









Monthly Magazine of The Institute of Marine Engineers (India)





The Institute of Marine Engineers (India)

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Features: Experienced Faculty, Individual Attention

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Technical Meeting on Innovations in Maritime Sustainability and Technology A Night of Honour: Maritime Leaders and Their Lasting Impact

Commencement of DG-Approved Modular Courses at IME(I), Goa Successful Launch of IGF Basic Course at IME(I) METC Kolkata Women's Day at IME(I): Empower, Inspire, Celebrate Promoting Gender Sensitivity in the Maritime Industry Strengthening Maritime Training: Delegates Visit IME(I) Advancing Maritime Skills for a Better Future India to Launch Bharat Global Port Consortium for Overseas Port Development

Obituary

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₹4,800 Crore Investment in 26 Assam for Waterways and **Infrastructure Development** Strengthening India's Ports: Key **Initiatives for Efficiency and Sustainability Boosting Trade & Connectivity: MoU Signed for Varanasi Logistics Park** 28 **Strengthening Women's Futures** with Skill and Independence **JNPA Boosts Agro-Trade with New Processing & Storage** Facility Sailing into History: India's 30 **Stitched Ship Redefines** Tradition PRAYAAN 6.0 - A Grand 31 **Confluence of Talent, Innovation** and Celebration **Blue Economy 4.0: Transforming** the Maritime Industry **Breaking the Cycle: Empowering** Women, Transforming Society **Renewable Energy-Powered Liquid Nitrogen Generation for** Work Extraction 41 The Titanic - Part III - Ship Construction

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From the Editor's Desk

Dear Esteemed Readers,

As we step into March, the maritime industry continues to evolve, driven by innovation, collaboration and an unwavering commitment to progress. This edition of **iMélange** captures a diverse range of developments—technical advancements, strategic initiatives and events that highlight the resilience and dynamism of our maritime community.

Technical excellence remained at the forefront with **the Annual Technical Paper Meet in Kolkata**, where industry professionals and students engaged in thought-provoking discussions on emerging maritime challenges and solutions. Complementing this was the **Technical Meeting on Innovations in Maritime Sustainability and Technology in Chennai**, which showcased cutting-edge advancements shaping the industry's future.

In Goa, the commencement of DG-approved modular courses at

IME(I) marked another milestone in strengthening maritime education, while Kolkata witnessed the successful launch of the **IGF Basic Course at IME(I) METC**, reinforcing IME(I)'s commitment to future-ready training programs.

On the sporting front, IME(I) Kochi Branch demonstrated remarkable team spirit at a maritime sports event, reflecting the camaraderie that defines our industry. Meanwhile, in Chandigarh, A Night of Honour paid tribute to maritime leaders, acknowledging their lasting impact and contributions to the profession.

March also brought a strong focus on gender inclusivity. **Women's Day at IME(I)** was a celebration of empowerment and progress. The inspiring article **"Breaking the Cycle: Empowering Women, Transforming Society"** by Mrs. Neeru Gupta reinforced the significance of skill development and independence in shaping a more inclusive workforce.

At a national level, major infrastructure initiatives took center stage. India announced the launch of the **Bharat Global Port Consortium**, a move set to enhance overseas port development and strengthen India's maritime footprint. Investments of ₹4,800 crore in **Assam for waterways and infrastructure development** highlight the country's commitment to bolstering inland transport networks. Additionally, the **MoU for the Varanasi Logistics Park** promises to boost trade and connectivity, while **JNPA's new agro-trade processing and storage facility** is set to expand India's export capabilities.

Heritage and tradition also found prominence with **India's stitched ship project**, a remarkable initiative that blends historical craftsmanship with modern innovation. Meanwhile, the **Blue Economy 4.0 discussions at TRANSTECH 2025** delved into the transformative potential of sustainable maritime practices.

Rounding off this issue, our student column explores **Renewable Energy-Powered Liquid Nitrogen Generation** for Work Extraction, while our maritime reflections continue with **Titanic - Part III: Ship Construction**.

As we navigate these exciting developments, it is clear that innovation, inclusivity and sustainability will continue to shape our industry's course. I encourage you to share your insights and articles at editornewsletter@imare.in and subeditor@imare.in by 7th April 2025.

Wishing you all a month of progress and inspiration!

SUNIL KUMAR Honorary Editor – iMélange



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ME(I) Kochi Branch actively participated in the Sports Meet organised by the National Maritime Day Celebration Committee, in collaboration with METI, Cochin Shipyard, Kunjali Marakkar School of Marine Engineering (KMSME), CUSAT, Eurotech Maritime Academy and the Indian Maritime University (IMU).



Mr. Senthil Kumar, PO MMD, Kochi (Chief Guest) arriving



Invitees being led by Mr. George Abraham, METI HOD to the venue

The Inaugural Function, hosted by METI, CSL took place at 0900 Hrs. on 15th February 2025 at the Training Institute premises. The event commenced with a March Past featuring cadets from various Marine Training Institutes in Kochi. The Chief Guest, **Shri Senthil Kumar**, PO MMD, Kochi, inaugurated the event, while the keynote address was delivered by **Shri Sreejith K. Narayanan**, Director (Operations), CSL. Felicitations were extended by **Mr. R. Venugopal**, Director, KMSME, **Capt. Biju**, **Principal** (Eurotech) and other distinguished dignitaries from MMD/DG Shipping and IMU. Following the inauguration, the first match of the Sports Meet, a football match, was held on the METI sports field. Various other competitions took place at METI, CIFNET Kochi and Eurotech Maritime Academy, Kochi, leading up to the Closing Ceremony on 24th February 2025 at 1630 Hrs. at Eurotech Maritime Academy.

IME(I) Kochi students and staff actively participated in the inaugural and closing ceremonies, as well as various sports competitions. Notably, the students secured victory in the Table Tennis Doubles Match and achieved the runner-up position in the Cricket Match.



Football Team



Volleyball Match in progress

()Mélange

Glimpses of the Event



Cricket Team



Spectators



March Past – Closing Ceremony at Eurotech



March past at Closing ceremony, Eurotech



Teams at CIFNET, a venue for sports events



Mr. Asharaff Sultan, Principal, IME(I) Kochi Training Institute giving felicitations at Closing Ceremony at Eurotech



Members attending the Closing Ceremony at Eurotech





TT Team M/s. C.K. Ravindranath and Vinay Kumar





Team playing TT match finals which they won



Audience at Closing ceremony at Eurotech

Branch News

Kolkata

Navigating the Future: Insights from the Annual Technical Paper Meet



The Annual Technical Paper Meet of IME(I) Kolkata Branch was successfully held on 4th January 2025, from 9:30 AM onwards at Princeton Club, Kolkata. This year's theme, '**The Future of Navigation**,' explored emerging trends, technological advancements and evolving challenges in the maritime sector.

The event commenced with a warm welcome from **Mr. Gautam Sen**, Chairman, IME(I) Kolkata Branch who emphasised the broader meaning of **'navigation'**—not just ship movement but also the technological, environmental and regulatory advancements essential for maritime operations.

The proceedings were conducted by **Shri Abhijit Banerjee**, Hon. Secretary, who ensured a smooth flow of discussions throughout the event.

The Chief Guest, Mr. B.N. Bera, Ex-Director, DMET Kolkata, was unable to attend due to a sudden health concern. All attendees extended their heartfelt wishes for his speedy recovery.

The Guest of Honour, **Rear Admiral Amit Bose (Retd.)**, Director, Indian Maritime University (IMU) Kolkata Campus provided valuable insights into the expected transformations in shipping. He stressed the need for maritime professionals to stay ahead of technological advancements and embrace industry changes.







Technical Paper Presentations

- Mr. Arun Kumar Singh, Visiting Faculty, IMU Kolkata Campus, delivered an engaging talk on Artificial Intelligence (AI), Machine Learning (ML), Big Data Analytics and fuel-efficient technologies in maritime navigation. He discussed how automation, environmental awareness, regulatory changes, and cybersecurity will shape the industry's future.
- Commodore Prodyut Kumar Banerjee (Retd.), Navy veteran and author, addressed the challenges of safe navigation in the future. He explored the concept of 'Blue Acceleration'– the rapid expansion of human activities in the ocean–and emphasised the importance of technological advancements and the human element in maritime safety.
- Mr. Soumitra Neogi, Professor of Practice (Marine Engineering & Technology), IMU Kolkata Campus, provided an in-depth analysis of technological innovations that will define the future of shipping. He highlighted

the importance of training seafarers to adapt to evolving technology, regulatory shifts, and industry demands.



An interactive Q&A session was moderated by **Mr. Sen**, where attendees actively participated in discussions on the latest maritime trends and challenges.

Mr. S.K. Sarkar, EC Member, summarised the key takeaways from the event, ensuring that the insights gained were well captured.

The event also featured a showcase of Cmde. Banerjee's latest book, '*Command of a Warship*', adding an enriching literary dimension to the meet.



The event concluded with a vote of thanks by the Hon. Secretary, followed by a networking lunch.



Branch News

Chennai

Technical Meeting on Innovations in Maritime Sustainability and Technology

The Chennai Branch of IME(I) held a Technical Meeting on 21^{st} February 2025 at 6:30 PM at The Seafarers Club, Chennai.

The session began with a welcome address by **Mr. R. Muthusamy**, Hon. Secretary, IME(I) Chennai, who introduced the meeting's objectives and guidelines. **Mr. Suresh Shenoi**, Chairman, IME(I) Chennai, then welcomed all attendees and thanked them for their participation.



The meeting featured three insightful presentations by industry experts:



- "Decarbonizing Shipping: A Multifaceted Transition"

 Mr. M.S. Mithunraj, Lead-Technical Compliance, Operations Support Centre, V Ships, discussed strategies for reducing carbon emissions in the shipping industry.
- "Future Digital Survey" Mr. Anil Kumar, Principal Surveyor and Mr. Srikant Saripaka, Head of Global Remote Survey Centre, Lloyds, explained how digital technology is transforming ship inspections and remote surveys.
- "Slade Gland Packing" Mr. J. Kripasagar, Nekhil Incorporate, shared insights on advanced sealing techniques used in marine applications.



The presentations were engaging and interactive and the audience showed great enthusiasm. A Q&A session, moderated by **Mr. Muthusamy**, followed, where participants asked insightful questions.

To appreciate their contributions, IME(I) Chennai presented mementos to the speakers. The tokens of appreciation were given by Past Chairman **Mr. V. Mohanan** and Senior Member **Mr. T.B. Srinivasan**.

The event concluded with a vote of thanks from **Mr. S. Ramesh**, Executive Member, IME(I) Chennai, who expressed gratitude to the speakers and attendees for making the meeting a success.



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Branch News

Chandigarh

A Night of Honour: Maritime Leaders and Their Lasting Impact

The News18 NRI Conclave was held on 6th March 2025 at Hotel J.W. Marriott, Chandigarh, presented by HDFC Bank in association with various partners. The event honoured notable professionals, including three respected mariners.

Among those recognised were:

- Mr. Arun Kr. Agarwal, Chairman, IME(I) Chandigarh Chapter
- Mr. Rakesh Mittal, President of MNOA
- Capt. Jagdeep Kahlon, Chairman, CMMI Chandigarh Chapter









Mr. Arun Kr. Agarwal received the prestigious award for "Global Excellence in Community Development and Education", recognising his outstanding contributions to social work. The award was presented by His Excellency, the Governor of Punjab and Administrator of Chandigarh, Shri Ratan Lal Kataria.

The event highlighted the significant contributions of the maritime community and honoured individuals making a meaningful impact on society.





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Branch News

Goa

Commencement of DG-Approved Modular Courses at IME(I), Goa



The Institute of Marine Engineers (India), Goa Branch, received official approval on 27th February 2025 to conduct the following DG-approved modular courses:

- Security Training for Seafarers with Designated Security Duties (STSDSD)
- 2. Ship Security Officer (SSO)
- **3.** Basic Training for Ships Using Fuels Covered Within the IGF Code (IGFB)
- Basic Training for Liquefied Gas Tanker Cargo Operations (LGTF)
- Basic Training for Oil & Chemical Tanker Cargo Operations (OCTCO)

Marking a significant milestone, the branch successfully conducted its inaugural STSDSD course on

 $17^{\rm th}$ and $18^{\rm th}$ March 2025, with a batch of 20 candidates from IMS, Bogda, Goa.

Strategically located in the heart of Dabolim, Goa, IME(I) offers a dynamic training environment featuring state-of-the-art classrooms designed for interactive learning. The institute boasts a well-equipped library with extensive training materials, complemented by Ocean Technologies Training Videos, ensuring candidates have access to the latest industry knowledge.

The faculty comprises highly qualified professionals with extensive sailing experience, bringing practical insights into the classroom. With expertise in training both pre-sea and post-sea candidates, the instructors provide comprehensive instruction in STCW and modular courses, supporting seafarers in advancing their maritime careers.

> As one of the pioneering Marine Training Institutions (MTIs) in the region, IME(I), Goa, takes pride in offering a diverse range of modular courses locally. This initiative enables the seafaring community to undergo essential training without the need for extensive travel while ensuring high-quality education standards. Committed to excellence, the institute continues to deliver top-tier training programmes that equip candidates with the skills and knowledge required to succeed in the maritime industry.





Kolkata

Branch News

Successful Launch of IGF Basic Course at IME(I) METC Kolkata

METC, The Institute of Marine Engineers (India) Kolkata Branch has successfully commenced its first IGF Basic Course on 17th March, 2025. This milestone is the result of sustained effort and dedication, marking a significant and historic step with dedication and hard work in the branch's commitment to professional maritime training.

The inaugural batch saw an enrollment of 15 candidates, with a small inauguration and puja followed by prasad distribution conducted before the commencement of classes.

The inaugural sessions were led by **Capt. Bibhas Pal** (Principal cum Course-in-charge) and **Mr. Biman Mistry** (Faculty), setting a strong foundation for the course.

This achievement reflects the branch's dedication to advancing marine engineering education and fostering excellence in the industry.







The METC, IME(I) Kolkata branch is all set to provide world-class maritime training & education to seafarers equipping them with the necessary theoretical knowledge and practical skills to work on ships in the maritime industry.

The institute aims:

- To be the Premier and World Standard Maritime Institute.
- To cater to the training requirement of seafarers from Eastern Zone and equip them with specialised knowledge and skill for various roles within maritime industry.
- To provide opportunity to learn from experienced faculty to ensure the quality and credibility of the training.
- To ensure that the course content is comprehensive and up-to-date with the latest industry standards and practices.
- To provide individual attention for a positive and effective learning environment.
- To provide the best quality course handout to ease the learning process.
- To conduct engaging and interactive classes.

METC, Kolkata branch holds a commitment to excellence and move forward to a brighter future of maritime industry.



Navi Mumbai

The Institute of Marine Engineers (India) celebrated Women's Day with great enthusiasm and appreciation at its headquarters. The event featured a cake-cutting ceremony, bringing everyone together in a spirit of unity and celebration. It was a heartfelt tribute to the dedication,

resilience and contributions of women in maritime domain. IME(I) remains committed to empowering and supporting women in the field, encouraging an inclusive and progressive maritime community.





Women's Day at IME(I): Empower, Inspire,

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Navi Mumbai

Promoting Gender Sensitivity in the Maritime Industry

Women constitute less than 2% of the global maritime workforce. However, the tides are shifting as an increasing number of women seafarers are now pursuing careers in both deck and engine roles.

To support their journey and cultivate a more inclusive and equitable work environment, a Gender Sensitivity Course has been introduced. IME(I) Navi Mumbai Chapter regularly conducts this course for its Class 1 and Class 2 students, ensuring that future maritime professionals are equipped with the awareness and mindset necessary for inclusivity. Recently, these sessions have also been integrated into the Refresher and Upgradation Training (RUT) Course further expanding their impact.

At IME(I) Navi Mumbai Chapter, this initiative is spearheaded by Mrs. Lata Khatri, a distinguished visiting faculty member. Designed as an interactive and thoughtprovoking workshop, the course encourages





students to identify and challenge their inherent biases. Through a series of real-world case studies, participants gain invaluable insights into the importance of

creating a safe inclusive and supportive environment onboard—an essential quality for the maritime leaders of tomorrow.



Branch News

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MEO Class II – Preparatory Course	Medical First Aid & Medical Care					
Second Mates (FG) Function Course	MEO Revalidation & Upgradation					
Chief Mate (FG) – Phase I Course	AECS Course					
Chief Mate (FG) – Phase II Course	TSTA Course					
Advanced Shipboard Management	Ship Security Officer Course					
SIMULATO	R COURSES					
Diesel Engine Combustion Gas Monitor Simulator, ERS (Mgmt) & ERS (Ops) level						
Radar Observer, ARPA, & RANSCO Courses						
Ship Maneuvering Simulator and Bridge Teamwork						
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ME Engines Advanced / Familiarization- (Physical or online)	5/3 days	Internal Auditor for QMS/EMS/OHSMS/ EnMS	3 days	
ME-GI Dual Fuel Engines Operations – (online)	5 days	5 days Internal Auditor for ISM/ISPS/MLC		
BTM/BRM/ERRM physical or online	5/3 days	Risk Management & Incident Investigation	2 days	
Marine Electrical Workshop	6 days	Onboard Assessment	2 days	
Soft Skills for induction into Merchant Marine	2 days	Emergency Preparedness	1 day	
Safety Officers Course	2 day	SIRE 2.0	2 day	
Be-spoke training	As desired	Navigational Audits	1 day	



IME (I) GOVERNING COUNCIL, BRANCH, AND CHAPTER COMMITTEE ELECTIONS 2025-27

As the elections for The Institute of Marine Engineers (India) approach, we wish to notify all Corporate Members of the following procedures:

SCHEDULE

Soft Copy of Nomination Papers:

- The entire election process will be communicated exclusively through electronic media.
- Nomination forms will be sent via mass email and can also be downloaded from the IME(I) website.
 Completed forms must be returned to the Election Officer.
- Nomination papers for Council elections will be emailed by 15th May 2025 to the registered email ID.
- The Institute's office must receive the completed nomination papers by **15th June** 2025.
- The last date for withdrawing nominations is **30th June 2025**.
- The Election Committee will complete the scrutiny of nomination papers by **5th July 2025**.
- After scrutiny, the Election Officer will publish the CVs of eligible candidates on the IME(I) website.

E-VOTING

As a Corporate Member (on the Roll as of **15th May 2025**), you can cast your vote in the upcoming IME(I) elections using the **e-Voting** system exclusively.

- Two voting options will be available:
 - o Head Office (HO) Elections
 - o Branch Level Elections (if applicable)
- Overseas Members will have the option to vote only for the HO level elections.

- If your email address has changed, you must update it by emailing electionofficer@imare.in no later than 15th June 2025.
- Members will receive the e-Voting link only at their registered email addresses as per IME(I) records on 1st June 2025.
- To update your email ID or contact details, write to membership@imare.in by 10th May 2025.
- E-Voting will commence on **15th July 2025** and remain open until **1700 hrs on 31st August 2025**.

ELIGIBILITY TO STAND FOR ELECTION

- All office bearers of the Council and Council Members must be Fellow Members from branches or chapters only.
- Office bearers and Council Members must have been Corporate Members for at least four years at the time of filing their nomination and must have served at least one full term on the executive committee of a local branch or chapter before being eligible to stand for election from that branch.

USE OF WORKPLACE / OFFICIAL EMAIL IDS

- In the past, mass emails have been blocked by certain organization domains, flagged as spam, or led to the blacklisting of the IME(I) domain. To avoid this, we strongly recommend using personal email IDs only.
- Using your personal email ensures you receive all important election-related communications.

For any queries, please contact: Election Officer electionofficer@imare.in

Branch News

Navi Mumbai

Strengthening Maritime Training: Delegates Visit IME(I)

Adelegation from NYK Ship Management, including Mr. Praveen Kumar Kamboj, Deputy General Manager (Head of Nautical Studies), NYK Singapore, Mr. Daisuke Miwa, Training Manager, NYK Singapore and Mr. Katsumi Masuyama, Incharge of Seafarer Training, Marine Group Coordination Team, NYK Line Japan, visited the IMEI House in Nerul on 6th March 2025.





They were warmly welcomed and accompanied by the Director, Deputy Director, faculty members and the Deputy General Manager (Training) for a tour of the IMEI House. The delegation highly appreciated the institute's infrastructure, particularly the advanced simulators.









Advancing Maritime Skills for a Better Future



The Future Skills Maritime (FSM) 5.0 Global Conference took place on 7th and 8th March 2025, at Goa. This event marked five years of progress in maritime skills development. The conference brought together government officials, shipowners, management companies, training institutions, seafarers and students to discuss the future of maritime training and employment.

FSM is organised by The Naval Connection (TNC) and has become a key platform for skill development in the maritime industry. This year was special as TNC also celebrated its 5th anniversary, highlighting its journey in promoting training, talent development and partnerships.

A closed-door meeting was held between the Hon. Chief Minister of Goa, **Dr. Pramod Sawant** and key maritime leaders. The discussion focused on training seafarers, infrastructure development and investment opportunities. **Capt. Venzy Viegas**, Hon. MLA of Benaulim and **Capt. Shoukat Mukherjee**, Founder & CEO of TNC, facilitated the meeting. Representatives from FOSMA, MASSA, IME(I), MUI and major shipping companies also participated. Dr. Sawant assured government support for world-class maritime training facilities in Goa.

The event was inaugurated by Dr. Pramod Sawant, along with top industry leaders. A keynote address was



delivered by **Dr. Sunita Karad** from MIT Art Design and Technology University, emphasising the importance of modern maritime education. The day included panel discussions on industry-academia collaboration, re-skilling senior seafarers and crew mental wellbeing. Exclusive sessions featured discussions with Maharashtra Academy of Naval Education and Training (MANET), Pune and a showcase by Qatar Airways on maritime connectivity.

Mr. Sunil Kumar, Hon. General Secretary, IME(I), and Head, T&A, G.E. Shipping, played a key role as a panellist in the discussion on "Re-skilling Senior Seafarers:



Staying Relevant in a Changing Landscape and Aligning Training to Meet the IMO 2030 Strategy." Drawing from his experience as a member of the Indian delegation at various IMO forums, he provided valuable insights that contributed to the development of structured training programmes to help senior seafarers adapt to evolving industry standards and international regulations.

With the maritime sector undergoing rapid technological advancements, Mr. Kumar, who regularly participates in Maritime Just Transition Task Force (MJTTF) meetings, emphasised the need for upskilling senior seafarers to ensure they remain competitive alongside younger professionals who are more adept with modern digital tools. He also highlighted the importance of aligning training initiatives with the MJTTF's objectives, facilitating a seamless transition towards a greener and more sustainable shipping industry. His contributions underscored the significance of standardised training programmes aligned with global sustainability goals, equipping seafarers to effectively meet the IMO 2030 Strategy.

Other key sessions covered IMEC's Cadet Programme and its impact in India, technical discussions on Biofuel B30, Marine Simulation Training and new training solutions. The "Seafarers' Connect" Open Forum allowed students and professionals to discuss career paths and challenges directly with industry leaders.



Dr. Pramod Sawant presented the prestigious Sagar Ratna Awards to Capt. Venzy Viegas, Master Mariner & Hon. MLA of Benaulim, **Ms. Nita Jha**, Director at MSC Shipmanagement Ltd. and **Dr. Sanjay Bhavnani**, Director & COO of MMS Maritime India, for their outstanding contributions to the maritime sector.

With 150+ industry leaders, 200+ seafarers and students in attendance, FSM 5.0 set a new standard in maritime training.





















Industry News

India to Launch Bharat Global Port Consortium for Overseas Port Development

ndia is moving forward with plans to establish the Bharat Global Port Consortium, a new initiative aimed at developing and managing ports internationally. As part of the plan, Sagarmala Development Co. Ltd. will provide funding, India Port Rail & Ropeway Corporation will oversee construction and India Ports Global Ltd. will be responsible for port operations, officials confirmed. The final structure of the consortium is expected to be decided soon.

A Memorandum of Understanding (MoU) formalizing the consortium was signed in Mumbai on 27th February 2025 by the three entities in the presence of Shri Sarbananda Sonowal, Union Minister of Ports Shipping and Waterways.

India Ports Global Ltd., which operates under the Union Ministry of Ports Shipping and Waterways, currently manages Chabahar Port in Iran. Other major players in the global port sector include PSA International Pte Ltd., a subsidiary of Singapore's Temasek Holdings Pte Ltd. which runs container terminals worldwide and DP World Ltd., a Dubai-based government-owned company that is among the world's top three container terminal operators.



Obituary

Balu K Shankar (F 0060)

With deep sorrow, IME(I) announce the passing of its esteemed member, Shri K. Shankar (F 0060), on 8th February 2025. He was a distinguished marine engineer (D.M.E.T. 1961–1965), Extra First Class, former Editor of Marine Engineers Review, and past Chairman and Governing Council Member of the Chennai Branch.

We pay tribute to his remarkable contributions and pray for strength and peace for his family during this difficult time. May his soul rest in peace.





Industry News

₹4,800 Crore Investment in Assam for Waterways and Infrastructure Development

n a significant push towards enhancing Assam's waterways and infrastructure, Union Minister of Ports, Shipping and Waterways, **Shri Sarbananda Sonowal**, announced an investment of over ₹4,800 crore. This initiative aims to unlock the immense potential of Assam's complex and dynamic waterways system, propelling regional growth in line with Prime Minister Narendra Modi's vision of *Viksit Bharat*.

Investment to Transform Assam's Inland Waterways

Speaking at the Investment Summit, Assam 2.0, Shri Sonowal highlighted the strategic importance of Assam's rich riverine network, particularly the Brahmaputra (NW2) and Barak (NW16) waterways. "With its intricate web of rivers, Assam has historically served as a vital conduit

for trade and commerce. By modernising its inland waterways, we are reviving this legacy and positioning Assam as a key player in India's economic transformation," he said.

Globally recognised as a futuristic mode of transport, inland waterways offer a cost-effective, efficient and environmentally sustainable alternative for cargo and passenger movement. Shri Sonowal emphasised that schemes like *Jalvahak* are incentivising businesses to transition towards inland waterways, reducing logistical costs, decongesting road and rail networks and fostering a robust trade ecosystem. "Assam is set to play a pivotal role in India's journey towards becoming the world's largest and self-reliant (Atmanirbhar) economy by 2047," he added.

Key Announcements at the Summit

1. ₹1,500 Crore for Green Vessels Transition under 'Harit Nauka' Scheme

Recognising the need for sustainable shipping solutions, the government has allocated ₹1,500 crore to facilitate the adoption of Green Vessels by 2030. This initiative is expected to reduce the carbon footprint of Assam's inland waterways and align with India's



commitment to environmentally friendly maritime transport.

2. ₹1,500 Crore for Cruise Tourism and Cargo Handling Expansion

To boost Assam's cruise tourism sector and enhance cargo handling capacity in NW2 and NW16, an additional ₹1,500 crore has been earmarked. This investment aims to transform Assam into a premier destination for riverine tourism while significantly improving trade efficiency by 2027-28.

A Vision for the Future

Shri Sonowal reiterated that these investments align with the broader goal of strengthening India's inland waterways and positioning Assam as a major trade and tourism hub. "By enhancing our riverine infrastructure, we are not only modernising transportation but also creating employment opportunities, boosting economic growth and reinforcing Assam's strategic role in India's maritime future," he concluded.

This landmark investment is expected to revolutionise Assam's water transport system, offering sustainable and cost-efficient solutions while contributing to the state's overall economic progress.

Industry News

Strengthening India's Ports: Key Initiatives for Efficiency and Sustainability

n a landmark move to streamline and standardise operations across India's major ports, Union Minister **Shri Sarbananda Sonowal** launched the 'One Nation-One Port Process (ONOP)' during a stakeholder meeting in Mumbai. The initiative aims to eliminate inconsistencies in documentation and operational procedures, thereby reducing inefficiencies, cutting costs and minimising delays in port operations.

Key Announcements and Initiatives

1. One Nation-One Port Process (ONOP)

ONOP is designed to harmonize port procedures by removing redundancies in documentation and processes, ensuring a more efficient, transparent and cost-

effective maritime ecosystem. As a first step, the Ministry has standardized documentation with Immigration, the Port Health Organisation, and Port Authorities, leading to a reduction in container operation documents by 33% (from 143 to 96) and bulk cargo documents by 29% (from 150 to 106).

2. Sagar Ankalan - Logistics Port Performance Index (LPPI) for FY 2023-24

The launch of LPPI is a crucial step toward enhancing the global competitiveness of India's maritime sector. By assessing port performance, efficiency and logistics capabilities, LPPI aims to drive operational excellence and position India's ports among the world's best.

3. Bharat Global Ports Consortium

This strategic initiative is set to strengthen global trade by expanding India's maritime reach and bolstering global trade resilience. The consortium will enable deeper collaboration with international ports, innovation, efficiency and investment in India's port infrastructure.

4. MAITRI - Master Application for International Trade and Regulatory Interface

The introduction of the MAITRI application is a game-changer in trade facilitation. This digital platform is designed to streamline trade processes, minimise bureaucratic hurdles and expedite clearances. It reinforces India's commitment to the ease of doing business by integrating various regulatory bodies into a single interface.

5. Virtual Trade Corridor (VTC) with UAE

MAITRI will play a pivotal role in operationalizing the Virtual Trade Corridor (VTC) between India and the UAE.

This corridor aims to enhance seamless trade by reducing logistical bottlenecks and enabling real-time coordination between regulatory authorities.

6. National Centre of Excellence in Green Port and Shipping (NCoEGPS) Website

Shri Sonowal also unveiled the NCoEGPS website, a milestone in India's pursuit of sustainability in the maritime sector. The platform will provide insights, best practices, and research focused on reducing carbon footprints, promoting cleaner fuels and implementing eco-friendly port management strategies.

Vision for India's Maritime Future

In his concluding remarks, Shri Sonowal emphasised the significance of the Blue Economy in job creation, trade, sustainability and economic growth. He highlighted India's ambitious goal of becoming a top 10 shipbuilding nation by 2030 and called for active stakeholder participation in shaping a world-class, future-ready maritime ecosystem.

"India's Blue Economy is not just about ships and ports—it's about jobs, trade, sustainability and economic growth. We are committed to ensuring the right policies, financing and environment for the sector to thrive. Let's build, innovate and collaborate to shape India's economic destiny," he stated.

These initiatives mark a transformative step in advancing India's maritime sector, aligning with the Maritime Amrit Kaal Vision 2047 to establish India as a global leader in port efficiency, trade facilitation and sustainable shipping.

JNPA Boosts Agro-Trade with New Processing & Storage Facility

J awaharlal Nehru Port Authority (JNPA) has signed an agreement with Trident Agrocom Exports Pvt. Ltd. and Man Infraconstruction Ltd. to develop a modern agro-processing and storage facility at the port. This project, worth Rs. 285 crores, will be built under a Public-Private Partnership (PPP) model.

JNPA Chairperson **Shri Unmesh Sharad Wagh** highlighted that this will be India's first integrated agro-based facility at a port, matching global standards. It will strengthen agro-trade, create business opportunities and boost India's agricultural exports.

Located on 27 acres, this facility will handle 1.2 million tonnes of agricultural goods annually. It will include:

- Cold storage, frozen storage and dry warehouses under one roof.
- Processing, sorting, packing and laboratory testing for food safety.
- Storage for both perishable and non-perishable goods, including fruits, vegetables, meat, rice, maize, spices and marine products.
- Advanced technology for better preservation, quality control and reduced post-harvest losses.

To improve efficiency, the facility will have export packhouse and loading/unloading zones, custom clearance and food testing labs for quick processing and a local distribution hub for domestic and imported agricultural goods.

JNPA awarded the project contract in December 2024, and once completed, this initiative will enhance agricultural exports, reduce wastage and promote coastal trade, making India a stronger player in global agrocommerce.

Boosting Trade ර Connectivity: MoU Signed for Varanasi Logistics Park

Nanagement Limited (NHLML) and Inland Waterways Authority of India (IWAI) signed a Memorandum of Understanding (MoU) today to develop a Multi-Modal Logistics Park (MMLP) in Varanasi, Uttar Pradesh. According to the press release, the agreement was signed in the presence of Union Minister of Road Transport and Highways, Shri Nitin Gadkari, and Union Minister of Ports, Shipping and Waterways, Shri Sarbananda Sonowal. The 150-acre logistics park will be connected to NH7 via a 650-metre access road and will integrate with

the Eastern Dedicated Freight Corridor through a 5.1 km railway line from Jeonathpur Station. It will also connect to National Waterway-1 and is located 30 km from Lal Bahadur Shastri Airport. The project aims to enhance trade efficiency, strengthen India's logistics sector and create investment and employment opportunities. The initiative aligns with India's efforts to develop its logistics infrastructure and improve connectivity.

Strengthening Women's Futures with Skill and Independence

On International Women's Day, Deendayal Port Authority (DPA) opened the 'Deendayal Mahila Sashaktikaran Kendra' in Gandhidham. This is an important project to support and empower women, helping them become independent.

The center was inaugurated by Smt. Maltiben Maheshwari, Hon'ble MLA of Gandhidham and Smt. Nisha Singh.

DPA also started an Artificial Jewellery Making Program under the Deendayal Kaushal Vikas Program, in partnership with the Gandhidham Collegiate Board. This program aims to teach rural women valuable skills to improve their livelihoods.

The event also included a certificate distribution ceremony for women who completed different skill training programs and an exhibition displaying their handmade products.

Industry News

Sailing into History: India's Stitched Ship Redefines Tradition

n a historic revival of India's maritime heritage, the country's first ancient stitched ship was launched in Goa on 26th February 2025. Modelled after a 5th-century vessel depicted in the Ajanta Cave paintings, the ship was designed and built by Hodi Innovations (OPC) Pvt Ltd in collaboration with master artisans from Kerala. Unlike modern ships it is uniquely stitched together using coconut coir rope with its hull reinforced by "sardine oil, natural resins and seasoned wood" to ensure durability.

The vessel will embark on a historic voyage to Oman and Indonesia by the end of 2025, retracing ancient maritime trade routes. A 15-member Indian Navy crew will sail the ship with specialised training taking place at Karwar under the mentorship of Captain Dilip Donde (Retd), India's first solo circumnavigator. A circumnavigator is a sailor who completes a full journey around the world by sea, navigating through different oceans and overcoming extreme weather conditions.

Speaking at the launch, Rear Admiral K M Ramakrishnan emphasised the ship's cultural significance. "This is not just the launch of a vessel it is a tribute to our ancestors who dominated these waters with their unparalleled seafaring skills," he remarked. Historian and economist Shri Sanjeev Sanyal who conceptualized the project highlighted its significance in rediscovering ancient shipbuilding techniques. "This is more than just a reconstruction—it is a live experiment in maritime archaeology. We have built an ancient hull but we are yet to understand how it will perform in open waters," he said.

With masts and rigging set to be completed by May 2025 extensive sea trials will follow before embarking on its landmark voyage. This remarkable feat not only resurrects a lost maritime tradition but also sets the stage for future research into India's ancient naval prowess.

Industry News

PRAYAAN 6.0 – A Grand Confluence of Talent, Innovation and Celebration

n 7th and 8th March 7th 2025, IMU Mumbai Port Campus (MERI Mumbai) witnessed an extraordinary celebration of creativity, knowledge and culture through PRAYAAN 6.0. The two-day extravaganza seamlessly blended technical brilliance with cultural vibrance, providing a platform for participants to showcase their skills, innovation and passion. The event was graced by Mr. Sudipto Mukherjee, Assistant Vice President, Great Eastern Shipping (Chief Guest), Capt. Sanjay Gujral, Managing Director, CUL Shipping (Chief Guest), Mr. Rajeev Sarang, Head Marine HR- Fleet Management, Mr. Prasad Nayak, General Manager, Training, Anglo Eastern, Mr. Mohan Singh Pal, Director, Maritime Education & Training, The Institute of Marine Engineers (India), Mr. Rajesh Doshi, Co-Founder, Dwarka Kutchh Ferries and Tourism Pvt. Ltd., Mr. Rajesh Kasaragod, Hon. Treasurer, IME(I) Mumbai Branch, Mr. Sanjeev Mehra, Hon. Secretary, IME(I), Mumbai Branch, Mr. Rajeev Goyal, Managing Director, Exmar Shipmanagement, Capt. Viswanathan Visveswaran, Senior General Manager, Synergy Marine Group and Mrs. Pranali Dhamapurkar Divekar, HR- Recruiter, Senior Marine Personnel Officer, Synergy Marine Group. whose guidance and expertise added immense value to the fest.

PRAYAAN 6.0 was powered by HSBC as the core sponsor, along with the support of DMET-MERI Ex Cadets Association (DMECA), The Great Eastern Shipping Company Ltd., The Institute of Marine Engineers (India), Exmar Shipmanagement Pvt. Ltd., Sealine Group, Dynacom Tankers Management Ltd., A.G Maritime Pvt. Ltd., Synergy Marine Group, Shivtech Marine Control Systems & Services Ltd., Mitsui O.S.K LINES, Anglo-Eastern Shipmanagement and proud alumnus Mr. Abhishek Amal Sanyal.

The fest was a grand celebration of talent, creativity and competitive spirit, featuring a diverse range of events across technical, artistic and athletic domains. From Prayukti, where intellect met innovation in technical paper presentations, to Kashti, where engineering skills were put to the test in RC boat racing, each event challenged participants to excel. Gaming enthusiasts battled it out in Chakravyuh, while artists unleashed their creativity in Kalamkaar. Intellectual minds competed in Pra-Gyaan, and dancers mesmerised in Taal Tarang. Abhinaya showcased diverse talents, Atman tested personality and confidence and Sangharsh pushed physical limits in a CrossFit showdown. The fest also celebrated music with Mridang, storytelling with Chalchitra and provided an unforgettable platform for expression, learning and competition.

Each event was a true reflection of creativity, teamwork, and innovation, making PRAYAAN 6.0 a remarkable success.

Glimpses of the Event

Industry News

Blue Economy 4.0: Transforming the Maritime Industry

Tolani Maritime Institute (TMI) successfully hosted the 18th edition of its prestigious All-India Technical Seminar, "Transtech 2025," from 4th to 6th March 2025. Organised in collaboration with The Institute of Marine Engineers (India) and The Institution of Engineers (India), the event revolved around the theme, "Blue Economy 4.0: Harnessing Innovation for a Sustainable Maritime Future."

The seminar commenced with an inaugural session featuring esteemed dignitaries, including Chief Guest **Shri Deependra Singh Bisen**, Deputy Director General of Shipping, Guest Speaker **Mr. Vaibhav Nagarkar**, and **Mr. Sanjeev Ogale**, Chairman, The Institute of Marine Engineers (India), Pune Branch. The lamp lighting ceremony was followed by an address from **Dr. Sanjeet Kanungo**, Principal, TMI, who emphasised the event's role in fostering innovation among future maritime professionals. **Mr. Swapneil Tamhankar**, Faculty in Charge, IME(I) Student Chapter, TMI Pune, and **Dr. Dhiren Dave**, convenor for Transtech 2025, also shared their insights on sustainable maritime advancements.

The Chief Guest Shri Bisen released 'Tolani Maritime Institute's Journal of Maritime Fundamental and Applied Research' followed by his Inaugural speech. The inaugural session was concluded with the vote of thanks by the Vice-Principal, Marine Engineering, **Mr. Shailendra Kumar.**

The inaugural session was followed by Technical Paper presentations conducted in presence of the Judges Mr. Anand Thakoor, Mr. Anil Bhat, Mr. Deepak Saranjame in two sessions with the session chairs Capt. Rajkumar Goel and Mrs. Sujata Ganganmale from TMI, wherein six papers were presented on various topics by the participants. Day 2 was full of competitive activities, including the Marine Quiz, Model Making and Poster Making, saw enthusiastic participation. There were two guest speakers who made very information presentations. The first guest speaker was **Mr. Srujal Sharma**, Partner, Jaysons Chemical Industries. He presented a very informative lecture on the Ammonia Handling and Uses on Ships. The second guest speaker was **Mrs. Smita Santoki**, SILLC and Sakal Media Group. She presented a very energetic and enlightening talk on "Entrepreneurship in Shipping-Careers in Shipping and beyond." Following this, Sr. Vice Principal, **Capt. Manoj Hirkane** presented vote of thanks.

The session was followed by Technical Paper presentations chaired by Dr. Nitin Junnarkar and Mr. Sankar Subramanian respectively. A total of seven papers were presented on various topics by the participants.

The event was followed by the much-awaited Marine Quiz. The quiz was preceded by an elimination round as a total of ten teams from various maritime training institutes like Tolani Maritime Institute (TMI), Samundra Institute of Maritime Studies (SIMS), Ganpat University, Great Eastern Institute of Maritime Studies (GEIMS), Hindustan Institute of Maritime Training (HIMT), Noorul Islam Centre For Higher Education, Maharashtra Academy of Naval Education and Training (MANET) etc., participated. The winner of the Marine quiz was declared as Tolani Maritime Institute.

The final day of Transtech 25 was the valedictory function. The event began with the welcoming speech by Dr. Kanungo, followed by the a very informative talk by the Guest speaker **Mr. Ravi Kiran Sethi**, COO, YC Ventures, Singapore, and a very inspiring talk by the Chief Guest **Mr.**

Yasovardhan Chinni, Entrepreneur and Group CEO, YC Ventures, Singapore. The Guest speaker Mr. Sethi, talked on "Technology/ Artificial intelligence in maritime industry" while the chief guest, Mr. Yasovardhan Chinni, spoke on his journey from a marine engineer to a ship owner.

The Chief Guest Mr. Chinni, released Transtech-2025 - Book of Proceedings.

Finally, the much-awaited Prize Distribution function was held in which all the winners were awarded certificates and Cash Prizes. The Transtech 2025 Theme Poster prize was won by Cdt. Anshul Kushwaha. Cdt. Anshul Kushwaha and Cdt. Pranay Tripathi, won the Transtech Video Making Competition. The winners of the very popular Marine Quiz competition were Cdt. Dhruv Kumar Mangal and Cdt. Shivam Kumar from TMI followed by Kaushik Raj and Sarvotham from SIMS, Pune, in second place and Cdt. Akshay S S and Cdt. Akshay Mittal from the TMI secured the third position.

A total of 23 entries were registered for the Model-Making Competition. The models were judged by **Mr. Arvind Kumar** and **Ms. Mangala Deoghare**, 1st Assistant Engineer, Chevron Shipping Corporation, San Ramon. The winner of the Model Making Competition were **Cdts. Manas Kapoor** and **Ved Vinod Menon** from TMI with their model on "Automated anti-piracy water hose and Defender." This was followed by models by other two teams of PVG College of Engg. Tech., Pune, at second and Samudra Institute of Marine Studies at third positions. Out of the 2 potential entries, the winner of the Poster Making Competition were **Cdts. Kishor Kumar, Arvind** and **Mahmad Sameer** from HIMT for their poster on Innovative ideas for environmental protection.

The General Manager, Class NK, **Mr. Sumithran Sampath**, also awarded the cash prizes and certificates, instituted by Class NK for model makers of TMI.

The technical paper presentation, being the highlight of the event, had its top three technical papers in the following order; the third place was secured by Cdts. Dakshrajsinh Jadeja and Pushkar Jadhav from TMI, for their paper titled, Cyber Security in Autonomous Ships. The second place was taken by Cdts. Abhishek Krishna A J, Siva Jayakumar and Aswin S from Kunjali Marakkar School of Marine Engineering, Cochin University of Science and Technology, for the paper titled, Charting a New Age in Inland Water Transport: A Case study On Kochi Water Metro. The winner of the paper presentation competition were Cdts Atharv Laxmikant Bhagwat and Parth Satish Bhosale from SIMS, for their paper titled, Upskilling the Seafaring Workforce: Strategies for an Evolving Industry. The first three prizes for paper presentations i.e. 1st Prize Rs. 10000/-, 2nd Prize Rs 6000/- and third prize Rs. 4000/- were sponsored by IME(I), Pune. IMEI has been sponsoring these prizes from the beginning of Transtech.

The valedictory session was concluded with the vote of thanks by, Capt. Hirkane.

Member Article

Breaking the Cycle: Empowering Women, Transforming Society

"That country and that nation which does not respect women has never become great, nor will ever be in future."

- SWAMI VIVEKANANDA

HASTINAPUR

Third to fourth Century BCE

At the game of dice being played between the Pandavas and the Kauravas, Yudhishtir has lost everything including Draupadi who is married to all the five Pandavas.

Dushasana drags a menstruating, flimsily clad Draupadi by her hair to the gambling hall where he tries to disrobe her in the presence of the high and mighty of Hastinapur.

A helpless Draupadi pleads with everyone present in the assembly to save her honour but all the great men, on the pretext of their loyalty to the throne of Hastinapur by a solemn oath, express their inability to stop the shameful 'Chir Haran' of Paanchali.

-m-0-

DELHI

December 16, 2012 CE.

On the dark cold night of December 16, 2012, Nirbhaya (not her real name), a 23yr old physiotherapy intern and her male friend board an off duty chartered bus for getting back home after watching a movie.

There are six other men on the bus, including the driver. They are all drunk. Smelling a rat, Nirbhaya's friend tries to raise an alarm, but he is badly beaten. For about an hour the bus is driven through the roads of Delhi and Nirbhaya is gang raped and tortured.

After the heinous act, a seriously injured Nirbhaya and her wounded friend are thrown out of the bus.

Nirbhaya succumbs to her injuries on December 29th, 2012. The incident leads to wide spread demonstrations and protests across the country.

> Four out of the six men who committed the evil act on that fateful night, are hanged, one commits suicide and the sixth man ,a juvenile, is awarded 3years in a reform facility.

KOLKATA

August 9, 2024 CE.

Abhaya (not her real name), a 31 year old female postgraduate doctor at R.G. Kar Medical College and Hospital, has just gotten off duty after a rigorous 36 hrs at work. She is looking forward to a good night's rest.

Her body is found the next morning on the campus, in the seminar room.

The autopsy report confirms brutal rape and murder.

The horrifying incident is widely covered by the media. The doctors across the country strike off work and stand in solidarity with the family demanding justice for Abhaya.

Insiders allege of irregularities and malpractices at the hospital and because Abhaya dared to stand up against them she was made to pay the price. Investigations by CBI are still on. Three persons have been arrested so far.

POINTS TO PONDER

What does the mirror on the wall show us? From time immemorial, women have been held responsible and are punished for the folly of men. Was the outspoken and proud Draupadi an object to be gambled off by none other than Dharmaraj Yudhishtir? Was the solemn oath of loyalty to the crown of Hastinapur above the honour of a woman?

A lot of people believe that women provoke men by the way they dress up and behave. Some agree to the fact that women moving around at odd hours deserve to be sexually harassed. Nirbhaya's case is an unfortunate testimony to this mind-set.

At work place, women are expected to be obedient subordinates to their male bosses. If you know too much and refuse to toe the line, you will be silenced in a manner so brutal that the rest of your tribe will forget to raise its head. May be, this was what happened to Abhaya.

Sexual assault is, by far, the most monstrous of all the abuses that anyone can be subjected to. It intrudes upon the victim's privacy besides causing immense humiliation together with mental, physical and psychological trauma. The victim is scarred for life. Rehabilitation, if not impossible, becomes a big challenge. Pre-emptive measures should be taken to prevent its occurrence. It will not be out of context to quote Justice Bhanumati who opined that, "Apart from effective implementation of various laws protecting women, change in the mind-set of the society at large and creating awareness in public on gender justice would go a long way to combat violence against women."

As rightly pointed out by the learned judge, bringing about a change in the thought process of the society, will definitely make a positive difference. It is a long drawn process but it will ultimately have the desired impact.

Family is the institution where children learn their first lessons in social relations and humanity. Gender sensitivity training should be given within the family and all children should be treated equally without gender bias.

Educational institutions, especially at the school level, should conduct interactive seminars and workshops on various gender issues so that the future citizens of the country grow up having the right perspective about women.

Men have an important role to play in preventing sexual violence against women. They should help promote changes in attitude of other men towards the fairer sex.

Media should bring women's issues to the public domain in a forceful manner.

Women should be taught to speak out against any injustice perpetrated against them instead of suffering silently.

Strict laws should be enacted to prevent violence against women and the culprits should be punished speedily. Delayed justice encourages the spirit of the criminal minded elements in the society.

Women should be EMPOWERED in the true sense of the word because empowerment is essential for achieving gender equality and creates an environment free from fear and discrimination.

A society in which half the population is not assured of safety needs to reconsider its claim of being civilized. Swami Vivekananda

WE DEMAND JUSTICE FOR ALL THOSE WOMEN WHO HAVE BEEN WRONGED BY ENSURING THAT IN FUTURE NONE OF THEIR SISTERS SUFFER THE SAME FATE.

About the Author

Mrs. Neeru Gupta, an M.Sc. in Physics, has been a Visiting Faculty at IME(I) since 1999 and at IMU Mumbai Port Campus from 2010 to 2016. She is the wife of Mr. A.K. Gupta, Chairman of the IME(I) Navi Mumbai Chapter.

Student's Column

Renewable Energy-Powered Liquid Nitrogen Generation for Work Extraction

Abstract: In today's world and the new marine pollution carbon emission goals (MARPOL 23), achieving net zero carbon emissions is challenging. However, there are numerous ways to achieve it, such as alternate fuels and renewable energies. In the case of vessels, it is quite difficult to propel them with the direct usage of renewable energy electricity. IC Engine has a great power-to-weight ratio, but they are directly not supporting us in reducing carbon emissions. Coping up with the MARPOL laws and the current global warming crisis, this technical paper shows us a system that uses renewable energies to generate liquid nitrogen into an open loop pressure vessel and a turbine cycle. The article goes through a line diagram where liquid nitrogen boils to generate pressure with the help of ambient air and, creating a zerocarbon cycle with a slightly expensive initial setup. Liquid nitrogen can be a energy storage entity except batteries and water head used currently.

Keywords-Renewable, Cryogenic nitrogen generator, Cryogenic boiler, Turbine, Net Zero

1. Introduction

In a conventional passenger vessel or barge, a single propeller is connected to a propeller shaft, which is connected to a gearbox that takes it to drive from a fourstroke diesel engine, either single or two in number. The fuel used is Diesel oil, Marine Generator oil, or Heavy fuel oil in large vessels transporting goods and cargo. Another way of propelling a ship is using steam. Both systems having a high change in temperature from the ambient room temperature. Heat losses are generally high, reaching the maximum efficiency of 50 percent. Focusing on the near future, carbon emissions must be reduced; an alternative is required to achieve this. The paper takes you through a system of power generation that uses ambient room-temperature air as a fuel to heat liquid nitrogen and pressurize it. The pressurized liquid nitrogen can run a turbine, generating the required power. Liquid nitrogen production is done through renewable energies, either solar panels, wind turbines, or

hydroelectricity plants. The paper showcases the usage of LN2 as a medium of power generation and storage. Nitrogen is abundant in nature and does not react with metals at room temperature.

2. Nitrogen System Line Diagram

Figure 1: - Production, storage, supply, usage of liquid nitrogen cycle.

A renewable energy source will generate electricity, which will be supplied to a liquefication plant. This plant will generate liquid nitrogen and oxygen and store them in designated cryogenic storage tanks. The liquid nitrogen is transferred to a high-pressure heat exchanger, which uses normal air from the surroundings to heat the nitrogen into a pressurized chamber slowly and gradually. The pressure will rise, the pressurized nitrogen gas will be sent to a turbine, where work is done.

3. LN2 Propulsion on Ship

Figure 2: - Usage of pressurised nitrogen gas on board for propulsion and power generation.

In the case of vessels, it is not technically possible to generate electricity using renewable sources such as solar panels and wind turbines, but on the shores, it is quite possible to get a high efficiency of these equipment which can generate electricity.

Challenges that prevent us from installing solar panels on board ship - Moving platform, Saltwater exposure, Limited surface area.

4. Main Components

The main components required to run a nitrogen plant are as follows: the power source and liquefaction plant are present on shore and not on vessels.

4.1 Renewable Energy-Solar Panels, Wind Farm, Hydroelectric Generation plant

Renewable energy sources will be required to run a cryogenic air liquidiser plant, which can be wind turbines installed near shore, solar fields in deserts, Hydroelectricity near water reservoirs, or Biogas recyclers. They need to generate enough liquid nitrogen, which can last enough to propel vessels for daily ferry usage. When the plant is not running, the electricity can be directly supplied to nearby facilities.

4.2 Air Liquification

The air is sucked with the help of a compressor, and then it is cooled, and slowly the gases are separated, and liquid n2 and oxygen are stored in tanks with highly thermal insulating walls. This are generally referred as cryogenic separators.

4.3 Liquid N2 Storage

The liquid N2 is delivered inside the cryogenic container, which is typically made of metals that can sustain -250°Celsius; they are double-walled, and a vacuum is present between them, which makes it nearly hard for the outer heat to enter inside the tank and evaporate the liquid nitrogen the tank is also fitted with a relief valve which will lift when the pressure exceeds a specific limit and keeps the container free from any pressure which can make the container burst. The materials are.

- Aluminium 1100 (UNS A91100)
- Aluminium 3003-F (UNS A93003)

4.4 Liquid N2 Pressure Vessel along with Heat Exchanger

The manufacturing of the pressure vessel, which is a new part of the whole maritime industry, must have the following properties, the bottom-most part of the pressure vessel must sustain extremely low temperatures and have a heat exchanger that can absorb heat from the surroundings.

Therefore, the material should be able to handle high pressures such as 60 bar, and at the same point, it must handle low pressures till- 220°Celsius.

To understand this pressure vessel. We can refer to it as a conventional boiler, which is boiling water to generate steam with the combustion of gases, the differences between this pressure vessel and a steam boiler.

Temperature - the steam boiler can reach up to 300°Celsius. In contrast, a N2 pressure vessel will reach maximum ambient room temperature as we use atmospheric air to boil the liquid nitrogen. Due to high change in temperature.

Heating Medium for LN2 - the tubes carrying nitrogen should have fins on the heating side/Atmospheric air heating side. A drain should be placed below the heating medium fins as it will drip a massive amount of atmospheric moisture, which is converted to liquid water.

Material Selection - Material with high-pressure handling capacity and negative temperature resistance should not react with liquid nitrogen, which is fit for the pressure vessel.

4.5 Nitrogen Gas Driven Turbine

The turbine used here is driven by nitrogen gas, mostly lower than room temperature; it can be either an impulse or a reaction type. This will be precisely calculated according to the flowing medium density and must be designed accordingly, considering that the drive is compressed nitrogen.

4.6Essential Equipments for Running the Plant.

External Forced Draught Fan

Heating Coil at the discharge of FD fan

Feed Pump to Supply LN2

Pressure Control System

5. Calculations for Nitrogen Generation

Figure 3: - LNGC Disha 100% MCR (Taken from Disha Operating Manual)^[4]

For this steam plant if we compare with LN2 plant we get the following results of LN2 consumption

Power Required = 16 kw for Propelling a passenger ship carrying 100 tourists

$$P = \dot{m}C_{\nu}(T_2 - T_1)$$

Initial temperature is 23 degree Celsius and Exhaust temperature we need to find according to inlet conditions.

$$\frac{T_1}{T_2} = \left(\frac{P_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$$

From this considering Inlet temperature as 30 degree Celsius and inlet pressure as 18 Bar taking gamma as 1.238 exhaust pressure of 1 bar, we get the exhaust temperature of 174-degree kelvin or - 98 degrees Celsius. Average consumption will be 7.7 L of compressed nitrogen for the same steam plant to run with compressed nitrogen.

6. Challenges of Running the LN2 System

Storage

Storing liquid nitrogen in containers is possible, but no material is a pure heat insulator, so some heat enters the liquid nitrogen. It is quite possible that it boils some amount of LN2 and generates gas, which will slowly increase pressure in the container and at negative temperatures, the metals become brittle, which prevents them from handling tension, so a relief valve is fitted on the top to relieve the pressure generated. This gas, which increases the pressure, is called boiloff gas, and the boiloff rate can vary from 0.01 litres per hour to 0.05 litres per hour. This can increase or decrease according to the design of the Cryogenic container.

Exchanger Design

The part that will be heating the N2 gas will be made in such a way that the FD fan delivering the air for heating, considering the moisture inside the air, will stick to the heating side of the exchanger and convert to solid ice once the ice is coated the heat exchange rate will decrease and more and more ice will be sticking to surface. Preventing measures such as a small vibrating disk must be present on it, which will remove the ice stuck on it, and it can be prevented a suitable arrangement of the drains should be present.

Very Low Exhaust Temperatures

This is the most challenging part of the system; building a turbine that works at such low temperatures is quite hard to achieve as it is difficult for the turbine to generate high RPM with high centrifugal forces and, at the same time, such a low temperature. Solving this problem needs a solution for sustenance at low temperatures, such as -100 degrees Celsius, or a source to heat nitrogen to 100 degrees Celsius to reduce the exhaust temperatures. An alternate can be used by using an IC engine by supplying sea water for heating it, and a Cryogenic temperature coating on the top of the piston can be a solution.

7. Advantages of Liquid Nitrogen Generation

Massive Increase in Energy storage

Current conventional batteries have a limited amount of energy storage capacity. We have two ways to store renewable energy: Batteries and Water Head. Both have limited amount of storage capacities. When we take the case of LN2, you can continuously generate liquid nitrogen and store it. This can hugely increase energy storage.

Zero Carbon Emissions

This is an entirely Zero Carbon production and propulsion plant. The initial manufacturing of this system will require some energy in the form of Hydrocarbon. The plant is an N2 production unit separating the oxygen and

†Mélange

Nitrogen, which will be liquified according to the need. So consistently, this is a zero-carbon production and a Propulsion system.

No Heat Losses

The usage of liquid nitrogen will be at exceptionally very low temperatures. The external temperature will be very high, so instead of heat loss, it is a heat gain system. IC engines generally have 30 per cent heat losses; if counted to the total losses, they will always have vast amounts of heat losses.

 Least amount of Equipment Needed Compared to Steam Plant

Equipment such as steam trap condensers won't be needed; liquid nitrogen won't be required to be condensed; on the other hand, the FD fan needs to be blown off at a higher rpm for more heat exchange.

8. Conclusion

The system's major components are renewable energy sources to power the cryogenic gas liquefaction plant. This plant produces nitrogen, which is stored in cryogenic container and then transferred to a high-pressure heat exchanger. Here, normal ambient air compresses nitrogen, creating a cycle in which a turbine generates electricity. Challenges such as storage, exchanger design, and minimum extraction temperature were addressed, highlighting the need for specific engineering solutions. Furthermore, the paper identifies the main advantages of this system, including significantly increased energy savings, negligible carbon emissions and minimal heat loss. Ultimately, this innovative approach to using liquid nitrogen for marine resources and energy generation represents an important step toward sustainability goals in the marine industry. Although the initial system may be relatively expensive, the long-term benefits of carbon reduction, increased energy savings and operational efficiency make this system a promising candidate for future shipbuilding technology. They are Combining renewable energy with cryogenic technologies represents a strong synergy with global efforts to combat climate change and reduce carbon footprints. With further research, development and deployment, this system has the potential to change the way ships operate, contributing to a cleaner and more sustainable maritime industry.

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Cohort Reflection

Sailing Memoirs

The Titanic - Part III - Ship Construction

About the Engine Room and Machinery

 No. of Propellers (Total 3) - 2 x 23 feet dia, 4 bladed, outer wing propellers, moved by two directly coupled Triple Expansion Engines. 1 x 16 feet dia, 3 bladed propeller, centrally located, run by a Parson's Turbine. (There is a dispute about the centre propeller - 3 bladed or 4 bladed?)

This photograph of the propellers, with the workmen standing. The centre propeller (to the left of the picture) looks to be three bladed - photograph not very conclusive.

Unsubstantiated photograph - may not be the Titanic - showing a different configuration of propellers (Four bladed centre propeller and 3 bladed outer propellers)

- The two outer propellers were right handed, capable of being reversed by the Triple Expansion Engines that they were attached to.
- The centre propeller was left handed, unidirectional, driven by a Steam Turbine.
- Single Plate Rudder mounted centrally, behind the three bladed propeller with the Low Pressure Turbine as its Prime Mover. The rudder was massive, over a 100 tons in weight, 78 feet high, 15 feet wide. (Single plate rudders were already being replaced by double plated hollow rudders in that era).

- No. of Boilers 24 Double Ended, 5 Single Ended -Total 29. Huge number by any standards and any day, capable of delivering steam at 215 psi.
- No. of Furnaces 159 total 6 per Double Ended Boiler, 3 per Single ended Boiler.
- No. of coal bunkers 6 compartments, from which coal was manually transported to the boiler furnaces. The gang that dealt with shifting of the coal were known as the 'black gang' and included 'trimmers', who ensured that the coal was removed evenly, to prevent the vessel from taking a list. They were the largest group of crew on board.

One side of the Double Ended Boilers shown here - 3 furnaces this side, 3 furnaces at the other end

 Main Engines - Two - 15,000 HP Triple Expansion Reciprocating Steam Engine.

And One Parson's Low Pressure Steam Turbine Engine generating 16,000 Horse Power.

It was a unique blend, almost a hybrid system, discussed later.

The Boilers supplied steam at 215 lbs/ sq inch pressure to the two Four Cylindered Triple Expansion Engines.

After exhausting from the 4 LP cylinders of the TE Engines, the steam entered the Parson's Turbine at 9 lbs/ sq inch, (much below atmospheric pressure {14.7 psi}) to run the Turbine.

The two Triple expansion Engines have to be working at near full speed, after which only the Parson's Turbine can be started / coupled to run the centre propeller. *This played an important part in the last few minutes before the Titanic struck the iceberg, to be taken up later.*

- Combined Horse Power : 2 x 15,000 + 16,000 = 46,000 HP (designed).
- Looking at the configuration of 3 propellers and one rudder, I think her manouvering capabilities at slow speeds were limited, especially when they would have had to stop the (centre) Parsons Turbine, which would have given maximum impetus to the rudder, had the turbine been running.
- Without the centre turbine, how effective would the two side engines be on a centrally placed rudder.
- The likelihood of using one Triple expansion Engine on 'ahead' and the other on 'astern' would probably be the way they dealt with turning the ship during manouvering.
- Main Electrical Power Plant 4 x 400 kw steam driven electric generators, total output 16,000 amps at 100 V DC. (Located aft of the Turbine Enngine).
- Emergency Electrical Power plant 2 x 30 kw auxiliary generators, total output 600 amps at 100 V DC.

One of the interesting aspects of this photograph is the *TAPER* at the end of the Starboard Tail shaft (covered, with a man hanging over the edge of the shaft) - which I thought was more of a modern design / invention

Photograph of Titanic's port Engine Lower Section in the shop

The Port Engine's Upper side - shows the LP Cylinder

THE DESIGN AND CONSTRUCTION

The object was to build the safest of ships, the biggest of ships, not necessarily the fastest.

- The Chief Designer's drawings included some cutting edge ship construction features that were not so common in ship building but already existing in a few ships, such as water tight compartments to elevate the safety levels of the ship. This gave it the reputation of being 'unsinkable', a tag that would haunt it forever.
- The design called for 16 watertight compartments and 15 transverse bulkheads.
- The Titanic's watertight compartments were only watertight horizontally. Also, some of them did not run in a vertical straight line.
- The compartments were of varying sizes (volumes), with the Engine Room being the largest.
- The critical point to note is the vertical bulkhead(s)
 whether in a straight line or not reached only the Upper Deck, which was not a Continuous Weather Deck.

Sketch showing the water Tight Bulkheads

The Crucial Forward Area

The Original Drawing showing the WT Bulkheads

- Had the transverse bulkhead(s) reached the uppermost continuous deck, the Titanic may have well deserved the title of 'unsinkable'. At the worst, she would have given the survivors on board - mostly the men passengers, the Third Class passengers and crew - a few more hours, which would have made the difference between life and death. The 'Carpathia' and other ships would have reached the vicinity. Dawn would have come. Hope would have come.
- The lower areas of each compartment was given to coal bunkers, boiler spaces, machinery spaces, engine spaces.
- Above them were crew's quarters, passenger cabins. The higher the deck, the better the class of passengers.
- As a Marine Engineer, I am flabbergasted that they did not go that extra distance and say "We'll take the transverse bulkhead right up to the top". But I am talking from hind sight. (I have, personally, had, in an explosion forward, the experience of the forward hull / bow being holed on port and starboard sides badly, the hull plates tearing like a piece of cloth, the Fore Peak fully flooding, Lower Fore Peak store flooding to a ¹/₂ metre level, the Collision Bulkhead cracking and #1 Hold flooding. The next transverse watertight bulkhead held. We were fully loaded and 'down by head' quite a bit, with water lapping the deck at # 1 and # 2 Holds, but managed to slowly reach a port for repairs. At the same time, the Australian Navy / Coast Guard were geared up to evacuate us. Except for the time when the explosion caused a massive fire in the (upper) Fore Peak Store - which we fought and put out in a matter of 4 hours - I do not seem to recall that I was ever worried).
- One of the obvious questions are "If the transverse bulkhead is going right up to the Upper Deck, how can people or equipment move along the ship?" For this,

several massive, heavy watertight doors had been provided, that could be opened and shut as needed. Most of these water tight doors were the lowering type. They could be lowered from the decks above from a remote position. They could also be raised or lowered locally.

Water tight door coming down

The Watertight Door could be

- **a.** Closed from a remote location
- b. Locally
- **c.** It had a float mechanism that sent the door down, if the water level were to rise, possibly the mechanism on the right of the photograph
- It could be opened locally by means of a pulley / handle mechanism

Another view of the water tight doors

But the concept of 'water tight compartments' whether initially designed for the Titanic or not is a matter of debate - was, later, discussed in innumerable design offices, improved upon and, finally, reached the inevitable stage of being a continuous bulkhead right upto the continuous weather deck, making the compartment 'watertight' in the full sense of the word.

Present day Ships:

 If it is drawn and listed as a Watertight Bulkhead, it must reach the Continuous Uppermost (Weather) Deck in the vertical plane. Horizontally, it should be from end to end. The forwardmost such Bulkhead is known as the 'Collision Bulkhead', thicker and stronger than the others

(From 'Marine Insight')

(From 'Marine Insight') Elevation of a corrugated bulkhead

A Corrugated Watertight Bulkhead on a Modern Ship This looks like one of the Watertight Bulkheads of a Bulk Carrier

 Most Container Ships have a design wherein there are Under Deck Passages that run the full length of the ship on both, port and starboard, sides. For them to become completely watertight, heavy doors with dogs are placed at each compartment, in line with the Watertight Bulkhead. These heavy doors can be opened and closed from both sides.

A Modern Ship's Water Tight Door. Note the 'Dogs' (Cleats) that Lock the Door Down

The Launching of the Ship (Stern First) (Same as today)

The Titanic Nearing Completion - her iconic four funnels in place

One of the State Rooms

SOME ASPECTS OF THE 'SHIP CONSTRUCTION' DETAILS OF THE 'OLYMPIC' CLASS OF VESSELS

- Interestingly, many of the 'Ship Construction' features of that era still prevail in modern day ship building. Below, I will be alternating between the details of the Titanic and modern day practices as mandated by SOLAS.
- The different types of keels prevalent at that time were the Flat Keel, the Duct Keel and the Bar Keel.

Modern Duct Keel

Other Keels:

One of the famous features of H&W - almost an autograph of the shipyard - was the 'Belfast Bottom'. Most ships were, then, designed with near - knife edge bottoms, as a pre-requisite for speed. Harland (of Harland & Wolff) came out with ships having flatter bottoms, hence the moniker of 'Belfast Bottom'. He proved to the ship builders of that time that, even with flat bottoms, neither speed nor stability would be lost or compromised. The 'Belfast Bottom' was integrated with a squared off bilge. The advantage of the flat bottom was that H&W were able to increase the length of the ship, without increasing the width.

Ships of the modern era, almost without exception, have flat bottoms. The modern day 'turn of the bilge' at the Bilge Strake gives a near-half round shape to the ship, instead of a squarish bilge which, with welded constructions, may become a point or area of extreme stress concentration, leading to cracks.

'Bilge Keels' - one on either side - are a common sight in today's world and are part of the ship's construction in order to reduce the rolling motion. They are double riveted on to a flat steel bar that extends nearly the length of the ship. These rivets are the only ones on the hull of today's welded ships.

It is a common sight - in dry dock - to see this Bilge Keel either bent or torn at several places, implying some type of underwater contact.

Perhaps, if the Titanic had been provided with a 'Bilge Keel' of a larger size, this may have ripped off when in contact with the ice berg, instead of tearing the main hull.

 The Keel Plate was 1 ½" thick with a solid 3 ½" thick 'Keel Bar' that ran practically the full length of the ship. In addition, the keel was further strengthened by a 5 foot box girder, 3" thick. A surprising innovation for a ship built 115 tears ago.

Modern ships either have the 'Keel Bar' along with the centre longitudinal division plate (centre girder) or a 'Duct Keel', a box like structure to strengthen the keel area, which also becomes the space in which pipes, valves, cables are carried. A small rail / trolley arrangement is also provided to transport men and material along the length of the ship, for maintenance purposes.

The Interior of a Duct Keel

• Previously, each longitudinally placed plating had a name. The 'Garboard Strake' was the one either side of the 'Keel Strake'. Then there was the 'Bilge Strakes', the 'Sheer Strakes', 'Bottom Strakes', 'Lower Strakes' etc. They have been replaced by letters for convenience.

The strake numbers are starting from 1 at the stern end to any ending number at the forward bow. Each strake is therefore indicated by a letter to show its level, a number to show its position.

Identification of steel plates on side shell plating for box shape ship

11.	1	8 1	3 1	4	15	16	17
H.1	H2	на	-114	H.5	Hő	HZ	HB
61	G	2 0	19	14	G-5	3.6	87
E.I	F2	FB	·F4	F.5	F.6	F7	F8
E 1	E	2 E	3 E	4	E5	E.6	E7
01	D S O	Da	D4	D.5	D.6	D7	D 8
C 1	G	2 0	a (14	C5	0.6	67
8-1	82	83	84	8.5	8.6	87	88
A1		a. A	3 /	14	AB	A6	A7

• The thickness of each strake was more the prerogative of the Designer at the time of building the Titanic.

Nowadays, a formula is used to calculate what should be the thickness of each plate and is dependent on the size of the ship, the tonnage of the ship and the draft of the ship.

- I won't go into the details of frames and their spacing or web frames and their spacing. The only comment I wish to make is that they were remarkably similar to today's constructions.
- The transverse strength was from the watertight bulkheads and girders.
- The other safety feature that earned her the rather unwanted sobriquet of 'unsinkable' were her Double Bottoms, a concept taken for granted in today's ship construction world, but still in its infancy in the 1900s.
- The Titanic construction was a marvellous piece of engineering and ship design, most of which is followed to this day.
- Probably one of the exceptions was in not bevelling the plate edges, stress relieving etc. (There is no recorded mention that plate edges were bevelled - I may be wrong). For example, the rivet holes were cold drilled into the plates, which would require removal of burrs and bevelling of the edges of the holes, before the rivets are driven in. I don't think this was done.
- 'Stress relieving' did not seem to be a term much in use in that era.

Can the cause of the Titanic's sinking be, finally, attributed to the steel used or the quality of rivets? What does the latest scientific evidence say?

WROUGHT IRON USED IN THE TITANIC DAYS

- Wrought iron was made by smelting pig iron and oxidising it with iron oxide in a 'puddling' furnace. The ease with which it could be worked into practically anything, made it very popular.
- 'Puddling' was a process of mixing and stirring molten metal in large vats where, at the same time, oxides were added to react with the carbon, manganese, phosphorous, silicon impurities and produce a more refined product, *with slag being a by-product*.
- The quality of the product depended on the skill of the 'puddler' and the quality varied with each batch.
- While wrought iron had many advantages, its main weakness was that it was not as strong per unit cross

section as steel. In other words, where you can use a 1" steel plate to obtain a certain strength, you may have to use a 4" thick wrought iron plate to obtain the same strength as steel, making it much heavier and larger in structures, ships. (My comment - the 1" to 4" thickness is not a calculation, just an approximation, a guess)

- Wrought iron came into ship building use in the 1800s. In ship building it appeared in the form of 'Ironclads'. Wooden ships were prone to be destroyed by explosives, fire or incendiary shells, in naval battles. So, cladding the wood with thick wrought iron plates sometimes as thick as 7" to 8" became the benchmark of a superior navy. The progression to wrought iron ships was just a step away.
- By 1860, the weaknesses of wrought iron became evident, at least as far as ship building went, so the changeover to steel took place, especially with the proliferation of Open Hearth furnaces.
- One of the by products of the smelting process for wrought iron is slag, which makes the finished product brittle. The slag in the wrought iron rivets is one of the main suspects in the sinking of the Titanic. As far as the 'Titanic' was concerned, I'll be exploring the impact of wrought iron rivets that were used in joining of plates.
- "In the case of wrought iron from the foundries, there were huge variations. Some slag chunks were so large that cooling following the 'puddling' process took a very long time. As a result, coarse, tree like, structures known as 'dendrites' had enough time to form inside the slag. When large chunks of slag are left unrefined, they can single handedly control the wrought iron's mechanical properties.

STEEL USED IN THE TITANIC DAYS

- In the present day, steels are broadly divided into 4 classes : carbon steel, alloy steel, stainless steel and tool steel.
- During the Titanic days, two types of steel were common : mild steel with less than 0.25% of carbon and carbon steel with carbon between 0.25% and 1.4%. Alloy steels were in their infancy, if it existed at all, in European circles. (Some Asian countries / civilisations were famous for alloy steel products more than two millenia ago).
- Due to the addition of coke during the smelting process, the sulphur content in the steel plates used to be high, sometimes as high as 0.5%. Sulphur in steel can have an enhancing effect in the machinability and weldability of the steel, The process used for steel making was the Siemens Martin Open Hearth process.
- The steel used on the Titanic was the same type of steel that had been used on the armed merchant cruisers, the 'Teutonic' and 'Majestic; in 1889 / 1890, 20 years before. These vessels had seen service of

20 years without a doubt being cast on the quality of steel and were even then without blemish, in remarkable condition.

- This kind of steel was referred to, by the dock workers, as being of 'battleship quality.'
- Plate sizes were 6 ft wide and 30 to 36 feet long. (The standard size plates of today are 2 mtrs x 6 mtrs). Depending on the size of the ship, sizes may be much larger for new ships under construction.
- The rivet holes were cold punched into the steel plates.
- But at low temperatures, freezing point and below, the sulphur can cause the steel to become brittle and could easily crack.
- The 'Titanic' was built up of thousands of 1" thick steel plates. A few of the plates have been salvaged from the wreck. Dr. Phil Leighly, a Professor of Metallurgical Engineering at the University of Minnesota, Rochester, examined one or a few of them not very clear here and opined that *the steel used in the construction* <u>did play a role in the ultimate destruction</u>.
- At the University of Minnesota Rochester, chemical and stress test of the metal samples from the hull and bulkhead show that the steel used to build the ship was incredibly inferior to modern steel. In fact, it was 10 times more brittle than modern steel when tested at freezing temperature, which was the estimated temperature of the water at the time Titanic struck the iceberg.
- "Tests of the steel's chemical composition also showed a high content of sulphur, oxygen and phosphorus. High levels of those elements cause steel to be more brittle" said Leighly in his findings.
- The chemical analysis of the hull plate revealed low level of manganese, which is another symptom of brittle steel.
- According to Historian Jennifer Hooper McCarty, who studied the archives of the builder, Harland and Wolff, in Belfast, Northern Ireland, shortages of steel rivets peaked during the Titanic's construction. The Board of H&W were stressed and in crisis mode.
- To build quicker, Harland and Wolff started reaching beyond their usual suppliers of rivet iron and employed smaller forges, who at that time tended to have less skill and experience.
- Their ability to cut corners saw the company order No.3 bar, known as "best", instead of No.4, known as "best-best". Shipbuilders of that time typically used No. 4 iron for anchors, chains and rivets.
- Many of the rivets recovered and studied by scientists were found to be riddled with high concentrations of slag, which is a glassy residue of smelting that can make rivets brittle and prone to fracture.

() Mélange

- Given that the iron rivets were not as strong as steel rivets, Harland and Wolff decided to use the steel rivets only on the Titanic's central hull, where stresses were expected to be greatest. Iron rivets were used for the stern and bow - they were easier to handle in the curved areas. (Wrought iron rivets)
- And so, as history tells us, the bow is where the iceberg struck. Approximately six seams opened up in the ships bow plates. Scientists argue that had the rivets been better quality, Titanic might have stayed afloat long enough for rescuers to arrive, saving hundreds of lives. I will debate this later.
- Some of the above data have been sourced and, sometimes, quoted verbatim from 'ShapeCUT Steel', a leading manufacturer of steel in Australia.
- There are differing opinions on the fracture of the steel, even if it had become brittle. Some scientists say that the quality of steel was good and would have cracked only if the surrounding sea water had reached the temperature of liquid nitrogen, which would be -196 deg C (or between 63 to 72 Kelvin under atmospheric conditions).
- In my opinion, the above would hold true if the steel plate does not have any impact with an object. With sulphur content being high and the sea water temperature being low (-2 deg C or below), the additional stress of impact of an object 52,000 tons weight, traveling at a speed of 22 knots - the force created by the impact would have been enormous.
- Of course, if the ship had only scraped the iceberg, the steel plates may not have broken. But the rivets

 particularly rivet heads - would have been smashed causing the rivets to 'pop', opening up the seams of the plates.
- More about the steel analysis in a later chapter.

RIVETS

- Present day ships are welded ones and have rivets at very few places.
- At the time of building the Titanic, the accepted procedure for joining two plates together was to rivet them. Either the two plate edges were overlapped and riveted or the butts of two plates had a secondary plate behind the butt which was riveted. See drawing below.
- Rivets of various sizes were needed. There were the hull rivets, bulkhead rivets, porthole rivets, deck rivets, boiler rivets and more.
- The keel rivets were 1 ½" thick of steel or wrought iron, and had to be long enough to penetrate through 3 plates, each 1 ½" thick (total 4 ½") or 3 plates each 1" thick.
- Riveting was a laborious process. Depending on the size of the ship, literally thousands of plates - each 20

ft x 6 ft sizes - had to be riveted to make them water tight.

- There were a total of between 2.5 to 3 million rivets (approximately) that were used on the Titanic.
- Inexperienced riveting personnel included 13 year old boys, who were responsible for heating the rivets in a small oven and throwing the hot rivets to the riveter, who would nimbly catch them in a bucket. Each rivet required at least 5 people - the boy heating the rivet, the riveter, one other to hammer home the rivet and two on the inside of the hull to hammer the rivet on the inside. As the Titanic completion was falling behind schedule, the pressure on the riveters became immense.
- The heating of the rivets were based on colour.
 'Cherry red' was approximately 850 deg C and 'blood red' meant about 550 deg C.
- Every rivet had to heated up to exactly the right heat (distinguished by the colour of the heated rivet, rather than any other means), before being driven home. Otherwise, there could be no water tight seal between the plates.
- In contrast, in the modern day, plates, frames, stiffeners are all held together by welding, whether by the human hand or by a robot.
- Though the connection is not tangible, half the riveting team were unskilled workers, who were (allegedly) paid meagre wages by H&W. There were rumbles of dissatisfaction from time to time. Could this have led to a drop in quality of riveting? This is a conjecture that has not been put to rest. (The skilled workers were well paid).
- Steel rivets were used hydraulically riveted in the inner th of the length of the ship. The two outer th, the stern and the fore part had iron (read wrought iron) rivets, manually riveted.
- The heavy hydraulic riveting machines were cumbersome to operate and use. Even then, they were used on the more flattened sections of the hull. The more curved sections, such as the bow and stern, needed to be riveted using sledge hammers.
- Titanic had three rows of rivets where the stresses were calculated to be the highest - mainly the midship area, which accounted for the centre 3/5th of the ship. This is where the heavy hydraulic riveting machines were used.
- The bow and stern had only two rows of rivets for each plate.
- So it came to pass that the rivets of the centre section of the hull were hydraulically riveted. The bow plate rivets were hammered home. Which is where the iceberg struck.
- There were four forges contracted to deliver the 15 different types of rivets that the Titanic needed. The quality varied.

The 4 ton Hydraulic Riveter - could not be used on curved surfaces The two most used riveting methods are shown below.

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 One of the perplexing details that have come to light was the fact that Harland & Wolff bought rivets that had been rejected by Cunard Lines - who were building the Mauretania in 1906. H&W were leading lights in the ship

building fraternity and had very high standards. So why?

- The inadequacy of the Titanic period was that there was no particular standard enforced by a regulating authority in ensuring quality of steel or rivets, or even the quality of riveting.
- It was only post Titanic tragedy that standards were evolved, formulated and, slowly, were set, mostly by the Board of Trade. In close resemblance to today's reactions to a disaster by the official body, standards were revised and set after an accident, a disaster, after the results of an investigation were published.
- The only tests made on rivets were that of checking with a hammer and distinguishing between the difference in the tonal quality of sound made between a rivet that was 'home' and a rivet that was loose. One an imagine what it would have taken to 'hammer test' 3 million rivets.
- Sufffice it to say that riveting standards were not specifically high and there did not seem to be much of quality checks, leading to the suspicion that poor quality riveting contributed to the sinking of the Titanic.
- In H&Ws favour, they had been producing ships with the same quality of steel plating, steel or wrought iron rivets for decades without any suspicion being cast on the steel or the rivets.
- Again, in H&W's favour, I can categorically state the following. If a 53,150 ton vessel, travelling at 22 knots (or 40 km /hr), scrapes the side of a solid, stationary object, hundreds of rivets, maybe even thousands depending on the time period of the impact, will be destroyed and pop. (F = m x a)
- Even with modern day practices of welded hulls, the chances of the plates getting holed / tearing is high. The most optimistic result one can expect is the massive denting of the hull at the point of contact. There would also have

been an impact force that would have pushed the hull away, after the initial collision.

- Wrought Iron was the 'miracle metal' of the early 1800s in Europe. By the 1850s, it had lost its lustre due to several accidents where the metal was deemed to be at fault, as scientists and engineers began to realise that wrought iron was 'anisotropic', defined as "having a physical property which has a different value when measured in different directions. An example is wood, which is stronger along the grain than across it".
- They rightly concluded that, along the slag stringers, the wrought iron was less brittle and more strong. But acoss the stringer they were brittle and cracked open easily.

Microscope comparison of the Titanic's steel rivet (Top) and a wrought iron rivet (bottom)

From 'What really sank the Titanic'

Various Steels' strength at different temperatures. Note the graphs of wrought iron and structural steel and steel castings. From Engineering Stack Exchange

My Conclusions:

- If a massive object of 52,500 tons is travelling at a speed of 22 knots = 11.3 mtrs / sec or 37. 13 feet per second, the force created - when it impacts an object - is tremendous. (F=mxa).
- When this tremendous force scrapes against an object - in this case the iceberg, which can be taken as a near solid object - the rivets will shear and break, however strong the rivet is.
- Imagine a disc grinder rotating at 3000 rpm that is used for cutting the head of a bolt. How easily does it cut through?
- Now imagine something that is at least 10,000 times more powerful, this generated by the speed and momentum of the ship, rubbing powerfully against the iceberg.
- The heads of the rivets, whether steel or wrought iron, whether brittle or ductile or strong, whatever be the size, will shear off.
- The force of rubbing will generate heat, wherein the rivet holes expand slightly.
- The force and pressure of the water will 'pop' the rivets into the ship's spaces.
- The plates will separate and water will find its way in.
- It also depends on the overlay of each plate as it gets riveted.
- Like the overlapping of the lapels of a button-down shirt, if the top plate was facing forward when rubbing against the iceberg, the friction caused will tear up the plate also, along with the rivets.
- So the quality of steel or the quality of the rivet, in my opinion, did not matter.
- Purists point to the 'Olympic's' crashing into the Naval vessel HMS Hawke and compare that accident and the Olympic not sinking - with the sinking of the Titanic. The two vessels collided and there was impact damage.
- Had HMS Hawke scraped heavily and ground itself against the 'Olympic', the result would have been similar to the Titanic scraping against the iceberg. Rivets would have popped, plates would have separated. Possibly, plates would have torn.

Would a ship of today - when colliding with an iceberg, much as the Titanic did - have succumbed to the collision in a similar manner? Food for thought.

About the Author

Mr. A. Ranganathan, 1970 batch of DMET, now retired, worked in Sisco and Barber SM. Of the 38 years at sea, 28 were as Chief Engineer, served on Car Carriers, Container Vessels, Bulk Carriers, MPCs and Self Unloaders.

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