above ground level.

Thanks to a good Architectural layout, the tower has a very economical structural system. Three residential wings are arranged around a central triangular atrium. The atrium ensures maximum light and ventilation inside the tower. Structural rigidity is provided by one shear wall with door openings in each wing. Shear walls in each wing are inter-connected to form a stable triangle. Staircases and elevators are housed within this triangle. RCC columns placed along the periphery of the wings are tied to the central core by floor slabs and framing beams.

Columns in front of the elevators, at the Entrance level as well as at the Stilt level, are avoided. This is achieved by designing the framework of columns and beams above these levels as "Vierendeel Trusses". Temporary columns are provided during construction to ensure that this load transfer takes place safely and satisfactorily.



Chakan Hotel - Pune

Located in MIDC area of Chakan, Pune this hotel building, presently under construction, is. The building comprises of a part Lower Ground floor, Ground Floor, a service floor and 7 guest floors with 127 guest rooms and 14 suites. Taking advantage of the natural slope of the land, a lower ground floor was created to house the STP, Water tanks, Boiler rooms etc. The ground floor has a multi-specialty restaurant, grand reception area, entrance canopy, a business centre and ballroom. In order to provide a column free entrance lobby at ground level, a 3.9m deep transfer girder is designed with 3 openings of 900mmx900mm for ventilation.

The hotel floors are designed using conventional column, beam and slab system. The floor to floor height is 3.3m. Most of the building columns are carried right down to foundation level – avoiding transfer girders. However, where necessary, 1.8m deep transfer girders are introduced to float the super structure. The service floor permits easy transfer of MEP services and accommodates a Gymnasium. There is a swimming pool in the rear side of the service floor and a landscaped garden in the front. A continuous skylight separating the guest rooms and the terrace ensures privacy to the hotel guests as well as admits natural light into the central part of the lobby at ground floor.



MMRDA Head Office - BKC, Mumbai

Presently under construction in Bandra Kurla Complex, is the head office for MMRDA. Not only is this a unique architectural form but is also a challenge for the structural designers. It offers the largest "column-free" space on every floor - measuring 18m X 27m. This huge floor plate is supported on two major plate girders spanning 22.5m in length as well as two girders concealed in exterior glazing spanning 27m.

Each box shaped wing comprises of 3 office floors and one terrace floor. Such boxes are stacked over each other in a staggered fashion giving this

building its unique character. The stability of the building is ensured by the service core which is eccentrically placed. Torsional movement is prevented by the shear walls placed at the end of each wing. The stability of these shear walls is ensured by the rigid structure of the fire escape staircase.

## Recently Completed Projects

### The Orchard Residences - Ghatkopar, Mumbai

This is a luxurious residential complex located next to R-City Mall on LBS Marg in Ghatkopar. The project has been developed on 6 acres of land with built up area of approximately, 12 lakh sq.ft. This complex has 10 buildings accommodating almost 600 flats. The complex is designed with a basement, stilt level, podium and 14 residential floors.

The apartments have solid flat slabs to maximize usable area with clear head room as the floor to floor height is restricted to 2.9m only. Eliminating the central beam between adjacent flats also facilitates merging of these flats if they are purchased by a single owner.

A large central podium is constructed on a flat slab to maximize head room in the parking area below this level. The Podium includes all the modern amenities like landscaped garden, lawn, club house, gymnasium, swimming pool, tennis court etc.



### Dosti Pinnacle - Thane, Mumbai



This landmark IT park was recently completed for Dosti Group in Thane. Offering about 3,50,00 sq ft of area, this RCC building has three wings surrounded by a single storey podium. Each wing is of different heights as the number of floors for the three wings is 7, 9 and 11 respectively. The columns are spaced on 8.5m x 8.5m grids for two wings and 8.5 m x 11.0 m for the third wing. The floor structure consists of flat slabs without drop panels of 300mm thickness for 8.5 m x 8.5 m panels and 325mm thickness for 8.5 m x 11.0 m panels with shear reinforcement. The entrance of the building has a prominent suspended steel canopy covering an area of 6 m x 12 m. The entrance lobby leads to an impressive atrium with a height of about 50m.

### Neptune Dosti IT Park - Thane, Mumbai

This commercial building was recently completed in Thane. The planning has been done by Amatrix Architects, Hong Kong and the local architects are Vijay Panjabi Consultants. In Phase-1 the building has two basements, a lower and upper Ground Floor and nine upper floors. Each floor plate provides an approx area of 2300 sq mt with large column free spaces. The building is curved in plan with dimensions of 110m X 29m. The height of the building is 53.6m.

The structural feature of this building is the Flat Slab System with 3 rows of columns and 2 lift cores. Columns are spaced, on a grid of 8.9m X 11.5m. There is also a 4.6m cantilever projection along the longer edges of the building which makes the design both challenging and interesting.



### Peninsula Technopark - Kurla, Mumbai



This project is located at the junction of the Bandra Kurla road and L.B.S Marg. There are four IT buildings - namely A,B,C and D. Building A is stilt + 7 storied structure having parking in the stilt and the IT offices on all the floors above. Building B has one Basement, ground and 7 floors. The basement houses the parking and services for the entire project. Building C has 2 basements, Ground and 7 Upper floors. A club house is located on the Podium level to cater to the needs of these buildings. Building D has 2 basements, Ground and 10 upper floors. The structural system for building A B and C is a flat slab with drop panel system to maximize the headroom under the false ceiling as the floor to floor height is only 3.2m. The peripheral beams are avoided to have a good glass façade as per architectural intent. In

building D banded slab floor system is adopted to cater to the larger column free area of 11m x 8m.

## Research & Development at Sterling:

### Controlling The Temperature Of 2m Thick Raft

When the time came to cast the 2m thick raft foundation at La Citadel project in Mumbai, in the sweltering heat of the month of May 2010, special precautions had to be taken. The approximate plan area was 1600 sq.mts. The design engineers at Sterling worked closely with the site team to ensure proper handling, placing, finishing and curing of concrete.



1. At the RMC plant, the concrete temperature was reduced significantly by using chilled water and ice cubes.
2. The aggregates were wetted thoroughly with normal water and then sprayed with chilled water before mixing.
3. The area ready for concreting was covered with tarpaulin sheets before concreting, to avoid the direct rays of the sun. This shade was maintained for 3 days after concreting.
4. Thermo-couples were installed before concreting at the core and at 100 mm inside the surface.
5. Hessian cloth was wrapped around the concrete pipeline and kept wet in order to insulate the concrete flowing through it.
6. Temperature at the time of pouring of concrete was checked at site and was about 32 degrees as per specifications.
7. Compaction was properly done, to avoid sudden thermal jumps in the material due to presence of voids.

8. Curing compound of the approved brand was applied immediately after setting of concrete, in the proportions specified by the vendor.

9. Immediately after the curing compound dried, the surface was covered with thermocole and plastic sheets.

10. Temperatures were noted at every hour, up to 72 hours and thereafter every 6 hours up to one week.

11. After 72 hours, thermocole and plastic sheets were removed. Curing by ponding method was done with normal water for 10 days.



The peak temperature rose to almost 83 degrees at the core at 71 hours. Insulating the surface was instrumental in maintaining the surface temperature to 63.5 degrees at the corresponding hour. After taking all the above precautions, it was heartening to know that the maximum temperature difference between the surface of the raft and the core was less than 20 degrees centigrade. This resulted in a flawless work sequence and a superior quality mass concreted raft that stood the vagaries of extreme weather conditions as well as the high heat of high grade concrete.

- Arvind Kanaujia, BKC

### Effect of pre-stressing on vertical deflections in flat slabs:

It is common knowledge that pre-stressing is used to balance self-wt. gravity loads in flat slab design. In most cases about 70% to 90% of the self-wt load is sought to be balanced. It is also acknowledged that pre-stressing would reduce the deflections due to self-wt., but to what extent? Would it reduce the self-wt. deflections by 80%, if say 80% of the self-wt. is balanced?

It has been observed that the reduction due to pre-stressing is much less than the expected 80%. What is the reason?

In PT slabs, the pre-stressing force is adjusted so that the self-wt. bending moments at various sections, are negated by 70% to 90%. Therefore when we say that say 80% of the self-wt. load is balanced, it is with respect to local stresses at a section. But when we have to work out the upward deflection due to pre-stressing, the cable profile has to be considered.

In flat slabs there are multiple spans, because of this, the cable profile has a hogging parabolic profile over the supports and a sagging parabolic profile in the mid-spans. This means that the cables are above the centroidal axis near the supports and below the centroidal axis in the mid-spans. This causes a downward udl at the support and an upward udl in the mid-span. Thus the net upward deflection at the mid-span is based on these two types of opposing udl's. Therefore the reduction in the dead load deflections due to pre-stressing is less than expected.

The extent of reduction will vary depending on the cable profile, the position of points of contraflexure of the cables, depth of slab and drop, etc.. The reduction could be in the range of 30% to 60% instead of 80%.

- Vinayak Naik, Fort

## ❖ Social Events

### ❖ Time for celebrations!

- 1) Our draftsman in BKC office, Kavita Raut got married to Milind Patil on 28th November 2010.
- 2) Our engineer from BKC office, Aniket Kadam tied the knot with Rashmi on 1st January 2011.
- 3) A baby girl – Sanvi – was born to our engineer from Fort office - Kundan Ghogre and his wife Sheila on 1st of December 2010.
- 4) Rajdatta and his wife Aditi were blessed with a baby boy, Advait on January 11th 2011.
- 5) On 15th Feb 2011, Arvind Kanaujia's wife delivered a baby boy!
- 6) Engineer Abdul Hafiz from BKC office got married to Shabista Parveen on 19th Dec, 2010.

- ❖ We are pleased to know that for the past three years, Ashok Patil and Rahul Thakur are involved in helping the adivasi community near Vasai in many ways. Not only do they help by donating funds but also distribute educational material to the school. Every year, for Diwali, they distribute sweets and crackers in these rural areas. We congratulate them on their efforts and encourage them to work for this important social cause.

## ❖ Creative Strokes



Our very own draftsman, from Bandra West office, Pradeep Dhuri is a very talented "kandeel" maker! Each year, he makes over 300 lanterns for Diwali. The preparations begin a month in advance and Pradeep personally collects all the materials like crepe paper, kite paper, thread, glue and bamboo sticks from Mohammad Ali Road. His entire neighbourhood is engaged in this kandeel making craft and are well known in Matunga and Mahim

areas. Pradeep has been making these kandeels since Std 1 and is proud to say that he has no left over kandeel at the end of the festive season! He even specializes in theme lanterns such as World Cup, Birds, Traditional and Modern kandeel patterns – so do look out for his colourful display at L. J. Road, Matunga, this Diwali!

## ❖ Down Memory Lane (This feature revives memories of old and remarkable projects)

### ❖ Imax Theatre, Wadala, Mumbai

India's first IMAX Dome was inaugurated in Mumbai on 25th March 2000. This has the world's largest screen measuring 13,700 sq. ft with a capacity of 520 viewers. It provides a hi-fidelity audiovisual experience in which the film envelopes each viewer with 12000 watts of digital wrap-around sound. The giant screen dome is about 99 ft (30m) in diameter.

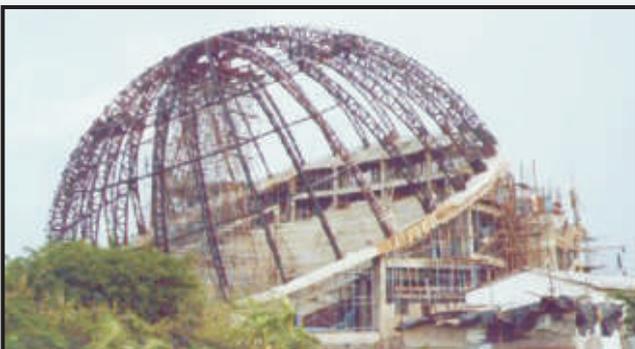
The large titled dome of the IMAX catches our eye even from a distance. The main difference between other IMAX theatres and this one is that the 'screen dome' (on which the picture is projected) is housed inside a 'structural dome'. Otherwise, the simplest solution would have been to install the screen dome inside a 'rectangular box'.

The 37m-diameter structural steel dome can be compared to a globe sliced at the equator and then tilted at an angle of 30°. The dome is primarily made up of fabricated structural steel open web girders, which divide it into 16 segments. These open web girders facilitate easy installation of several services. The girders are supported on an RCC ring beam, which in turn is supported by 16 peripheral columns. The girders converge at the pole of the globe where they are connected to a 4m diameter compression ring. Due to the large diameter each of the longitudinal segments is further divided by an intermediate girder spanning a shorter distance. In addition, there are four circumferential steel girders dividing the entire curved length, from the ring beam to the compression ring, into five almost equal parts. Diagonal bracing members along the entire structure provide additional strength and stiffness. The structural dome is also designed to support the catwalks, speaker platforms, air-conditioning ducts and acoustic panels.

The waterproofing for the entire dome has been carried out using a special polyurethane foam insulation followed by elastomeric membrane. This allows for the expansion and contraction of the surface without cracking.

The two inclined elevational RCC fins on either side of the dome were also analyzed and designed to resist wind loads. The specialty of this imposing elevational feature is that each fin is supported only at one point beyond the foundation.

Due to the 30° tilt in the dome, the forces in each of the girders as well as the RCC members were not evenly distributed. Radial members are subjected to axial compression as well as bending. Therefore the challenge was to make the dome safe and stable without any distortion. To suit the subsoil conditions, all the columns were supported on precast pre-bored piles.



IMAX dome under construction



Completed IMAX theatre

## Editorial



### Our Engineers - Men of Steel

By the time you receive this newsletter, we will be well into the New Year but I do take this opportunity to wish each one of you a very healthy, happy and successful 2011.

This time, we bring to you some special steel structures designed by our company. Right from the IMAX Dome in Wadala, completed in the year 2000, more than a decade ago, to the almost completed Sunshine Towers in Dadar - it has been a memorable journey for our engineers - "our men of steel"!

For the IMAX, the challenge was in designing a 37 meter diameter tilted dome in steel, the largest of its kind in the world! The dome was made up of structural steel open web-girders which are now hidden underneath the RCC shell covering the dome.

At Sunshine Towers there were several challenges. The design engineers had to find solutions to problems such as working on a plot with space constraints, providing the construction methodology for the steel framed structure and paying attention to details in designing the tallest commercial steel building in India! These challenges have simply pushed our engineers to give better solutions not only in terms of structural stability but also aesthetics. It is important to note that the cross-bracings in this structure have been beautifully adopted by the architect and in fact expressed in the elevational treatment of the tower lending it a sleek and sophisticated look.

We are filled with a sense of pride and admiration for the creativity of our engineers as well as the tenacity in dealing with new challenges in design and execution of these buildings.....

In this issue, we have our regular sections too showing the completed as well as on-going projects in our company. In the research section, we have an article on temperature controlled concrete sent in by Arvind Kanaujia. It is heartening to see the delicate "kandeels" made by our own Pradeep Dhuri in our creative strokes section. So do go ahead and enjoy this issue and send in your feedback to us on [deepalihadker@sterlingengg.com](mailto:deepalihadker@sterlingengg.com)!

Dr. Deepali Hadker

### Marathi Poem by Mrs. Asha Hadker on the celebration of our 25th anniversary in 2003

स्टर्लिंग म्हणजे मौल्यवान, एका विशिष्ट दर्जाचं  
सार्थ आहे ना नाव? आपल्या या कंपनीचं?  
पाया घातला दादांनी, मदत केली सहस्त्रकरांनी  
कमलसरांच्या परिस-स्पर्शाने केली किमया सोन्याची  
धडपडीला अर्थ होता सार्थ झाली श्रांत मने  
झाल्याही असतील काही चूका पण त्यातूनही सावरले सारे  
अहो, आता तर कुठे आम्ही गाठलीय पंचविशी  
तारुण्यातली जिद्द आणि उभारी असते अगदी बावनकशी  
इंजिनियरिंगच्या क्षितिजावरचा, चमचमणारा शुक्रतारा  
कमलसरांच्या कल्पनाशक्तिचा, आविष्कार आहे न्यारा  
पंचविशीच्या उंबरठ्यावर, आता अधिकच जोर येणार  
दीपालीच्या स्नेह ज्योतीने, परिवार हा उजळणार  
खासियत आहे स्टर्लिंगची, कला आणि विद्येची  
आशा आहे यशाची प्रेरणा आहे आत्मीयतेची  
आहेत इथे अनुभवसमृद्ध विव्दान, अभ्यासू आणि सिद्ध  
चिकित्सक, मेहनती पण होतात कधी कधी क्रुद्ध  
चिडतात, रागावतात, वैतागतात खंतावतात  
पण कानात सांगते तुमच्या दुसऱ्या दिवशी आनंदात येतात  
ज्ञानाच्या इच्छेने येतात इथे साधक  
हा परिवार जणू आहे लोहचुंबक  
एकजुटीत आहे याच्या शक्ति मोठी  
हीच आहे इथल्या आनंदाची जडीबुटी  
बांद्रा कुर्ला कॉम्प्लेक्सचं होतंय म्हणे सिंगापूर  
स्टर्लिंगचा वाटा सिंहाचा, त्याची कीर्ति सर्वदूर  
अशा या परिवाराला रजतमहोत्सवाच्या शुभेच्छा  
भरभरात होवो सर्वांची हीच आमची इच्छा

## Welcomes & Goodbyes

We are always happy to welcome new members to our Sterling family. This time they are:

**Mr. Mukesh Kadakia** - Senior engineer – Fort office  
**Mr. Mahesh Patil** – Junior engineer – Bandra West office  
**Mr. Mahendra Pawar** – Junior engineer – BKC office  
**Mr. Vinayak Balkawade** – Draftsman – Pune office

We wish those members who have bid us goodbye the very best for their future. They are: **Allwyn Chandra**, **Vaibhav Bhagat**, **Ashwin Gadhe** and **Dinesh Karpe**.

### STERLING OFFICES:

Fort Office:	sterlingfort@gmail.com
Bandra West Office:	sterlingbandra@gmail.com
BKC Office:	sterlingbkc@gmail.com
Bangalore Office:	secspl@vsnl.com

website: [www.sterlingengg.com](http://www.sterlingengg.com)