Real-Time Multi-Directional (RTMD) Testing Facility for Seismic Performance Simulation of Large-Scale Structural Systems

Peter Bryan
Lehigh University

Capabilities of (RTMD) Facility

- Large-scale – full scale structural subassembly tests with multiple members and connections
- Real-time – designed to reach peak displacement rates (velocities) and response history durations observed in earthquakes
- Multi-directional – 5 dynamic loading actuators for use in multiple 3-D configurations
- Advanced sensors – use of new technologies
RTMD Equipment

- Dynamic hydraulic actuators and servo-valves
- Dynamic controller (8-channel with two DSPs)
- Hydraulic accumulators (net accumulation of 4090 liters)
- Hydraulic service manifolds (one per servo-valve)
- High-Speed DAS (256 channels, 16 bit, 1000Hz/channel)
- Sensors (wireless accelerometers, piezoelectric transducers, fiber optic sensors)
- Tele-participation equipment (servers, video cameras)
Dynamic Actuators

- **Two Actuators (350mm bore)**
  - Force Capacity: 2050kN (460 kips)
  - Stroke Capacity: +/- 500mm (20in.)
  - Ported for three 1500liters/min (400gpm) servo-valves, 4500liters/min total per actuator.

- **Three Actuators (300mm bore)**
  - Force Capacity: 1500kN (340 kips)
  - Stroke Capacity: +/- 500mm (20in.)
  - Ported for three 1500liters/min (400gpm) servo-valves, 4500liters/min total per actuator.

- **Ten 1500liters/min. (400gpm) servo-valves**

---

Actuator Capacity/Hydraulic Power Supply

- **Maximum force and velocity range**
  - 2 - 2050kN actuators: 250 – 750mm/sec
  - 3 - 1500kN actuators: 340 – 1040mm/sec

- **Hydraulic power supply**
  - Enables sustained seismic testing for > 30 sec
Test Methods Enabled by RTMD Facility

- Effective Force Method
- Real-Time Pseudo-Dynamic Test Method
- Real-Time Hybrid Pseudo-Dynamic Test Method (multi-component)
- Others (e.g., distributed hybrid pseudo-dynamic testing)

Effective Force Method/ Real-Time Pseudo-Dynamic Test Method
Real-Time Hybrid Pseudo-Dynamic Test Method

Multiple Component Hybrid Test

Real-Time Hybrid Pseudo-Dynamic Test Method – Distributed Components

Distributed Multiple Component Hybrid Test
Advanced Sensors

- Optic Sensors
  - Brillouin Scattering Distributed Fibers
  - Bragg Grating Technology
- Robotic Cameras
- Piezoelectric Sensors
- Wireless MEMs Sensors

Instrumentation for Next-generation Research in Earthquake Engineering

Example Research Project @ RTMD Test Facility

- Bridge bent subjected to multidirectional EQ loading
  - Multi-degree of freedom (actuators) real-time hybrid pseudo dynamic testing