

Longitude: 79° East & Latitude: 9.2° North

3 m above the MSL and 30 m away from the seawater line on the Gulf of Mannar shore of Bay of Bengal

Weathering parameters / pollutants	Maximum	Minimum
Salt content in the atmosphere, $\text{mg m}^{-2}\text{day}^{-1}$ a) South West Monsoon b) North East Monsoon	1200 50	120 2
Relative Humidity, %	90	65
Temperature, °K a) Highest b) Lowest	310 300	301 293
Rainfall, mm a) South West Monsoon b) North East Monsoon	100 1250	Nil 300
Sunshine hours, monthly	300	170
Wind Velocity, Kmhr^{-1}	60	20

***Corrosivity of Different Sites - a comparison**

Site	Corrosion Rate, mg dm ⁻² day ⁻¹	Atmosphere
Galeta pt. Panama, C.Z	132.7	Marine
Mandapam Camp - 100'	120.7	Marine
Kure Beach, North Carolina - 80'	103.0	Marine
Point Reyes, California	96.3	Marine
Dungeness, England	93.8	Industrial Marine
Widness, England	69.0	Marine
Salt Farm - Bhavnagar & Chennai Port - 100'	44.2	Marine
Kure Beach, North Carolina - 800'	28.2	Marine
Cape Kennedy, Florida	25.3	Marine
Pilsey, England	19.9	Industrial Marine

***Corrosion rate of mild steel for a month**

Atmospheric Corrosion* of Metals & alloys in the tropical marine environment of Mandapam

Metals & alloys	Corrosion Rate, mg dm ⁻² day ⁻¹
Mild steel	175.00
Stainless steel - 304	0.09
Aluminium - 2S	0.15
Aluminum - 3004	0.04
Zinc - commercial	8.70
Copper - commercial	2.20
Brass - 70/30	1.70
Phosphor bronze	2.25
Lead - commercial	0.25

***Annual corrosion rate**

International Agencies (Listed a few) :

A number of international collaborative projects have been undertaken at this centre and under exchange programme scientist of the centre have visited countries such as Bulgaria, Russia and USA: To cite a few on the international agencies who availed the facilities at this centre:

- 1) Electrical Engineering Institute, IEP, Sofia (10 years);
- 2) Department of Electronics, USSR (10 years);
- 3) Institute of Metallurgy, Russia (20 years);
- 4) Institute of Physical Chemistry, Russia (5 years);
- 5) U.S Navy in collaboration with Dept. of Science & Technology, New Delhi (5 years);
- 6) International Lead & Zinc Research Organization, Florida, USA (2 years).

Besides that the R&D institutes of other countries like Bulgaria, Hungary and Norway have utilized the facilities available at this centre in evaluating their materials, coatings and components.

National Agencies (Listed a few):

A number of national agencies such as B.H.E.L, Trichy & Bhopal; CBRI, Roorkee; DRDO, Kanpur; NBO, New Delhi; RDSO(Railways), Lucknow; Steel Authority of India Limited; DMRL, Hyderabad; DRDL, Hyderabad; ISRO, Trivandrum; ILZDA, New Delhi; Central Soil and Materials Research, New Delhi; ONGC; IOC; Salem Steel Plant; MICO, Bangalore; Southern Railway, Chennai; DOEn., Chennai; and number other national agencies such as public and private sector agencies, including national laboratories, leading paint manufacturers and small scale industries; have utilized the facilities available at this centre.



Meteorological Observatory



**Atmospheric Corrosion Testing Yard
on the shore of Gulf of Mannar, Bay of Bengal**



Submerged rock structures along the Gulf Of Mannar Shore of Bay of Bengal



Stevenson chamber for indoor evaluation of materials



Inside view of Stevenson chamber



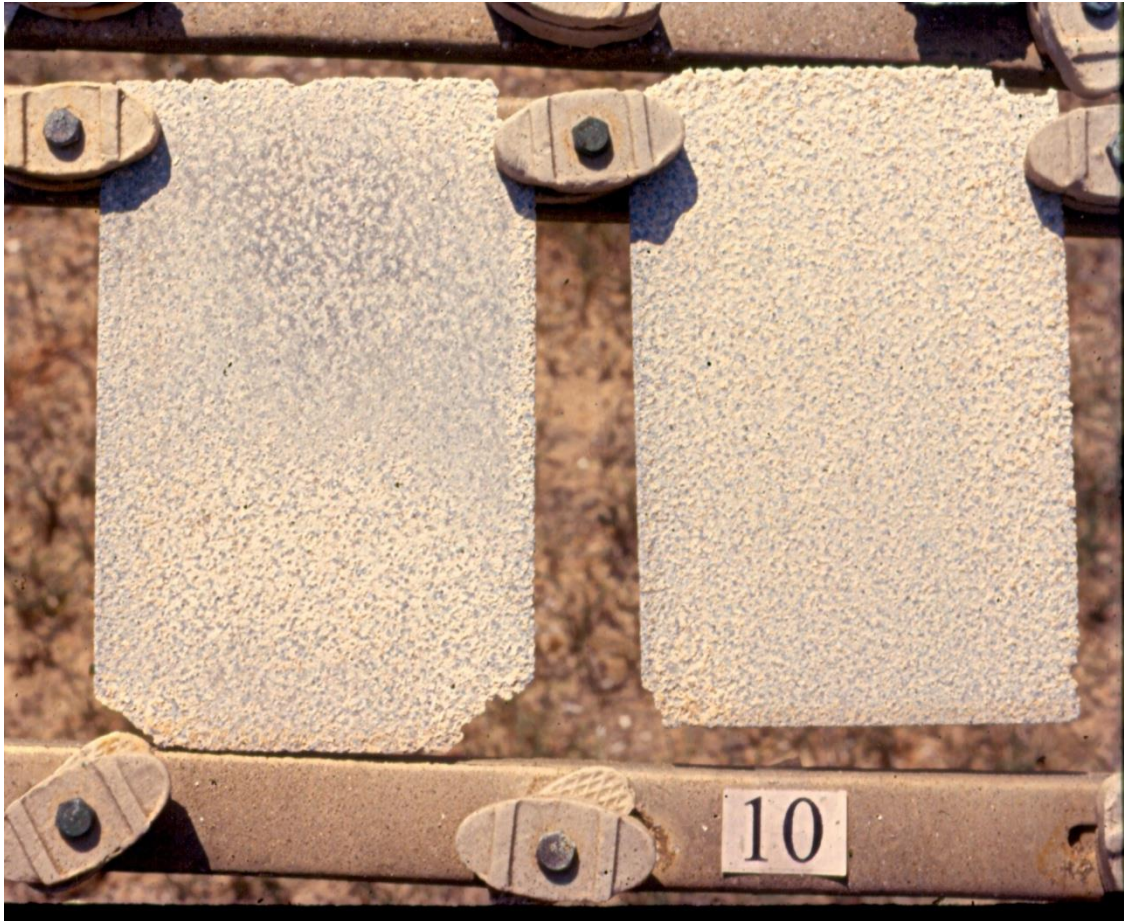
Austenitic Stainless steel of Institute of Metallurgy, Russia exposed at Mandapam for 20 years



**Dezincified Brass of Institute of Metallurgy, Russia exposed at Mandapam
for 20 years**



**Tarnished Copper of Institute of Metallurgy, Russia exposed at Mandapam
for 20 years**



Magnesium alloy of Institute of Metallurgy, Russia exposed at Mandapam for 20 years



Aluminium alloy of Institute of Metallurgy, Russia exposed at Mandapam for 20 years



Corrosion behaviour of steel and galvanized rebar (CTD & TMT) embedded in (a) cantilever slab of M15 & M30 concrete (plain, pre-cracked – 0.1 mm, 0.2 mm & 0.3 mm crack width) subjected to alternate wet & dry conditions, and (b) prisms in marine environment at Mandapam (for ILZRO, USA & ILZDA, India).

Major programmes carried out at this centre:

1. Accelerated Corrosion of Marine Alloys; US-India Funds (PL-480)
2. The stress corrosion cracking behaviour of HSLA steels (MDN maraging and DMR S250 Ni-Si-Cr steels) both coated and bare under various stress conditions in marine atmosphere for DMRL, Hyderabad.
3. Studies on the Corrosion behaviour of aluminium, magnesium and titanium alloys and performance of metallic coatings in marine atmosphere for DRDL, Hyderabad.
4. Studies on the enhancement of durability of concrete structure exposed to chemical and marine environment by using admixture to concrete and coatings, for Central Soil and Materials Research, New Delhi.
5. Studies on the corrosion behaviour of steel and galvanized rebars (CTD & TMT) embedded in (a) cantilever slab of M15 & M30 concrete (plain, pre-cracked – 0.1 mm, 0.2 mm & 0.3 mm crack width) subjected to alternate wet & dry conditions, and (b) prisms in marine environment for ILZRO, USA & ILZDA, India.
6. Evaluation of performance of epoxy and polyurethane based IPN coating systems in marine environment.
7. *Modelling for Service Life Prediction of Concrete Structures”, Board of Research in Nuclear Sciences, Mumbai*
8. *“Studies on the Development of High Durability and Multi-functional concrete”, Yonsei University, Seoul, South Korea*
9. *“Development of Electroless Nickel for Aeronautical Applications”, Aeronautical Development Agency, Bangalore*
10. Development of antifouling coatings using biocides and microencapsulated biocides Photo-inhibition of localized corrosion in marine waters,
11. Evaluation of the Protective Life of RUSTEX-3 Coating on Maraging Steel (MDN-250) and 15-CBB-6 Materials in the Marine Environment
12. Life Studies of Composite Canister Materials
Advanced Systems Laboratory, DRDO, Kanchanbagh, Hyderabad.
13. Integrated sensor gadget accessible through a custom designed mobile APP for corrosion monitoring in civil infrastructures.



CSIR-CECRI

Corrosion Testing Centre, Mandapam Camp

Eco-friendly Technology for De-rusting of Iron & Steel Components

Uniqueness of this process

- The process as a whole is eco-friendly & user friendly
- In this process the non-acid electrolyte can be reused
- A polished surface is obtained by the brush surface contact method
- Replaces cyanide bath for removing heat treated mill scale

Range of Industrial Products Electro-cleaned :

- Automobile Industry - MS Channel, Square tube, etc.,
- High Power Transmitter Relay Centre - Dexon Channel, Guy wire, etc.,
- Railway Bridge - Bearing plate, Sleepers hook bolts, Rail screws, etc.,
- Railway Coach (painted & partially corroded painted portion),
- Southern Railway - Components of Carriage & Wagon and coach springs
- Motor industry - pump housing & heat treated steel bearing plungers
- Hot dip galvanising Industry - Different dia of steel wires
- Commercially available engineering materials - Alloy steels & rebars
- Larsen & Toubro Limited, Puducherry - ms "U" head component

End Users:

- Plating, hot dip galvanizing, painting, pipeline, ship building, construction, automobile and surface (Road & Railways) transport, power transmission & telecommunication industries.

Licensee: Larsen & Toubro Limited, Puducherry - 605 111 (Year 2011)

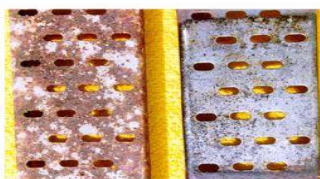
US Patent No. 20020092778.



Cast iron pump housing



Helical Coach spring



Dexon Channel



De-rusted coach portion

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CSIR-CECRI

Corrosion Testing Centre, Mandapam Camp

Eco-friendly process for prevention of biofouling

Biofouling is the undesirable accumulation of microorganisms, plants, and animals on submerged marine installations. Hence marine fouling is an economically important problem facing all the maritime nations of the world.

Uniqueness of this process

- Fouling is prevented and hence dry-docking not required
- The process is eco-friendly as no toxic chemicals are involved
- The fouling proof nature of the system conserves fuel and prolongs the life of the marine installations
- This process can be applied on materials with varied surface profiles

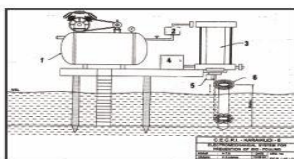
Design and Mechanism

- The present invention relates to an eco-friendly process to combat biofouling on the surfaces of steel and RCC materials of uniform configuration, using pneumatic system.
- The materials used for the investigation are bare as well as painted galvanized iron (GI) pipes, mild steel structures of L shaped, I shaped, square tube configuration, ship hull model and reinforced cement concrete (RCC) cylindrical piles.
- In this process, the formation of microbial slime on the surfaces of the specimen is removed by way of slow moving pneumatically powered brushes.

End Users:

- Navies, Sea Launch Agencies, Port Authorities, Oil & Natural Gas Commission Agencies, and Shipping Industry

Indian Patent No. 2162/DEL/2006



Schematic Design



Bare & Painted GI Pipes



Bare RCC pile



Ship hull model

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CSIR-CECRI

Corrosion Testing Centre, Mandapam Camp



World's one of the most aggressive
tropical marine atmospheric corrosion site



Marine Atmospheric Corrosion

Factors affecting atmospheric corrosion

Relative humidity, temperature, chloride, sulphur dioxide, nitrogen oxides, sunshine, rainfall, wind velocity, etc.



Alloy steel

Aus. Stainless Steel

copper alloy

Brass

Zinc alloy

Magnesium alloy

Marine fouling

Biofouling is of two types, micro and macro fouling, which are detrimental to marine installations and sea going vessels.



Algae

Barnacle

Ascidian

Oyster

Mussel

Bryozoon

Seawater Corrosion

The corrosive action of seawater is a function of various factors, such as salinity, temperature, dissolved oxygen, pH, local water currents, and the development of biofouling

Antifouling Coatings



Control



With biocide



Structural steel

HSLA steel

Aluminium

Copper



CSIR-CECRI

Corrosion Testing Centre, Mandapam Camp

International Clients

Russia (Department of Electronics, Institute of Metallurgy, Institute of Physical Chemistry)
Sofia (Electrical Engineering Institute, IEP)
U.S.A (Navy & International Lead & Zinc Research Organization)
Facility Users: Bulgaria, Hungary and Norway

National Clients

B.H.E.L, CBRI, DRDO, NBO, RDSO, SAIL, DRDL, ISRO, ILZDA, Central Soil and Materials Research, New Delhi; ONGC; IOC; Salem Steel Plant, MICO, Southern Railway, DOE.,

Technologies

1. A novel eco-friendly technology for de-rusting iron & steel components (Commercialized to L&T)
2. Eco-friendly system for prevention of biofouling

Patents Granted

India: 12 Nos.

USA: 01 No.

Ongoing Programme

Long term Outdoor atmospheric corrosion test facility for evaluation of the oxide coatings developed on 2024 aircraft aluminium alloy by NAL, Bangalore.

Evaluation of corrosion resistance behaviour and antifouling property of the oxide coatings developed on 2024 aircraft aluminium alloy in natural seawater.

Organized the Entrepreneurship Skill Development Training Programme (under CSIR - Integrated Skill Initiative) for fishermen in "Paints and Coatings for the Prevention of Corrosion and Fouling on sea going vessels"

Organized the Entrepreneurship Skill Development Training Programme (under CSIR - Integrated Skill Initiative) for Youth in "Protective Marine Painter"

Corrosion behaviour of aluminium alloys (AE001, AE002, AE003, AE004) in marine atmosphere

Future Programme

Evaluation of glass flake coatings in marine environment (atmosphere & seawater) for "Demech Chemical Products Pvt. Ltd., Pune"

Harnessing the Coral reef biodiversity for application in fuel cells & Coral Reef Ecosystem Conservation

Atmospheric Corrosion map for the coastal region of India