Study of Full-Scale / Big-Scale Experiment
(Report of theUS-Japan Symposium on the Seismic Performance of Urban, Reclaimed and Port Areas - Full-Scale Experiment at Tokachi Port -)

by

Takahiro Sugano[1] and Eiji Kohama[2]

ABSTRACT

The US-Japan Symposium on the Seismic Performance of Urban, Reclaimed and Port Areas –Full-Scale Experiment at Tokachi Port- was held under the sponsorship of the University of California, San Diego (UCSD), the Pacific Earthquake Engineering Research Center (PEER) and the Port and Airport Research Institute cooperated with the UJNR Task Committee A (Geotechnical Engineering and Ground Motion) at UCSD on February 27-28, 2003.
In past earthquakes, liquefaction-induced lateral spreading caused damages to under ground structures such as foundations, which in lead to the damages of superstructures that they were supporting. This includes the damages in port facilities, buildings, bridges, and lifelines.
Most of liquefaction and lateral spreading researches have focused on laboratory tests, centrifuge studies, 1G shake table tests, and case histories.
For the numerical simulation of liquefaction and lateral spreading phenomena, stress-strain relationships including excess pore water pressure generation and soil-structure interactions have to be considered.
These approaches mentioned above, however, cannot account for global translations of the liquefaction/lateral spreading soil-structure interaction. In light of this, full-scale/big-scale instrumented experiments are required.

KEYWORDS: liquefaction; lateral spread; earthquake; full-scale experiment.

1. SITUATION

As shown in Fig.1,

a) Actual damage investigation
b) Full/Big-scale experiments
c) Model tests, and
d) Numerical simulations

are connected by ‘complement’ or/and ‘verification’.

1.1 Actual damage investigation

The data we can obtain are as following;

1) Before an earthquake, design documents, sounding data, boring log, etc.
2) During an earthquake, fortunately strong motion records
3) After an earthquake, damage investigation data, etc.

The lack of data during an earthquake is serious.

1.2 Model tests

In order to study the soil-structures interactions, serious problem is ‘similitude’ relationships between a model and a prototype, even in the case of centrifuge tests. Then, how do we evaluate the accuracy of the model test results? However, model tests have an advantage in obtaining ‘dynamic behavior data’ during an earthquake.
The disadvantages are it is rather expensive and takes relatively long time to conduct.

1.3 Numerical simulations.

Generally, a constitutive law is based on laboratory soil test data, such as a triaxial compression test, and hollow cylindrical shear test. Problems of finite element modeling in 1D-2D-3D and arrangements of input parameters exist. How do we evaluate the accuracy of the numerical simulations? However, we can obtain useful information such as element stress condition including excess pore water pressure time history. The disadvantages are, it cost rather expensive and it needs skilled operator.

[1] Head, Structural Dynamics Division, Port and Airport Research Institute, Yokosuka, Japan
[2] Researcher, Structural Dynamics Division, Port and Airport Research Institute, Yokosuka, Japan

1.4 Full/Big-scale experiments

To improve the model test techniques, similitude law, the numerical analysis technique and the accuracy, a full/big-scale instrumented experiments are needed. A Full/Big-scale experiment is often difficult to conduct, because it is extraordinary expensive and takes long time.

2. RECENT TREND

2.1 E-defense (Table 1)

The National Research Institute for Earth Science and Disaster Prevention (NIED) has been constructing the 3-D Full Scale Earthquake Testing Facilities.
(http://www.bosai.go.jp/sougou/sanjigen/3De/index.htm)

2.2 Outdoor shake table (Table 1)

The UCSD has been constructing the Large High Performance (LHP) Outdoor Shake Table.
(http://www.nees.org/EQ/sites/p2_ucsd.html)

2.3 Actual quay wall observatory

Hokkaido regional Development Bureau constructed –5.5m design depth caisson type quay walls with about 180ch of instruments such as seismograph, pore water pressure gauges, accelerometers, velocity sensors, and large earth pressure gauges (1m by 1m), etc. in Kushiro Port. The five years observation project started on April 1, 2002.

2.4 Full-scale experiment using controlled blast

In order to assess the seismic performance of structures, the US-JAPAN joint research project of ‘Seismic performance of Urban, Reclaimed and Port Areas, -Full-scale Experiment at Tokachi Port- was conducted by 14 organizations.

3. COMMENTS

In case of a joint research of full/big-scale experiment, it is necessary to consider following matters,

1) Contract of joint research,
2) Fiscal year,
3) Budget handling,
4) Insurance,
5) In advance conference between researchers and construction workers,
6) Safety control of construction work and instrumentation work,
7) Synchronize data acquisitions,
8) Data handling, i.e. protocol and format, and
9) Publication.

Table 1 Specification of Shake Table

	NIED		UCSD
Payload	12MN		20MN
Size	20m*15m		7.6m*12.2m
Shaking Direction	Horizontal	Vertical	Horizontal
Maximum Velocity	200cm/s	70cm/s	180cm/s
Maximum Displacement	+-100cm	+-50cm	+-75cm
Maximum Allowable Moment	150MN-m	40MN-m	50MN-m

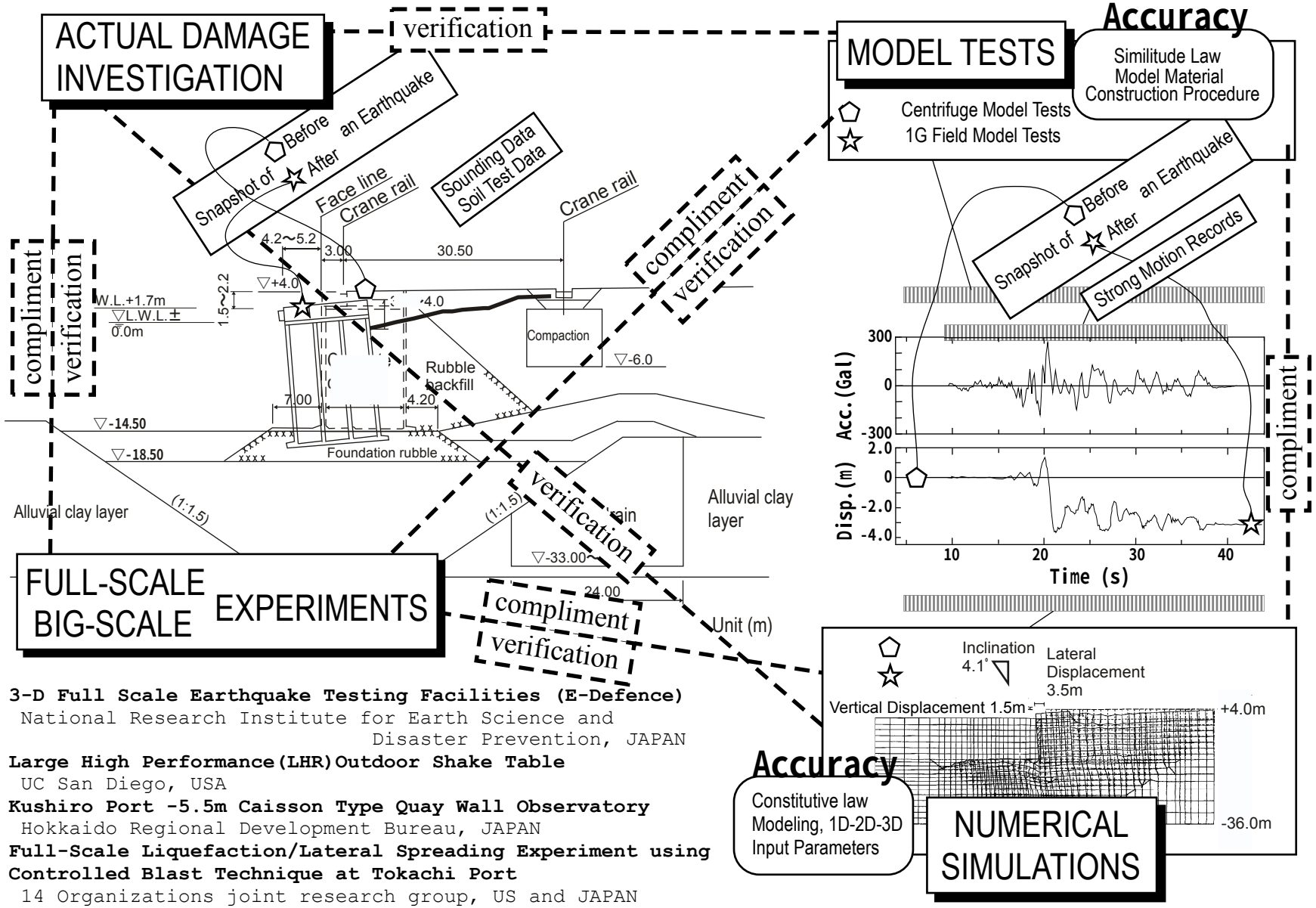

Fig.1 Situation of Full/Big-scale Experiments

3-D Full Scale Earthquake Testing Facilities (E-Defence)
National Research Institute for Earth Science and Disaster Prevention, JAPAN

Large High Performance(LHR)Outdoor Shake Table
UC San Diego, USA

Kushiro Port -5.5m Caisson Type Quay Wall Observatory
Hokkaido Regional Development Bureau, JAPAN

Full-Scale Liquefaction/Lateral Spreading Experiment using Controlled Blast Technique at Tokachi Port
14 Organizations joint research group, US and JAPAN