## Specification of Test Facilities

<table>
<thead>
<tr>
<th>Test Facility</th>
<th>Major Specification</th>
<th>Usage</th>
<th>Test Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire Test Facility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Anti-Fire System Test | Test space: 30 x 25 x 1[m]  
- Gas supply capacity: 14hG  
- Water supply capacity: 20 [m³/min]  
- Pool burner capacity: 14MW  
- Monitoring system: 50kA, 15kV | Indoor jet or pool fire test | ASTM E 1350  
EN 13541  
ISO 13702, 22899-1  
ISO 15541  
ISO 1970  
Korea Standard (KS) F 2257-4  
ISO 1970  
Korea Standard (KS) F 2257-3  
ISO 1970  
Korea Standard (KS) F 2257-6  
ISO 1970  
Korea Standard (KS) F 2257-7 |
| Fire Collapse Test | Max. temperature: 1.430°C  
Max. test specimen size: 4.5 x 0.25 x 4.5[m]  
Max. load: 2MN  
Measuring fire loading under varying axial loading | Fire proof test under load-bearing structures | ASTM E 119  
EN 13123-1, 2  
EN 13124-1, 2  
ASTM E 8, E 21, E 21, E 850  
ASTM A 388, A 788  
ASTM A 262, A 275, A 370  
ASTM A 131  
UL 10B, 10C  
ISO 834-1/KS F 2257-1  
ISO 834-2/KS F 2257-2  
ISO 834-3/KS F 2257-3  |
| Vertical Type Fire Wall Test | Max. temperature: 1.430°C  
Max. test specimen size: 4.5 x 0.25 x 4.5[m]  
Max. load: 2MN  
Measuring fire loading under varying axial loading | Fire proof test under load-bearing structures | ASTM E 119  
EN 13123-1, 2  
EN 13124-1, 2  
ASTM E 8, E 21, E 21, E 850  
ASTM A 388, A 788  
ASTM A 262, A 275, A 370  
ASTM A 131  
UL 10B, 10C  
ISO 834-1/KS F 2257-1  
ISO 834-2/KS F 2257-2  
ISO 834-3/KS F 2257-3  |
| Horizontal Type Fire Wall Test | Max. temperature: 1.430°C  
Max. test specimen size: 4.5 x 0.25 x 4.5[m]  
Max. load: 2MN  
Measuring fire loading under varying axial loading | Fire proof test under load-bearing structures | ASTM E 119  
EN 13123-1, 2  
EN 13124-1, 2  
ASTM E 8, E 21, E 21, E 850  
ASTM A 388, A 788  
ASTM A 262, A 275, A 370  
ASTM A 131  
UL 10B, 10C  
ISO 834-1/KS F 2257-1  
ISO 834-2/KS F 2257-2  
ISO 834-3/KS F 2257-3  |
| Subsea Test Facility | | | |
| Subsea Hyperbaric Pressure Test | Chamber size: 0.18 x 0.4[m]  
Max. pressure: 935bar  
Temp. range: 5 ~ 90°C | Deepwater subsea system failure | ASTME 123  
ASTME 321  
ASTME 123  |
| Subsea Flow Loop Test | Max. flow rate: 345LPM  
Max. flow velocity: 1 ~ 2.9m/s  
Max. pressure: 200bar | | EN13541  
ISO 834-5/KS F 2257-5  
ISO 834-6/KS F 2257-6  
ISO 834-7/KS F 2257-7  
ISO 834-9/KS F 2257-9  |
| Subsea Vibration Test | Vibration force: 1.500kgsf  
Motor: 2.75kw x 6P  
Amplitude: 6mm | | ASTM E 21  
ASTM A 131  
UL 10B, 10C  
ISO 834-4/KS F 2257-4  |
| Blast, Dropped Object & Structural Failure Test Facility | | | |
| Dropped Object Test | Test space: 3 x 10 x 5[m]  
Max. load: 3MN | Large scale structural failure test | ASTM E 247  
ASTM E 248  
ASTM E 249  |
| Full / Large Scale Structural Failure Test | | | |
| Full / Large Scale Explosion & Fire Test | | | |
| Outdoor Explosion & Fire Test Yard | | | |
| Impact Test Facility | | | |
| PPRJ (Pulse Pressure Loading Rig) | Test specimen size: 1 x 1[m]  
Max. pressure: 4bar | | ASTM E 21  
ASTM A 131  
UL 10B, 10C  |
| Quasi-Static Hyd.-Loading Actuator | Loading capacity: 2,000kN / 5,000kN | Quasi-static structural test | ASTM E 210  
ASTM E 8M  
ASTM A 370  
ASTM A 131  |
| Dynamic Hyd.-Loading Actuator | Loading capacity: 100kN / 100MN | Quasi-static structural test | ASTM E 210  
ASTM E 8M  
ASTM A 370  
ASTM A 131  |
| Universal Testing Machine | Loading capacity: 1,000kN | Material & structure test | ASTM E 8  
ASTM E 21  
ASTM E 850  |
| High-Speed Impact Test | Test specimen size: 1 x 5 x 1.5 [m]  
Impact speed: 1.000m/s | Dynamic structural test | ASTM E 119  
NFPA 13~16, 20, 25, 750  
ISO 13702, 22899-1 |
| Extreme Environment Test | Furnace: 20 ~ 100°C  
Chamber: -170 ~ 100°C | Extreme environment test | ASTM E 119  
ISO 13702, 22899-1 |
| Impact Loading Test Machine (Gun Type) | Max. pressure: 700bar  
Max. speed: 60m/min | Structural impact fracture test | ASTM E 8  
ASTM E 21  
ASTM E 850  |
| Pipeline Fire Resistance Test Machine | Test specimen size: 315.9mm (max. external diameter)  
Max. length: 250mm  
Max. flow rate: 33L/min  
Max. pressure: 7.8bar | Fire resistance test for pipeline | ISO 15546-1, 2  
ISO 15548  
ISO 28196  
ISO 28196-A  |
| Instrumentation | | | |
| Static Data Logger | TDS-303 (built-in switching box: 20 ch.) | Quasi-static test | ASTM E 119  
ASTM E 8M  
ASTM A 370  
ASTM A 131  |
| Dynamic Data Logger | Sampling rate: 1M/150, 8 ch.  
2M/8ch. | Dynamic test | ASTM E 119  
ASTM E 8M  
ASTM A 370  
ASTM A 131  |
| Residual Stress Measuring Test | Hole drilling type | Stress measuring test | ASTM E 119  
ASTM E 8M  
ASTM A 370  
ASTM A 131  |
| High-Speed Camera | Max. frame: 210,000fps  
4,820fps (at 1,280 x 800) | High-speed & impact test | ASTM E 119  
ASTM E 8M  
ASTM A 370  
ASTM A 131  |
Vision & Objective

To play as the global hub organization and leader in the structural integrity and systems performance of ships and offshore installations against extreme and accidental events in association with fundamental research, higher education, and industrial applications.

Selection of Historical Milestone

2015
- Operation of test facilities at Hadong Campus started

2014
- Total integrated subsea test bed construction started (until 2017)
- Subsea high pressure test facilities completed
- Large scale structural failure / dropped object test facilities completed
- Four types of fire test facilities completed
- Two types of explosion test facilities completed
- Collaborating agreement for the systems performance certification with DNV GL signed

2009
- Operation of test facilities at Yangsan Campus started

2008
- The Lloyd’s Register Foundation Research Centre of Excellence at PNU established
- The Korea Ship and Offshore Research Institute (KOSORI) at PNU established

Organization & Staff

<table>
<thead>
<tr>
<th>Department/Center</th>
<th>Staff</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Resource Committee</td>
<td></td>
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</tr>
<tr>
<td>President</td>
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<tr>
<td>Advisory Committee</td>
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<td>Steering Committee</td>
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<tr>
<td>Impact Research Center</td>
<td>Faculty Member</td>
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</tr>
<tr>
<td></td>
<td>Chair Professor</td>
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<tr>
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<td>Adjunct Professor</td>
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<tr>
<td>Subsea Research Center</td>
<td>Research Professor</td>
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<tr>
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<td>Research Engineer</td>
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<tr>
<td>Arctic Engineering Research Center</td>
<td>Postdoctoral Scholar</td>
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<tr>
<td>Ocean Engineering Research Center</td>
<td>Postgraduate Student</td>
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<td>Green Ship Research Center</td>
<td>Administrative</td>
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<td>Ocean Renewable Energy Research Center</td>
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<tr>
<td>Marine and IT Convergence Research Center</td>
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<tr>
<td>Research Planning Division</td>
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<tr>
<td>Cooperation Affairs Office</td>
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<tr>
<td>Administration Office</td>
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<tr>
<td>Total</td>
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</tr>
</tbody>
</table>

(As of May 2015)

Paradigm Shift & Research Subjects

- Functional Requirements
- HSE&E Requirements
- Linear / Simple Mechanism
- Nonlinear / Complex Mechanism
- Prescriptive Approach
- Probabilistic and Risk-Based Approach

Software Infrastructure (Computer Programs)

- ANSYS, LS-DYNA, MAESTRO, ALPS/SULSAP, ALPS/HULL, ALPS/GENERAL, ALPS/SCOL, USFOS, FLACS, KFX, KFX2DYNA, FLACS2DYNA, PHAST, FDS, ANSYS-CFX, ANSYS-Fluent, STAR-CCM+, ANSYS-AQWA, FLEXCOM, OLGA, OrcaFlex

Hardware Infrastructure (Test Facilities)

- Vertical Type Fire Test
- Horizontal Type Fire Test
- Indoor Fire System Test
- Fire Buckling Collapse Test
- Large Scale Structural Failure Test
- Dropped Object Test
- Blast Wall / Door / Window Test
- Outdoor Fire / Explosion Test
- High Speed Impact Test
- Pulse Pressure Loading Rig
- Subsea Hyperbaric Pressure Test
Indoor Fire Test Facility

Test Examples

- Jet fire test
- Pool fire test
- Commodity classification test
- Water deluge test

Sample Test Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO-22899-1</td>
<td>Determination of the resistance to jet fires of passive fire protection materials - Part 1: General requirements</td>
</tr>
<tr>
<td>ISO-22899-2</td>
<td>Determination of the resistance to jet fires of passive fire protection materials - Part 2: Validation, interpretation and classification methods</td>
</tr>
<tr>
<td>UL 199</td>
<td>Automatic sprinkles for fire-protection service</td>
</tr>
<tr>
<td>UL 2335</td>
<td>Fire tests of storage pallets</td>
</tr>
<tr>
<td>NFPA 10</td>
<td>Standard for portable fire extinguishers</td>
</tr>
<tr>
<td>OTI 95 634</td>
<td>Jet-fire resistance test of passive fire protection materials</td>
</tr>
</tbody>
</table>

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**Indoor Fire Test Facility**

**Objectives**
- Jet or pool fire testing to identify fire load characteristics, e.g., temperature and heat flux with or without fire suppression
- Fire performance and reliability testing of active fire protection systems, e.g., fire detection and alarm, fire suppression and firefighting systems, as well as passive fire protection (PFP) system
- Fire performance and reliability testing of water deluge, spray, and mist systems

**Features of Test Facility**
- Designated jet or pool fire scenarios can be tested.
- Water spray and deluge system is facilitated.
- Heat protection wall and roof panels are facilitated.
- Smoke and water vapor during fire testing are managed safely.
- Remote control and automatic test data measurements are made.

**Specification**
- Test space: 30 x 25 x 16 (m)
- Gas supply: ~1kg/s (LPG or LNG)
- Water supply: ~20 (ℓ/min)/m²
- Data acquisition: 5 S/s, 184 ch.
- Gas storage capacity: 4.9ton
- Water storage capacity: 600ton

**Key Components**
- Jet fire simulator
- Pool fire simulator
- Water discharging pipes
- Ventilation system
- Water storage tank
- Gas storage
- Water spray nozzle
- Protective chamber

**Overview**
- Test space: 30 x 25 x 16 (m)
- Gas supply: ~1kg/s (LPG or LNG)
- Water supply: ~20 (ℓ/min)/m²
- Data acquisition: 5 S/s, 184 ch.
- Gas storage capacity: 4.9ton
- Water storage capacity: 600ton
**Subsea Hyperbaric Pressure Test Facility**

**Test Examples**

![Test Example Images]

**Sample Test Standards**

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<thead>
<tr>
<th>Standard</th>
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<tbody>
<tr>
<td>ASTM A 723</td>
<td>Standard specification for alloy steel forgings for high-strength pressure component application</td>
</tr>
<tr>
<td>ASTM A 262, A 275, A 370</td>
<td>Standard practice for detecting susceptibility to intergranular attack in austenitic stainless steels</td>
</tr>
<tr>
<td>ASTM A 262, A 275, A 370</td>
<td>Standard practice for magnetic particle examination of steel forgings</td>
</tr>
<tr>
<td>ASTM A 262, A 275, A 370</td>
<td>Standard test methods and definitions for mechanical testing of steel products</td>
</tr>
<tr>
<td>ASTM A 388, A 788</td>
<td>Standard practice for ultrasonic examination of steel forgings</td>
</tr>
<tr>
<td>ASTM A 388, A 788</td>
<td>Standard specification for steel forgings - General requirements</td>
</tr>
<tr>
<td>ASTM E 8, E 21, E 850</td>
<td>Standard test methods for tension testing of metallic materials</td>
</tr>
<tr>
<td>ASTM E 8, E 21, E 850</td>
<td>Standard test methods for elevated temperature tension tests of metallic materials</td>
</tr>
<tr>
<td>ASTM G 48</td>
<td>Standard guide for characterization of inorganic process wastes for use as structural fill</td>
</tr>
<tr>
<td>ASTM G 48</td>
<td>Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution</td>
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Subsea Hyperbaric Pressure Test Facility

Objectives

- Safe performance and reliability testing of subsea equipment and components under subsea environments
- Vortex-induced vibration testing of subsea equipment under external pressure

Features of Test Facility

- Ultra high external pressure can be applied.
- Vibrating system to test equipment is facilitated.
- Internal flow system in test equipment is facilitated.
- Remote control and automatic test data measurements are made by real time display associated with video cameras and LED lighting devices.

Specification

- Internal diameter of chamber: 1.8m
- Overall internal length of chamber: 4m
- Maximum hyperbaric pressure: 825bar
- Temperature range: 5~50 deg. C

- Data acquisition: 25.6 kS/s, 64 ch.
- Vibration amplitude: ±6mm up to 15kN
- Maximum internal flow rate: 345 ℓ/min up to 200bar

Key Components

- Handling
- Vibration basket
- Flow loop top cover
- Main controller
- Vibration controller
- HPU
- Pressure intensifier
- Monitoring system
- Flow loop controller
- Camera & LED light
**Vertical Type Fire Test Furnace**

**Test Examples**

- Door test in fire
- Penetration seal test in fire
- Damper test in fire
- Shutter test in fire

**Sample Test Standards**

- **ASTM E 119**: Standard test methods for fire tests of building construction and materials
- **ISO 834-1**: Fire-resistance tests - Elements of building construction - Part 1: General requirements
- **ISO 834-4**: Fire-resistance tests - Elements of building construction - Part 4: Specific requirements for loadbearing vertical separating elements
- **ISO 834-8**: Fire-resistance tests - Elements of building construction - Part 8: Specific requirements for non-loadbearing vertical separating elements
- **UL 10B**: Fire tests of door assemblies
- **UL 10C**: Positive pressure fire tests of door assemblies
- **UL 1709**: Rapid rise fire tests of protection materials for structural steel

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Vertical Type Fire Test Furnace

Objectives

- Fire performance and reliability testing of vertical type structural systems or components (e.g., walls, doors, windows, penetration seals) in fires with or without mechanical loads in the vertical direction
- Fire performance and reliability testing of passive fire protection system for vertically positioned systems

Features of Test Facility

- Rectangular type vertical furnace is used to apply the elevated temperature due to fires.
- Temperature control is made in accordance with the designated temperature versus time history as per international standards or other fire scenarios.
- Hydraulic actuator is installed to apply the mechanical loads up to 2MN and/or 150mm stroke in the vertical direction.
- Watch holes are allocated to close-eye monitor during testing.
- Remote control and automatic test data measurements are made.

Specification

- Maximum specimen size: W4.5 x H4.5 (m)
- Maximum temperature: 1,430 deg. C
- Gas burner: Max. 463kW
- Exhaust gas treatment system: 1,200m³/min
- Maximum loading capacity: 2MN and 150mm stroke
- Data acquisition sampling rate: 10 S/s

Key Components

- Gas burner
- Combustion system
- Exhaust gas treatment system
- Hydraulic power unit
- Hydraulic actuator
- Gas storage
- Hydraulic clamp
- Load cell
Test Examples

- Steel column test with PFP in fire
- Cabinet test in fire
- Concrete column test in fire
- Column test in fire

Sample Test Standards

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<tr>
<td>ISO 834-7</td>
<td>Fire-resistance tests - Elements of building construction - Part 7: Specific requirements for columns</td>
</tr>
<tr>
<td>UL 1709</td>
<td>Rapid rise fire tests of protection materials for structural steel</td>
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**Fire Buckling Collapse Test Facility**

**Objectives**
- Buckling collapse performance and reliability testing of structural systems or components (e.g., columns, pillars, plate panels) in fires under axial compressive loads
- Fire performance and reliability testing of passive fire protection system with or without axial compressive loads

**Features of Test Facility**
- Cylindrical type furnace is used to apply the elevated temperature due to fires.
- Temperature control is made in accordance with the designated temperature versus time history as per international standards or other fire scenarios.
- Hydraulic actuator is installed to apply the mechanical loads up to 10MN and/or 200mm stroke in the vertical direction.
- Watch holes are allocated to close-eye monitor during testing.
- Remote control and automatic test data measurements are made.

**Specification**
- Internal diameter of furnace: 4.5m
- Maximum test model size: Ø2 x L5 (m)
- Maximum temperature: 1,430 deg. C
- Gas burner: Max. 463kW
- Overall internal length of furnace: 5m
- Exhaust gas treatment system: 1200m³/min
- Maximum loading capacity: 10MN and 200mm stroke
- Data acquisition sampling rate: 10 S/s

**Key Components**
- Gas burner
- Combustion system
- Exhaust gas treatment system
- Hydraulic system
- Hydraulic actuator
- Gas storage
- Manometer
- Load cell

**Overview**
Test Examples

- Floor collapse test in fire
- Cable tray test in fire
- Damper test in fire
- Beam test in fire

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<td>ISO 834-1</td>
<td>Fire-resistance tests - Elements of building construction - Part 1: General requirements</td>
</tr>
<tr>
<td>ISO 834-5</td>
<td>Fire-resistance tests - Elements of building construction - Part 5: Specific requirements for loadbearing horizontal separating elements</td>
</tr>
<tr>
<td>ISO 834-6</td>
<td>Fire-resistance tests - Elements of building construction - Part 6: Specific requirements for beams</td>
</tr>
<tr>
<td>ISO 834-9</td>
<td>Fire-resistance tests - Elements of building construction - Part 9: Specific requirements for non-loadbearing ceiling elements</td>
</tr>
<tr>
<td>UL 1709</td>
<td>Rapid rise fire tests of protection materials for structural steel</td>
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**Objectives**

- Fire performance and reliability testing of horizontal type structural systems or components (e.g., floors, ceilings, supporting beams or their assemblies) in fires with or without mechanical loads in the lateral direction.
- Fire performance and reliability testing of passive fire protection system for horizontally positioned systems.

**Features of Test Facility**

- Rectangular type horizontal furnace is used to apply the elevated temperature due to fires.
- Temperature control is made in accordance with the designated temperature versus time history as per international standards or other fire scenarios.
- Hydraulic actuator is installed to apply the mechanical loads up to 3MN and/or 450 mm stroke associated with concentrated or distributed loads in the lateral direction.
- Watch holes are allocated to close-eye monitor during testing.
- Remote control and automatic test data measurements are made.

**Specification**

- Maximum specimen size: W4.5 x L6.5 (m)
- Maximum temperature: 1,430 deg. C
- Gas burner: Max. 463kW
- Exhaust gas treatment system: 1,200m³/min
- Maximum loading capacity: 3MN and 450mm stroke
- Data acquisition sampling rate: 10 S/s

**Key Components**

- Gas burner
- Combustion system
- Exhaust gas treatment system
- Hydraulic power unit
- Hydraulic actuator
- Gas storage
- Manometer
- Load cell
ISO-22899-1
- Determination of the resistance to jet fires of passive fire protection materials
  - Part 1: General requirements

ISO-22899-2
- Determination the resistance to jet fires of passive fire protection materials
  - Part 2: Validation, interpretation and classification methods

UL 199
- Automatic sprinkles for fire-protection service

UL 2335
- Fire tests of storage pallets

NFPA 10
- Standard for partable fire extinguishers

OTI 95 634
- Jet-fire resistance test of passive fire protection materials

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**Objectives**
- Fire load and heat flux testing of structural systems and plants in fires
- Gas leak and dispersion testing of structural systems and plants in explosions
- Blast load testing of structural systems and plants in explosions
- Fire wall testing in jet fires

**Features of Test Facility**
- 1/2-scaled model of the topside separation module in a VLCC class LNG-FPSO is used.
- Various scenarios associated with gas leak in location and direction as well as speed can be tested.
- Various scenarios associated with ignition in location can be tested.
- Various scenarios associated with gas type and its concentration ratio can be tested.
- Various scenarios associated with congestion of structural systems and plants can be tested.
- Effect of water spray and deluge system can be tested.
- Remote control and automatic test data measurements are made.

**Specification**
- Test yard: L250 x W180 (m)
- Test model size: L20 x W15 x H10 (m)
- Maximum gas supply: ~ 2kg/s
- Test bed size: L27 x W22 (m)
- Maximum water supply: 20 (ℓ/min)/m²
- Blower: 50m³/min, 1HP
- Ignition plug: 20,000V
- Gas concentration ratio sensing: VOC gas, 5ppb~300ppm
Test Examples

- Blast wall test
- Explosion relief pannel test
- Blast window test
- Blast door test

Sample Test Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASTM F 2247</td>
<td>Standard test method for metal doors used in blast resistant applications (Equivalent static load method)</td>
</tr>
<tr>
<td>ISO 16933</td>
<td>Glass in building - Explosion-resistant security glazing test and classification for arena air - blast loading</td>
</tr>
<tr>
<td>EN 13541</td>
<td>Glass in building - Security glazing testing and classification of resistance against explosion pressure</td>
</tr>
<tr>
<td>EN 13124-1</td>
<td>Windows, doors and shutters - Explosion resistance test method - Part 1: Shock tube</td>
</tr>
<tr>
<td>EN 13124-2</td>
<td>Windows, doors and shutters - Explosion resistance test method - Part 2: Range test</td>
</tr>
</tbody>
</table>

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www.kosori.org
Blast Wall / Door / Window Test Facility

Objectives
- Blast performance and reliability testing of industry products (e.g., blast walls, doors, and windows) in explosions

Features of Test Facility
- Four models can be tested at the same time.
- Remote control and automatic test data measurements are made.

Specification
- Test frame size: L12 x W6 x H4 (m)
- Gas analyzer: 20ppb ~ 30ppm
- Maximum model sizes: L2 x W4, L4 x W4, L4 x W6, L4 x W8 (m)
- Data acquisition: 1 MS/s, 32 ch.
- Maximum blast pressure: 2bar (operational), 5bar (structure)
**Dropped Object Test Facility**

**Test Examples**

<table>
<thead>
<tr>
<th>Test Example</th>
<th>Image</th>
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<tbody>
<tr>
<td>Dropped Object Test Facility</td>
<td><img src="https://www.kosori.org" alt="Image" /></td>
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</tbody>
</table>

**Sample Test Standards**

<table>
<thead>
<tr>
<th>Standard Test Standards</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM E 208</td>
<td>Standard test method for conducting drop-weight test to determine nil-ductility transition temperature of ferritic steels</td>
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<tr>
<td>ASTM E 436</td>
<td>Standard test method for drop-weight tear tests of ferritic steels</td>
</tr>
<tr>
<td>ASTM E 604</td>
<td>Standard test method for preservatives in water-containing cosmetics</td>
</tr>
<tr>
<td>ISO/NP 10855-1</td>
<td>Offshore containers - Part 1: Design, manufacture and marking</td>
</tr>
<tr>
<td>ISO/AWI TR 18624</td>
<td>Guidance for conception, design and testing of LNG storage tanks</td>
</tr>
<tr>
<td>IACS</td>
<td>Common structural rule for bulk carriers and oil tankers</td>
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**Dropped Object Test Facility**

**Objectives**
- Safety performance and reliability testing of structural systems subjected to impact loads arising from collisions
- Nonlinear structural damage and structural crashworthiness testing involving crushing and fracture in impacts

**Features of Test Facility**
- Various scenarios associated with impact kinetic energy due to impact speed, mass and weight elevation can be tested.
- Various scenarios associated with temperatures in cold temperature due to Arctic environment, cryogenic temperature due to LNG, and elevated temperature due to fires as well as room temperature can be tested.
- Remote control and automatic test data measurements are made.

**Specification**
- Height of main frame: 8.8m, 17.7m
- Test bed: L3 x W3 (m), L9.7 x W9.7 (m)
- Maximum model size on bed: L1.8 x W1.8 (m), L3.4 x W3.4 (m)
- Load cell capacity: 1MN, 2MN, 24MN (2MN x 12 sets)
- Cold temperature chamber: -170 ~ 300 deg. C
- Elevated temperature chamber: up to 650 deg. C
- Dropped object holder capacity: 50kN, 100kN
- High speed camera: 108,000 fps @ 1016 x 16 (2 sets)

**Overview**

**Key Components**
- Striker holder
- Fall preventor
- Temperature control chamber

**Yangsan site**

**Hadong site**
Large Scale Structural Failure Test Facility

Test Examples

Sample Test Standards

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<td>ISO 16904</td>
<td>Petroleum and natural gas industries - Design and testing of LNG marine transfer arms for conventional onshore terminals</td>
</tr>
<tr>
<td>ISO 15401:2000</td>
<td>Ships and marine technology - Bulk carriers - Construction quality of hull structure</td>
</tr>
<tr>
<td>ASTM A131, A370,</td>
<td>Standard specification and test methods</td>
</tr>
<tr>
<td>ESM, E21</td>
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Large Scale Structural Failure Test Facility

**Objectives**
- Structural failure testing due to extreme loads
- Buckling and collapse testing of structural systems and components under monotonically increasing loads
- Failure testing of mooring systems or chains in tension
- Fatigue testing of structural systems and components under dynamically repeated loads

**Features of Test Facility**
- Full- or large scale test models idealizing real structural systems can be used.
- Combined loads can be applied.
- Remote control and automatic test data measurements are made.

**Specification**
- Test bed size: L42 x W13 (m)
- Reaction wall: L13 x W2 x H3 (m)
- Loading speed: 0.1 ~ 14mm/sec
- Data acquisition: 130 ch., 1Hz/ch.
- Loading actuator capacity: 30MN (10MN x 3 sets)
- Maximum stroke of actuator: 1,200mm
- Load cell capacity: 36MN (12MN x 3 sets)

**Key Components**
- Hydraulic actuator
- Hydraulic power supply
- Cooling tower
- Reaction floor
- Reaction wall
- Reaction block
- Load cell
- Servo valve
- Crane
- Total control and test data measurements
Pulse Pressure Loading Rig

Key Components

- Static mode
- Dynamic mode
- Toy PPLR
- Pressure sensing
- Control and data acquisition

Test Examples

- Plastic hinge along rigid angle weld-line
- Dishing of the top range
- Rupture buckle
- Opening out of 3 mm thick angle
- Plastic hinge formation along the rigid angle weld-line

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Pulse Pressure Loading Rig

Objectives

- Nonlinear impact response testing of plate panels under blast pressure loads arising from explosions
- Experimental study on blast-resistant characteristics of plate panels

Features of Test Facility

- Lateral deflection of plate panels under blast pressure can be tested.
- Blast pressure load profiles designated in advance, e.g., triangular type can be applied, with varying rise time, peak pressure or duration time of blast pressure loads.
- This test facility was donated by the Impact Research Centre of the University of Liverpool in the U.K.

Specification

- Maximum blast pressure: 2.5bar
- Blast pressure sensor: 1 MS/s (PCD-1MP)
- Test data: Pressure, strain, temperature
- Maximum test panel size: L1,000 x W1,000 (mm)
- Design code: BS 5500 TO BS 1501-151-430A
- Data acquisition: 8 ch. (DEWE-31-16), 1MS/s (per ch.)
Quasi-static / Dynamic Loading Actuators

**Objectives**
- Buckling and collapse testing of structures in quasi-static or dynamic loading conditions
- Fatigue testing of structures under dynamically repeated loading

**Features of Test Facility**
- Movable loading actuators are used to set the test structures up on the test frame in association with the applied loading conditions.
- Combined loading conditions can be considered.

**Specification**
- Quasi-static loading actuator: 2MN (Max. loading capacity), 0.05mm/s (Max. loading speed), 500mm (Max. stroke)
- Quasi-static loading actuator: 5MN (Max. loading capacity), 0.05mm/s (Max. loading speed), 500mm (Max. stroke)
- Dynamic loading actuator: 100kN (Max. loading capacity), 1,000mm/s (Max. loading speed), 500mm (Max. stroke)
- Dynamic loading actuator: 500kN (Max. loading capacity), 200mm/s (Max. loading speed), 500mm (Max. stroke)
Crushing test of square section hollow steel tube at room temperature

Crushing test of square section hollow steel tube at low temperature

Grade D carbon steel

Grade DH carbon steel

Before test

R.T.
-20 deg. C
-40 deg. C
-60 deg. C
-80 deg. C
-120 deg. C
-160 deg. C

ASTM E8/E8M
Standard test methods for tension testing of metallic materials

ASTM E21
Standard test methods for elevated temperature tension tests of metallic materials

ISO 6892-1
Metallic materials - Tensile testing - Method of test at room temperature

ISO 6892-2
Metallic materials - Tensile testing - Method of test at elevated temperature

ISO 6892-3
Metallic materials - Tensile testing - Method of test at low temperature

JIS Z2241
Method of tensile test for metallic materials

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Quasi-static / Dynamic / Impact Material and Structure Test Facility

Objectives
- Mechanical property testing of materials and structures in quasi-static loading
- Mechanical property testing of materials in dynamic / impact loading associated with high strain rates
- Mechanical property testing of materials in Arctic, cryogenic and elevated temperatures as well as at room temperature
- Crushing testing of structures in impact loads

Features of Test Facility
- Universal testing machine (UTM) is used to characterize the mechanical properties and stress-strain curves of materials in quasi-static loading.
- Effects of strain rates of materials can be tested on full scale specimen in wall thickness.
- Effects of temperatures at room, Arctic, cryogenic and elevated temperatures can be dealt with.

Specification
- Maximum loading capacity (UTM): 1MN
- Maximum displacement (UTM): 150mm
- Maximum impact loading capacity: 1MN
- Maximum impact loading speed: 20m/s
- Cold temperature control chamber: -190~200 deg. C  L0.5 x W0.4 x H0.6 (m) / L1.15 x W6.5 x H7.6 (m)
- Elevated temperature control chamber: ~1,150 deg. C  L0.5 x W0.4 x H0.6 (m) / L1.15 x W6.5 x H7.6 (m)

UTM with Temperature Control Chamber

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