STEEL News & Notes

INGAPORE STRUCTURAL STEEL SOCIETY

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Contents

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STEEL NEWS & NOTES

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The President's Corner

The gloom that hung over the construction industry in the psast few years appears to be gradually dissipating. With cautious optimism, we are looking forward to the growing number of projects in the Marina Bay, Sentosa, Jurong island, Orchard Road and other parts of Singapore. They will give the construction sector a much needed fillip. (According to BCA, construction demand in 2006 is expected to hit $12 billion to $13.5 billion, compared to $11.3 billion in 2005 and $10 billion in 2004.)

After an eventful 2005, our society is all set to face year 2006 with renewed vigor. We will kick off the year with an interesting evening lecture on 17 January at the Furama River Front Hotel. The speaker, one of the co-inventors of the Lysaght SmartTruss roof framing system will speak on Lightweight Steel Trusses.

This will be followed immediately (in February) by the start of the second run of our Qualified Steel Supervisors Course first launched in August last year. We anticipate a full class of more than 50 trainees in this run, after the overwhelming response at our inaugural course.

Our Scholarship fund raising efforts have brought us close to our target of $150,000, and we are all ready to award the first SSSS-BCA scholarship for undergraduate studies in the Civil and Structural Engineering courses at NTU and NUS.

We also look forward to organising the very popular annual SSSS-Continental Steel Golf Challenge in the second half of the year. Golfing enthusiasts from the industry can once again gather for a day of interaction and fun.

We will wrap up the year with our Annual Lecture and Dinner. After the fantastic turn-out and outstanding lecture given by our special guest lecturer in November 2005, it will be a challenge for our council members to try and match the standard set last year, but I am sure we will be up to it.

Our other educational and training activities such as site visits, evening talks, seminars and corporate members' gatherings are also in the pipeline. Watch out for these in our circulars and SSSS website.

I wish all of you a great year ahead and hope you will participate fully in the various activities that your society has lined up for you in 2006.

Tan Tian Chong

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22nd Annual General Meeting

The 22nd Annual General Meeting of the Singapore Structural Steel Society(SSSS) was held on 14th March 2006 at 6.30 pm at the Furama Waterfront Hotel (formerly Apollo Hotel). Before the AGM Mr Wada of ICM Pte Ltd delivered an interesting talk on "Intumiscent Paint" used for fire protection of Steel structures. The talk was followed by the distribution of certificates to the successful participants of the first batch of "Steel Supervisors' course" conducted by the SSSS. The certificates were given away by the President of the Society Mr Tan Tian Chong.

The AGM commenced at 8.00 pm with the address by the President of the Society. He highlighted the important activities of the Society during the past year. The Hon Treasurer then presented the balance sheet for the preceeding year which showed a healthy financial position of the Society. This was followed by the election of the office bearers for the term 2006/2007. The following members were elected for the term 2006/2007.

In addition two Honorary Auditors were nominated from the floor. They are Mr Lauw Su Wee and Mr Trimbakeshwaran. The AGM was adjourned at 8.30 pm. The AGM was followed by a buffet dinner for all present including the receipients of the certificates..

Mr Wada speaking on Intumiscent paint

Society President Mr Tan Tian Chor giving away certificate to a successful participant of the Structural Steel Supervisors' Course

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Mr M.S. Islam (Hon Editor)	Mr Lauw Su Wee
Dr Ng Yiaw Heong	Mr Look Boon Gee

21st Annual Lecture and Dinner

The 21st Annual lecture and Dinner was held on 27 October 2005 at the Furama RiverFront Hotel. It was attended by over 400 members of the engineering fraternity. The annual lecture was delivered by Mr Tristram Carfrae, Principal and Arup Fellow. He is responsible for the design of an impressive array of award winning buildings and is regarded internationally as a leading designer of sporting stadia and lightweight long-span structures. Tristram is behind the design of The Water Cube - Beijing's National Swimming Centre for the 2008 Olympics. He also boasts an impressive portfolio of facilities created for the 2000 Sydney Olympics, including the RAS Exhibition Halls, the Dunc Gray Velodrome and the Olympic Tennis Centre.

Tristram has collaborated with many of the world's leading architects, including Renzo Piano, Richard Rogers and Philip Cox, on projects where the structural form is itself an aesthetic statement. He has also helped design six structures that have won Special Awards from the Institution of Structural Engineers (IStructE) – the world's premier structural accolade. No other structural engineer has achieved this. Tristram believes that good buildings should consume less materials, energy, time and money while at the same time providing greater amenity.

He has a reputation for challenging the established way of doing things, to explore better solutions, moulding both materials and people to his vision. This unique approach has produced some of the world's most exciting structures including the City of Manchester Stadium, Singapore Expo, Aurora Place in Sydney, Brisbane Convention and Exhibition Centre and San Nicola Stadium in Bari, Italy.

Tristram is a member of the global Arup Group Board, Arup Australasia Board and deputy chair of the Global Buildings Board. He is also chair of the Design and Technical Executive, which advises the global practice on all design and technical matters. He is one of six Arup Fellows (out of a global staff of 7,000). This accolade honours those who have significantly contributed to the firm's reputation for excellence in innovation and design and designates him as a leader with the role of ensuring this continues. In 2005, Tristram was named as one of Australia's Top 100 most influential engineers. He was Australian Professional Engineer of the Year in 2001.

Outline of 21st Annual Lecture
The structure of stadia – from exoskeletons to haute couture

His lecture traced the development of Stadia structures, particularly roof structures, from independent truss cantilevers through mast and cable solutions to three dimensional cable nets and finally the completely wrapped stadium. Tristram illustrated this progression with Stadia that he has helped design:

- Sydney Football Stadium, also known as Aussie Stadium was constructed in the mid eighties and seats 40,000.
- San Nicola Stadium, Bari, constructed in the late eighties and seats 55,000. The focus for this stadium was sculptural quality.
- Asian Games Stadium, Bangkok, constructed in the early nineties and seats 25,000, this stadium sees the introduction of lighting masts.
- Lang Park, constructed in the late nineties with the desire to keep the overall height as low as possible whilst providing perfect sightlines for 50,000 spectators.
- City of Manchester Stadium, constructed during the millennium for the Commonwealth Games then had to be converted into a soccer stadium within a six month programme.
- Melbourne Cricket Ground North Stand constructed in the early noughties for the 2006 Commonwealth Games had to deal with the problem of a fairly aggressive wind climate.
- Khalifa Olympic Stadium constructed in the early noughties for the 2008 Asian Games. This stadium has been likened to a 'jewel in the desert'.
- Beijing Olympic Stadium constructed in the mid noughties for the 2008 Olympic Games. Developed using Catia, CAD/CAM software developed for the aviation and auto industry.
- Beijing National Swimming Centre constructed in the mid noughties for the 2008 Olympic Games. Also known as the Watercube.

This sequence of stadia not only illustrates the progression of architectural approach and resulting (or generating) structural systems but also the way that design ideas migrate from project to project.

SSSS Scholarship Fund

The SSSS has managed to raise $50,000 for the Scholarship fund at the last SSSS Golf Tournament held on 25 November 2005.
Together with the initial sum of $85,000.00 raised during the 20th Anniversary celebrations last year, the total sum in the scholership fund now stands at $135,000.00. This money in the scholership fund will be used to offer Scholerships to outstanding undergraduates persuing the Civil & Structural Engineering course at NUS or NTU. This will be implemented through the SSSS-BCA scholership scheme which is now open for application. The scholership is worth $7,000.00 per year for the entire duration of the course. Priority will be given to children of SSSS members both individual and corporate. However, the successful applicant will be required to sign a bond to work in any of the SSSS corporate companies for a period of two years.
Please submit names of your children/staff's children who wish to apply for the scholarship to SSSS Secretariet at 232A River Valley Road, Singapore 238290 together with copies of transcripts and testimonials.

ZAM Evening Lecture

SSSS organised an evening talk on "New High Corrosion Resistant Steel Coating and its Benefits". It was held on Monday 17 October 2005 at the Vanda Room, Singapore Polytechnic. The talk was sponsored by the Singapore Representative Office of Nisshin Steel Co Ltd, Japan and attracted 65 participants. Mr Yasuhiko Mikami, Marketing Manager, described the research, development and application of their new product, ZAM, a new highly corrosion-resistant hot dip coated steel sheet developed by Nisshin. He elaborated on the technical product superiority, quality features and benefits of ZAM steel. The new protection involved a coating of zinc, aluminum and magnesium. It showed superior corrosion resistance under salt spray test compared with ordinary galvanised steel. ZAM steel was also noted for good corrosion resistance at cut ends. Participants received handouts and trade samples showing the finish quality of ZAM steel.

An Update on the SSSS Steel Fabricators Accreditation Scheme

Since November 2002, when the steel fabricators accreditation scheme was introduced to enhance the improvement and to help raise the standard of the steel construction industry, 36 steel fabricators have been successfully accredited to the requirements under the four accreditation categories. Of the 36 firms, 5 are S1, 8 are S2, 22 are S3 and 1 is S4 accredited.

In category S1, firms need to have minimum net tangible assets (NTA) of $3 million, at least one in-house professional engineer and at least three supervisory staff. Firms must also fulfil other criteria such as being able to build a large span portal, bridge or trusswork of over 30 m span.

In S2, firms must have at least NTA of $2 million and at least two supervisory staff. For S3, companies need a minimum NTA of $500,000 and for S4, NTA of not less than $100,000.

The scheme, which is voluntary, is managed by the Singapore Structural Steel Society (SSSS) with the support of the Building and Construction Industry (BCA). BCA has sent out an advisory note to encourage IES and ACE members to specify, as part of the contract specifications that the steel fabricator employed should be accredited by the Singapore Structural Steel Society's Accreditation Scheme and in the category appropriate for the project.

To be accredited by the scheme, applicant firms must meet the requirements of the category they are applying for. The applicant firms must assemble their documentary evidence for submission. The auditor appointed by SSSS will review the documentary evidence and verify them at the firm's premise and fabrication yard.

The accreditation is valid for two years. At the expiry of the accreditation, firms have to resubmit fresh evidence for verification. Firms can also apply for category upgrade anytime if they fulfilled the requirements of the category. However if the firm failed to maintain the requirements or was charged under the building acts or in court of law during the accreditation period, the SSSS fabricator accreditation committee will conduct an investigate and may recommend the firm for downgrading, suspended or withdrawn from accreditation.

For more information about the scheme, please contact Ms Pauline Zee at Tel : 67356255. The details of the scheme and the list of accredited steel fabricators could be obtained at SSSS website www.ssss.org.sg.

Evening Lecture on Lightweight Steel Truss

The evening lecture was held on Tuesday, 17 January 2006 from 6.00 pm to 8.30 pm at the Furama RiverFront Hotel. The speakers were Mr Campbell Seccombe, Manager - Lysaght Technology and Mr David Humphrey, Systems Development Manager, Lysaght Technology. The talk was sponsored by BlueScope Lysaght.

Engineers in Singapore frequently use the British Standard (BS) as the basis for their design. However the current BS does not have a comprehensive standard for the use of high tensile steel in the design of lightweight cold-formed sections. BS5950 can only be used for the design of structures manufactured from 330MPa steel. Recent international research and development has enabled the use of lightweight high tensile cold-formed steel to be used in structures providing economy, and ease of construction whilst retaining good, if not better performance than conventional designs. Other international standards such as the Australian Standard AS4600 cater for the use of high tensile steel in cold-formed sections but these codes are still not widely used in this part of the world.

Recent problems with the collapse of light steel roof trussed structures reflected that the introduction of the new framing technology of lightweight steel structural system requires even more stringent checks and scrutiny. There are many reasons to cause a structural failure and this seminar will highlight how the latest overseas research and development work in the laboratories enables a complete understanding of the products and design technologies, which translates to confidence in the structural performance on site. This seminar provided the participants an insight to the development and design processes of a successful system with high structural integrity using materials of the future and efficient construction methods.

SSSS Fund-raising Golf Tournament

Singapore Structural Steel Society organised the SSSS Fund-Raising Golf Tournament on Friday, 25th November 2005, to raise funds for the SSSS-BCA scholarship. The charity Golf tournament will also promote interaction among members of the SSSS and those of the construction industry. The scholarship will be offered to students with outstanding results who wish to pursue a career in Civil and Structural Engineering in NUS or NTU. Priority will be given to children of SSSS members when considering the award.

The Champion of the Tournament was Mr. Shek Kam Chew. His name would be engraved on the SSSS Annual Challenge Trophy. There were lots of prizes and gifts sponsored by well-wishers. The golf event was followed by a sumptuous dinner.

Tee-off time was 12:45 pm and the game was held at Warren Golf and Country Club. Altogether there were 35 flights and we have had fine weather for the whole game. The guest of honor was the Chief Executive Officer of Building Control Authority, Mr. Chionh Chye Khye. Mr. Ong Chan Leng, Director, BCA also attended the Golf tournament.

The cost for each flight was S$1600.00 for 4 players or individually S$400.00. SSSS managed to raise S$50,000 from this event. Thanks to the well wishers and sponsors as well as to the effort of the council for all the hard work put in by the Council members.

Special thanks also to our First Vice-President Mr Ho Wan Boon for taking the photographs, some of which are featured in this article.

Certification Course for Structural Steel Supervisors

After successful completion of two runs of the course, applications for the 3rd run of the course is now open. The course offers a continuing education and training programme for engineers and technicians who are involved in planning, execution and supervision of the fabrication and erection of specialist structural steelworks to qualify as Certified Structural Steel Supervisors (StS). The course is specially tailored for technical personnel working in the steel fabrication yards and on construction sites. Developers and design office personnel who aspire to acquire specialized knowledge in structural steelwork planning, design, specification, procurement, fabrication and erection would also find the course very useful.

The course emphasizes the practical and safety aspects of structural steel construction. The course will also upgrade site supervisors such as Resident Engineers and Clerks-of-Works currently registered with the Building and Construction Authority with the StS qualification.

Course fees : $700.00 (For SSSS members)
$800.00 (For Non-members)
Venue : Singapore Polytechnic
Date of commencement : 11 September 2006
Duration : 30 hours.

For further information, please see our website at :
http://www.ssss.org.sg

Third International Conference on Steel & Composite Structures

ICSCS'07
The Third International Conference on Steel and Composite Structures

30 July – 1 August, 2007
The University of Manchester, UK

ICSCS'07 will be held in Manchester, 30 July – 1 August 2007. It is organised by the University of Manchester, in collaboration with the "Steel and Composite Structures", *An International Journal*. ICSCS'07 will bring together from around the world researchers, engineers, manufacturers, product providers, fabricators and erectors to discuss and exchange the latest information and technology on Steel and Composite Structures. This conference will include, but not limited to the following topics:

- Buildings, bridges, beams and columns, connections, space structures, plates & shells, whole building, hybrid structures, nonferrous metal structures, composite use of materials
- Buckling and stability, fire performance, fatigue, fracture, vibrations & controls, dynamic & seismic performance, wind resistance
- Analysis, experiments, computations
- Codes, case studies, construction steel, fabrication & erection
- Sustainable development, education, maintenance & health monitoring, optimization

Prospective authors are invited to submit (preferably by email) abstracts of 200 to 300 words by 30 September 2006, addressed to:
Secretariat, ICSCS'07
ConferCare
The University of Manchester
1st Floor, Barnes Wallis Building
Sackville Street, Manchester M60 1QD, UK
Tel: +44 161 3064068
Fax: +44 161 3064070
Email: mcc.reg@manchester.ac.uk
Webpage: www.meeting.co.uk/confercare/icscs07

New Members

Membership Number	Name	Organisation	Admitted
Associate Member			
AS 50	Tong Meng Chong	Specs Consultants Pte Ltd	10 November 2005
AS 51	Oliver Chow Chen Hai	GCC Construction Engineering Pte Ltd	8 December 2005
Ordinary Members			
OM 709	Hamzah Bin Ali		8 December 2006
OM 710	Yang Tao	Connell Wagner Pte Ltd	8 December 2006
OM 711	Ong Lay Leng	Jean Ong Consulting Engineer	12 January 2006
Corporate Members			
CM 67		Inbuilt Engineering Pte Ltd	27 October 2005
CM 68		Stelatex Holding Pte Ltd	10 November 2005
CM 69		Kian Hiap Construction Pte Ltd	10 November 2005
CM 70		Koon Hui Engineering Works Pte Ltd	10 November 2005

Mega-Floats for Singapore

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Introduction of Mega-Floats

In land-scare countries with coastlines, city planners and engineers resort to land reclamation in order to ease the pressure on existing heavily-used land space. Using fill materials from seabed, hills, deep underground excavations, and even construction debris, engineers are able to create relatively vast and valuable land from the sea. Countries such as the Netherlands, Singapore and Japan, have expanded their land masses significantly through aggressive land reclamation programmes. However, land reclamation has its limitation. It is suitable when the water depth is shallow (less than 20m). When the water depth is large and the seabed is extremely soft, land reclamation is no longer cost effective or even feasible. Moreover, land reclamation destroys the marine habitat and may even lead to the disturbance of toxic sediments. When faced with such natural conditions and environmental consequences, very large floating structures (or Mega-Floats) could offer an attractive alternative solution for birthing land from the sea.

As a general rule of thumb, Mega-Floats are floating structures with at least one of its length dimensions greater than 60 m. Referring to Fig. 1, a Mega-Float system consists of (a) a very large pontoon floating structure, (b) a station keeping system, (c) an access bridge or floating road, and (d) a breakwater (is needed if the significant wave height is greater than 4 m) to reduce the amplitude of the wave impacting on the floating structure.

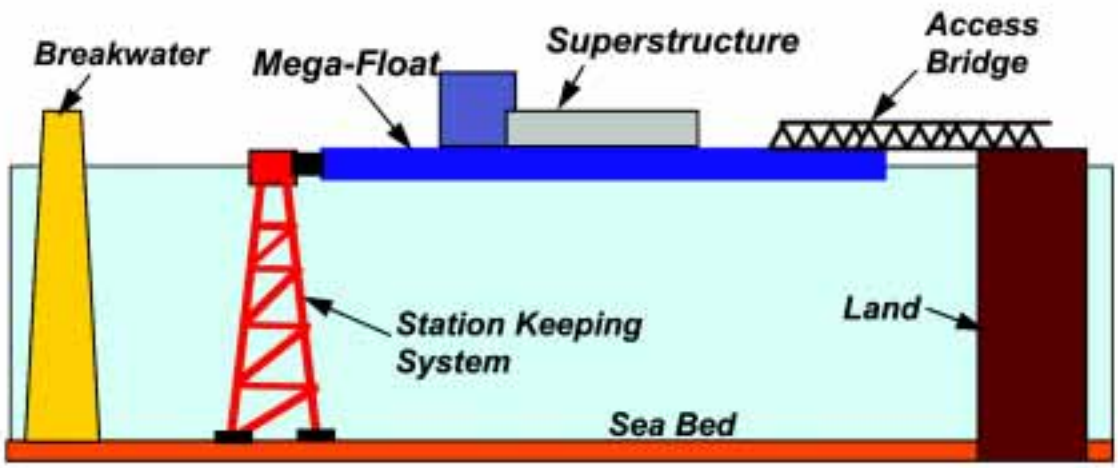

Fig. 1. Components of a Mega-Float System

These Mega-Floats have advantages over the traditional land reclamation solution in the following respects:

• they are cost effective when the water depth is large,

• environmental friendly as they do not damage the marine eco-system, or silt-up deep harbours or disrupt the tidal/ocean currents,

• they are easy and fast to construct (components may be made at different shipyards and then brought to the site for assembling) and therefore sea-space can be speedily exploited,

• they can be easily removed (if the sea space is needed in future) or expanded (since they are of a modular form),

• the facilities and structures on Mega-Floats are protected from seismic shocks since they are inherently base isolated,

• they do not suffer from differential settlement due to reclaimed soil consolidation,

• their positions with respect to the water surface are constant and thus facilitate small boats and ship to come alongside when used as piers and berths.

• they are not affected by rising water levels due to global warming

On the other hand, Mega-Floats have the following disadvantages

• they require a good anti-corrosion system against the adverse sea environment

• their value depreciates with time whereas reclaimed land is a permanent asset that appreciates with time

• they pose a great danger if the station-keeping system fails in the event of a freak tsunami.

• they need a ballast system to keep their surfaces horizontally

• they could be expensive to build if the expertise and dockyards are not available locally

Hitherto very large floating structures (VLFSs) have found many practical applications. Countries like Japan, for instance, have constructed a one-km long Mega-Float test model for floating airports in the Tokyo Bay (see Fig. 2) which is a precursor to future floating airports (such as the proposed 3.6 km floating runway for the Tokyo International airport), the floating amusement facilities in the Hiroshima Prefecture, floating emergency rescue bases in Tokyo Bay, Ise Bay and Osaka Bay, and floating oil storage systems in Shirashima (see Fig. 3) and Kamigoto. Canada has built a floating heliport in Vancouver, North Korea has a floating hotel, Hong Kong a floating restaurant, Bangladesh a floating power plant, Brazil a floating pulp plant and Saudi Arabia a floating desalination plant.

Fig. 2. Mega-Float in Tokyo Bay
Photo courtesy of Prof E. Watanabe (Kyoto University)

Fig. 3. Shirashima floating oil storage facility
Photo courtesy of Dr Y. Namba (Shipbuilding Research Centre of Japan)

Mega-Floats for Singapore

Singapore does not possess any sizeable floating structure presently but it is going to have her first mega floating structure in 2007. The Defence Science and Technology Agency will be constructing a 130 m x 100 m floating platform at the Marina Bay. It will be used for the National Day Parade celebration and also for sporting events such as rugby and football games. The presence of such a Mega-Float will not only create artificial land parcels from the sea but they also add buzz to our Singapore city. Below are some other potential uses of VLFSs on Singapore coastal waters.

1. Floating Desalination Plant at the Southern Islands or Jurong Island

Singapore has a relatively small catchment area for collecting and storing water for her population and industrial needs. It has to rely on Johor for her water needs. In view to lessen this reliance, desalination plants on land as well as on the sea should be constructed. Oil and chemical pollution at the source where seawater is drawn will significantly affect the operation of land based desalination plants. The advantage of having a floating desalination plant is that it is mobile and may be moved to sources where clean seawater may be drawn. Such a floating structure may be suitably positioned at the Southern Islands or Jurong Island.

2. Floating Seafood Restaurant and Sea-Sport Complex at East Coast Parkway

Singapore is internationally well known for her chilly and pepper crabs. Seafood restaurants at East Coast Parkway have been doing a roaring business for many years. This business may be enhanced if we shift the restaurants onto a Mega-Float. The Mega-Float could be shaped like a crab making it highly unique and probably the first in the world (see Fig. 4). The sea space between the CRAB Mega-Float and the beach provides a safe environment for swimming. The legs and pincers of the CRAB may be used as bum-boat piers, canoe piers, ski-jets piers and fishing piers. The central portion of the CRAB may be used as an entertainment centre. Visitors to the CRAB may enjoy their seafood dinner and later hop onto a bum boat for their dessert and a ride round the Singapore coastline towards the Marina bay area. Alternatively, they may wish to rent a canoe or a jet-ski for some sea-sport activities. The CRAB will undoubtedly be a talking point among Singaporeans and tourists.

Fig. 4. Proposed floating crab restaurant and sea-sport complex at East Coast Parkway (Crab dimensions: 160 m x 80 m x 2 m)

3. Floating Oil Storage at Jurong Island

Currently, oil is stored in tanks on the Jurong Island. These tanks are unsightly and occupy premium space on the Island. Moreover, accidental fires from these tanks may lead to a major catastrophic loss as the island has many petrochemical plants. We may consider storing the dangerous fuel in large floating structures, shaped liked flattened tankers as shown in

Fig. 3. Note that the total cost of Shirashima oil storage facility is about US$4 billion. It consists of 8 tankers (each tanker size is 397 m x 82 m x 25.4 m) and has a total capacity of 5.6 million kilolitres.

4. Floating Road and Bridge in the Southern Island or in the Marina Bay

We can connect the opposite sides of the Marina Bay or the Southern Islands using floating roads or bridges without destroying the marine eco-system. These floating roads and bridges are also visually pleasing and they allow users to enjoy the scenic body of water (see Figs. 5 and 6).

Fig. 5 Floating road for the Marina Bay or for the Southern Islands

Fig. 6 Floating bridge connecting the Southern Islands

5. Floating Container Terminal

There is a trend to build larger container ships as the demand for container shipment increases. In the present time, these mega-container ships with 10,000 to 15,000 TEUs capacity can only call at several ports. Most existing berths do not have the dimensions and layout to accommodate these ships with length of about 400 m and the required water depth of at least 18 m. Therefore, in the expansion plans of Singapore's container terminals, the design of terminals must be able to cater to such mega-vessels. The ports in Singapore are generally built on reclaimed land due to the acute shortage of land. The land reclamation solution is cost effective provided that the water depth is shallow and fill materials are available at a reasonably cheap price. However, when faced with large water depths and inaccessibility or very expensive fill materials, the land reclamation option becomes an expensive solution. The alternative solution is to construct a very large floating structure (VLFS) to provide the artificial piece of land in the sea for the container terminal (see Fig. 7).

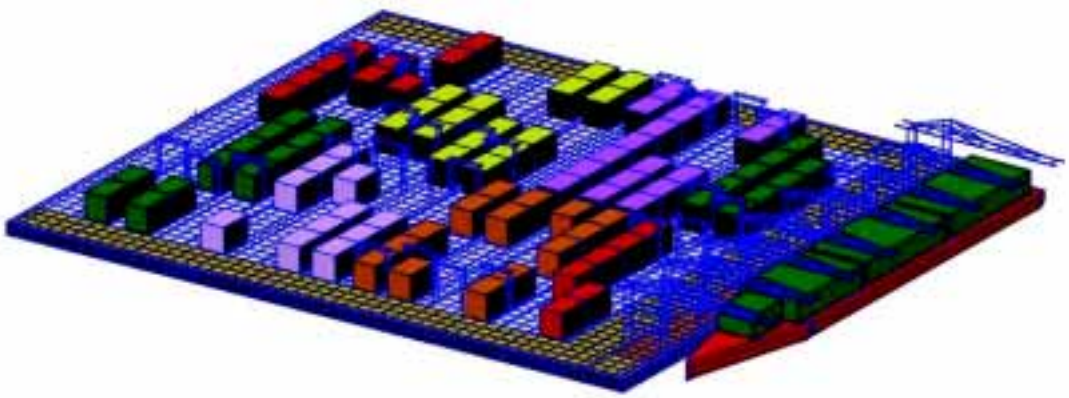

Fig. 7 Super-large floating container terminal (520 m x 470 m x 10 m)

6. Floating Cruise Centre

Singapore wishes to be a hub for cruise ships. The lack of water front space around the Sentosa Island and Marina South would mean that the Cruise Centre could only expand, for future needs, into deeper water. As a result, a mega-floating structure for the cruise centre extension becomes more attractive than the conventional design that uses gravity walls or pile decked structure. Figure 8 shows a possible site and an artist impression of the floating cruise centre that houses two international passenger terminals. Expansion of the floating cruise centre can be readily done by connecting additional floating units to the existing floating structure.

Fig. 8 An artist impression of the floating cruise centre

Costs of Mega-Floats

The construction and maintenance costs of floating structures depend very much on their applications, the site conditions, dimensions, materials used, anti-corrosion system and design life span. Thus, the cost of a Mega-Float has to be estimated individually. Based on the Japanese experience, the total costs of the following Mega-Floats are as follows:

Purpose	Dimensions	Site	Costs
International Airport Runway (at planning stage)	142 ha x 20 m height	Haneda in Tokyo Bay	450 billion yen
Mega-Float Runway model	8.3 ha x 3 m height (1000 m x 60-120 m x 3 m) Steel weight: about 38,000 tons	Yokosuka in Tokyo Bay	8 billion yen

It is envisaged that the costs of Mega-Floats made in Singapore may be lower because of cheaper construction costs and perhaps by using more cost effective materials such as high performance concrete or composite materials.

Acknowledgements

The author is grateful to Mr Timothy Wang (Melbourne University) for assisting in the drawing of the floating crab restaurant and the floating cruise centre. Special thanks to Emeritus Prof E. Watanabe (Kyoto University) for the pictures on the floating road and bridge.

TTJ DESIGN & ENGINEERING PTE LTD

Winged Canopies at Changi Airport Terminal 2 Upgrading

TTJ Design and Engineering Pte Ltd has from its humble beginning as Teo Contractor in 1975 transformed into a leading structural steel specialist around the region. TTJ is able to undertake design, engineering, fabrication and installation of structural steelworks. TTJ's greatest strength is in it's innovative approach to handling heavy structures and complex construction.

It has over the years completed many outstanding projects in various industrial, commercial and governmental sectors in Singapore and earned itself numerous accolades in quality, safety, design and performance from clients and the authorities. TTJ is committed in providing quality products and services that meet her client's requirements. It obtained certification for the Integrated Management System ISO 9001:2000, ISO 14001:1996 and OHSAS 18001:1999 in the design, fabrication and erection of structural steelworks. The certification of the Integrated Management System demonstrates TTJ's long term commitment in providing quality services to her customers at all times, environmental awareness and greater concern for health and safety. In addition, it is an important milestone in TTJ's pursuit of business excellence. TTJ has been an accredited structural steel fabricator for Category S1 by the Singapore Structural Steel Society.

With its in-house design and engineering capabilities, modern factories with advanced machinery in both Singapore and Malaysia, TTJ is well positioned to undertake big-scale design and build projects and projects of complicated nature with structural steelwork both locally and abroad.

Partially Completed Hangar Roof

Steel Structure Fabrication & Erection Engineering Company of 22nd MCC

The Steel Structure Fabrication & Erection Engineering Company (hereafter abbreviated as "SSFEE"), a subsidiary of China 22nd Metallurgical Construction Corporation (abbreviated as China 22nd MCC), is mainly devoting to steel structural engineering, fabrication and erection. As a specialized company, SSFEE has acquired the Grade One qualification certification in steel structure construction, and the Second Class in engineering design. Now, SSFEE has employees 1,730, including 1,300 technical professionals, and 68 designers for steel structure second designing. SSFEE annual capacity is over 100,000 tons in steel structure fabrication and erection, involved scopes including metallurgy, construction material, chemical industry, civil engineering, city public service etc.

In the whole metallurgical construction industry, SSFEE is the first company to have been awarded "The integrated management system certification for Quality, Environment and Occupational safety and health".

SSFEE is located in the Industrial Park of China 22nd MCC, which is a large modern industrial base, focusing on steel product fabrication for industrial and civil construction. The total area is 370000m^2, 50000m^2 modernized workshop equipped advanced processing machines and technique. The Industrial Park owns a series of steel structure production lines, such as heavy H steel, light H steel, box structure, pipe network structure, decking plate etc, to meet various requirements. Furthermore, China 22nd MCC has introduced into a whole box steel structure production line and relevant technology from Japan, which is the most advanced in the world. The automatic production-line adopted for the welding of box steel girder and steel column units combination is considered to be the cutting-edge technology at home as well as abroad in the said industry.

SSFEE has since expanded into the market of Singapore and is currently completing the Square 2 and IKEA Tampines. It is the company's policy to continue pursuing new opportunities in Singapore as well as the regional markets and at the same time, forming strategic alliances with potential partners to enhance our competitive edge.

FOR THE MOST VIABLE & CREATIVE SOLUTIONS IN STEEL, KINDLY CONTACT US AS FOLLOWS:

1. Li Wen Feng (H/P:90839780)
2. Chor How Choon (H/P:98791398)

Novena Medical Centre

Steel Structure Fabrication & Erection Engineering Company of 22nd MCC

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www.22mcc.cn/gyy

ISO 9001:2000,ISO 14001:1996,GB/T 28001-2001

Singapore Novena Medical Centre – 2463 tonnes

The Third Phase of Beijing International Trade Building – 50000 tonnes

Steel Work Project of Shijiazhuang Kaiyuan Plaza – 7000 tonnes

Beijing Lexijinxing (LG) Building – 14447 tonnes

Project of Beijing HQ Building of Siemens – 5023 tonnes

Airport Roof Truss

Aircraft Maintenance Hangar

Upgrading of Changi Airport Terminal 2

Seraya Chemical Phase 2
SSSS Merit Award Winner

Supreme Court Building

Kong Meng San Temple
SSSS President's Award

Blast Door

Blast Door

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CERT. NO. 97-2-0783
SS ISO 9001 : 2000

CERT. NO. 2004-0073
OHSAS 18001 : 1999

CERT. NO. 2004-0246
SS ISO 14001 : 1996

SINGAPORE ACCREDITATION COUNCIL

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