

# Extreme Performance Testing Center Seoul National University







Welcome to Extreme Performance Testing Center (EPTC). The EPTC at Seoul National University is the facility that can simulate the extreme loads and environmental conditions to evaluate the behavior of materials and structures. Extreme loads such as high impact or impulsive load due to the collision of transports, missiles, and natural disasters, and extreme environment under ultimate high or low temperature can be simulated in this testing facility. The EPTC has the world-class state-of-the-art research instruments and equipment, which enables research that can directly contribute to the public interests, including development of new materials, creation of an efficient structural system, and provision of a design specification. Overall, the EPTC will be the core facility that will improve the performance of building structures and civil infrastructure under extreme events.

Thank you.

Director Prof. Jae-Yeol Cho

#### History

12/23/2013	Project started
	(Establishment of Structural Performance Testing Facilities for Extreme Conditions)
03/06/2015	Design completed
02/07/2017	Construction work completed
10/22/2018	Project completed and the EPTC opening

#### Middle Velocity Propulsion Impact Machine (Single-stage Gas Gun)



- Specimen size : 2.1m×2.1m (B×H)
  - Projectile mass : 10~100kg
  - Impact velocity : 220~470m/s
- Application
- Simulation of aircraft collision to nuclear power plant
- Simulation of missile impact to weapon hangar
- Assessment of protective performance of ocean plant, and large vessel, etc.



#### High Velocity Propulsion Impact Machine (Single-stage Gas Gun)



- Performance Projectile diameter : ~60mm
  - Specimen size : 0.7m×0.7m (B×H)
  - Projectile mass : 0.5~5kg
  - Impact velocity : 0.5~1.2km/s

#### Application

- Verification of material performance of long-distance bridge/high-rise/factory
- Verification of performance of bullet and bulletproof equipment
- Verification of material performance of high-speed train/aircraft/vehicle/ship



#### Hypervelocity Propulsion Impact Machine (Two-stage Gas Gun)



- Performance Projectile diameter : ~25mm
  - Specimen size : 0.5m×0.5m (B×H)
  - Projectile mass : 25~200g
  - Impact velocity : 2.6~7km/s

Application

- Verification of safety of spacecraft and satellite for space debris impact
- Simulation of geologic formation in planets



#### Split Hopkinson Pressure Bar



Performance • Strain rate :  $\sim 10^4 \, \text{s}^{-1} / \sim 10^3 \, \text{s}^{-1}$ 

- Diameter of bar components : 19mm / 75mm
- Impact velocity : ~30m/s / ~20m/s
- Specimen materials : metal, concrete, ceramics, polymer etc.

Application

- Obtain the stress-strain curve of materials under high strain rate - Civil/building engineering field : concrete, UHPC, FRC, steel, etc.
  - Mechanics/aerospace/marine engineering field : aluminum, titanium, alloy, plastic, etc.

# Drop Weight Impact Tester



- Performance Weight : ~3tonf Height : ~15m
  - Strong bed : 4.5m×4.5m
  - Impact velocity : ~17m/s
- Application
  - Verification of protective performance of wall of plant, harbor structure, bridge pier
    - Verification of protective performance of vehicle, vessel, aircraft, etc.
    - Mock-up test of impact of heavy weight freight, falling rock, etc.



#### Extreme Temperature Chamber



- Performance Chamber size : 12m×5m×3m (L×W×H) • Temperature range :-60~60℃ Temperature deviation : ±1℃ • Temperature control rate : 1°C/min for heating, -0.5°C/min for freezing • Humidity control range : 25~90% (at 25~60℃) • A 500kN dynamic UTM in the chamber (Stroke : 300mm, Frequency : 5Hz) Application Performance test of member & material in high/low temperature - Verification of performance of vehicle, aircraft, & wind power supplier - Verification of qualities of materials such as concrete, aluminum, titanium, magnesium, alloy, etc. • Development and Verification of construction method in hottest and coldest places
  - Simulation of frost heaving due to freeze-thaw of the ground
  - Assessment of weld-ability on low temperature
  - Assessment of freezing behavior of pipe lines



#### High-speed Hydraulic Loading Machine



- Performance Compression force : 320kN at 5m/s velocity
  - Tension force : 330kN at 10m/s velocity
- Application
- Compressive, tensile, flexural test at high strain rate in various fields - Construction materials for bridge, building, and plant
- Mechanical, aerospace, and marine materials for aircraft, vehicle, and vessel

	Material		Specimen Dimension [mm]	Strength [MPa]		Gage	Strain Bate	Force	Velocity
				Static	Dynamic	[mm]	[/s]	[kN]	[m/s]
Comp.	General Concrete		Cylinder (Ф75×150)	40	72	50	100	320	5
Tension	General Concrete		Dumbbell Shape L×W×T (500×100×50)	5	15	100	100	75	10
	Fiber Reinforced Concrete			12	40	100	100	200	10
	Steel Bar (Grade 60)		Ф19	7:	710		95	200	9.5
	Steel Strand (7-wire Strand)		Ф15.2	1,860		100	100	258	10
				2,1	.60	100	100	300	10
				2,4	100	100	100	333	10
	FRP Bar	GFRP	Ф12	75	758		100	96	10
		CFRP	Ф12	2,068		100	100	234	10
		AFRP	Ф12	1,326		100	100	150	10
	FRP Tendon		Φ10	2,450		100	100	192	10
	FRP Composites Bar		Ф12	60	00	50	100	70	5

### • Material/Structure Test Facilities





#### Performance

Equipmer	nt / Facility	Performance	
Structural Test Facility	Strong Floor	• Size : 13m×33m (W×L)	
	Strong Wall	• Size : 13m×8m (W×H)	
	Loading Frame	<ul> <li>Capacity : 5,000kN, 5.2mx8m (W)</li> </ul>	:H)
	Overhead Crane	<ul> <li>Capacity : 25ton+10ton Dual</li> </ul>	
	Main Gate	• Size : 7m×6m (W×H)	
UTM	MTS 311	<ul> <li>Load : ±5,000kN (Dynamic)</li> </ul>	• Stroke : 500mm
	MTS 815	<ul> <li>Compressive load : 2,853kN (Dynamic)</li> <li>Tensile load : 1,344kN (Dynamic)</li> </ul>	amic) • Stroke : 100mm
	MTS 810	<ul> <li>Load : ±500kN (Dynamic)</li> </ul>	• Stroke : 100mm
Actuators	MTS 244.41	<ul> <li>Load : ±500kN (Dynamic)</li> </ul>	• Stroke : 508mm
	MTS 243.70T	<ul> <li>Compressive load : 1,460kN (Stati</li> <li>Tensile Load : 960kN (Static)</li> </ul>	c) • Stroke : 508mm
	STC 100D	<ul> <li>Load : ±1,000kN (Static)</li> </ul>	• Stroke : 300mm

# Pendulum Impact Tester



- Performance Impactor weight : 0.8~2.0tonf
  - Height : 5m
  - Impact energy : 39.2~100kJ
- Application • Verification of impact resistant performance of road safety facilities such as crash barrier, column of traffic signs, rigid protective wall, etc.
  - Evaluation of behavior of retaining wall for landslide
  - Simulation of ship impact for pier and pile



#### • High-speed Camera



#### Performance • Model : Phantom V711

- Max. resolution : 1,024×800pixels at 7,530FPS
- Max. frame rate : 153,200FPS with 256×128pixels
- Exposure time : 1µs
- Model : Photron FASTCAM SA-Z
  - Max. resolution : 1,024×1,024pixels at 20,000FPS
  - Max. frame rate : 300,000FPS with 256×128pixels
  - Exposure time : 0.159µs
- Application Obtain impact and crash image of projectile and specimen during high speed impact test

# Flash X-ray System



- Performance 450kV single X-ray tube
  - 2 Pulsers with 4 tube heads
  - 14"×17" image plate
  - Maximum steel penetration : 55mm
  - Limit film-to-source distance : 7.6m
  - Exposure time : 25ns
- Application • Obtain impact and crash image of projectile and specimen during high speed impact test when visible light is limited due to debris, flash, etc.
  - Especially, used to observe explosively formed projectiles, hypervelocity impact, energetic materials, etc.



### DAQ System



- Performance A/D measuring frequency : 1MHz
  - Minimum time interval : 1µs
  - The number of channels : 64channels
    - 16channels : accelerometer
    - 48channels : displacement meter, strain gauge, load cell, etc.
  - Capable of acquiring data at high rates



