WCDR in Kobe Jan.18–22, 2005

Cluster 4  Reducing the underlying risk factor
Cluster 4.6 Policies for Safer Buildings / Houses

Keynote Speech

Improvement of Seismic Safety of Buildings and Houses

Tsuneo OKADA

Professor Emeritus of University of Tokyo
President of Japan Building Disaster Prevention Association
Distribution of Epicenters
TOKYO in 2005

KASUMIGASEKI bldg. First High-rise in Japan
KOBE in 1995 (Great Hanshin/Awaji Earthquake Disaster)
1999/11
Düzce Earthquake

Jan. 19, 2005
WCDR in Kobe
T.OKADA
History of Earthquake Damage and Seismic Design & Seismic Evaluation in Japan

Structural Damage in Non-Engineered Buildings and/or in Non-Earthquake Engineered buildings

First Age: Adoption of Seismic Design Codes (1924)

Second Age: Revision of the seismic Design Codes (1971)

Second Age: Minor Revision of the seismic Design Codes (1977)

Promotion of Seismic Evaluation and Strengthening of Existing Buildings

Third Age: Adoption of Performance-based Engineering into Seismic Design Codes (2000 -)

Functional Damage in Engineered Buildings

Controlled Damage in Highly Engineered Buildings
Summary on Building Damage due to Kobe Earthquake

1. Buildings constructed after 1981 took less damage than those constructed before.

2. Seismic performances have been improved according to construction years.

3. If seismic evaluations and/or retrofits had been done, the damage would have been reduced much.
# Damage Statistics of Buildings

## 1995 Hyogo-ken Nambu Earthquake

<table>
<thead>
<tr>
<th>Total</th>
<th>Collapse or Severe</th>
<th>Moderate or Less</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1~2 Storied</td>
<td>46,022 (9.4%)</td>
<td>42,208 (8.6%)</td>
<td>401,046 (82.0%)</td>
</tr>
<tr>
<td>(wooden)</td>
<td></td>
<td></td>
<td>(100%)</td>
</tr>
<tr>
<td>3 storied or more</td>
<td>3,081 (6.4%)</td>
<td>3,273 (6.7%)</td>
<td>42,165 (86.9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>48,519 (100%)</td>
</tr>
</tbody>
</table>

Ministry of Construction 1995
# Damage Statistics of Reinforced Concrete School Buildings

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>332 (100%)</td>
<td>166 (100%)</td>
<td>133 (100%)</td>
</tr>
<tr>
<td><strong>Collapse</strong></td>
<td>18 (5%)</td>
<td>2 (1%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Severe</strong> (5%)</td>
<td>24 (7%)</td>
<td>9 (5%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>90 (27%)</td>
<td>39 (24%)</td>
<td>11 (8%)</td>
</tr>
<tr>
<td><strong>Minor</strong></td>
<td>41 (12%)</td>
<td>21 (13%)</td>
<td>7 (5%)</td>
</tr>
<tr>
<td><strong>Slight or No</strong></td>
<td>159 (48%)</td>
<td>95 (57%)</td>
<td>115 (87%)</td>
</tr>
</tbody>
</table>

AIJ 1995, Okada et al 2000
Why Seismic Evaluation and Retrofit Had Not Been Implemented Much? (Okada 1995)

1) A seismic retrofit is less attractive for owners, architects, engineers, researchers, constructors, administrators and politicians than new building construction.

2) Since a return period of a big earthquake is usually very long, owners are apt to hesitate to spend money for seismic retrofit of existing buildings.

3) Since a seismic retrofit is more complicated than a design and construction of a new building, it is usually troublesome for architects and engineers, and less paid.

4) Since the Japanese Building Code is not retroactive, a seismic retrofit is not legally enforced.
**Actions for Seismic Retrofit in 1995**

- **Hyogo-ken Nanbu Earthquake**  
  (Jan.)
- **Quick Report on Building Damage (MOC)**  
  (March)
- **Notice for Promotion of Seismic Retrofit (MOC)**  
  (March)
- **Report on Damage of School Buildings (AIJ)**  
  (March)
- **Network for Promotion of Seismic Retrofit**  
  (April)
- **Special Law for Earthquake Countermeasures**  
  (Subsidy for Seismic Retrofit of School Buildings)  
  (June)
- **Recommendations of AIJ**  
  (July)
- **Disaster Prevention Basic Plan revised (LA)**  
  (July)
### Seismic Grades of School Buildings

(Public Primary and Secondary Schools)

**[MEXT-7]**

<table>
<thead>
<tr>
<th></th>
<th>Total of Buildings</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100%</td>
<td>133,490 100%</td>
<td>133,490</td>
</tr>
<tr>
<td><strong>Post-1982</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Assumed Safe</td>
<td></td>
<td>45,903 34.4%</td>
<td></td>
</tr>
<tr>
<td><strong>Pre-1981</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) Evaluated Safe</td>
<td></td>
<td>6,871 5.1%</td>
<td></td>
</tr>
<tr>
<td>(C) Evaluated Unsafe and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrofitted or Reconstructed</td>
<td></td>
<td>8,210</td>
<td></td>
</tr>
<tr>
<td><strong>6.2%</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(D) Not Evaluated but Assumed Safe</td>
<td></td>
<td>15,500 11.6%</td>
<td></td>
</tr>
<tr>
<td><strong>(Sub Total of Safe Buildings)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>76,484</td>
<td></td>
<td>57.3%</td>
<td></td>
</tr>
<tr>
<td><strong>11,891</strong></td>
<td></td>
<td>8.9%</td>
<td></td>
</tr>
<tr>
<td>(X) Evaluated Unsafe but Not Retrofitted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>(Y) Not Evaluated but Assumed Unsafe</strong></td>
<td></td>
<td></td>
<td>45,115 33.8%</td>
</tr>
</tbody>
</table>
Recent Activities on Seismic Retrofit

- Estimation of Amount of Vulnerable Buildings
- Promotion of Seismic Retrofit of School Buildings
- Adoption of Seismic Retrofit of Buildings and Houses as the Highest Prioritized Measure in the National Master Plan of Earthquake Preparedness to Tokai–Earthquake
  (Central Disaster Management Council May, 2003)
  (Cabinet meeting approved July, 2003)
- Establishment of Supporting Systems for
History of Earthquake Damage and Seismic Design & Seismic Evaluation

Structural Damage in Non-Engineered Buildings and/or in Non-Earthquake Engineered buildings

First Age : Adoption of Seismic Design Codes
(1920’s – 1940’s)

Structural Damage in Insufficiently Engineered Buildings

Second Age: Revision of the seismic Design Codes
(1980’s – 1990’s)

Promotion of Seismic Evaluation and Strengthening of Existing Buildings

Functional Damage in Engineered Buildings

Third Age : Adoption of Performance-based Engineering into Seismic Design Codes
(2000’s –) for High-rise buildings, since 1960’s

 Controlled Damage in Highly Engineered Buildings
Recommendation-1

1) In order to sweep up seismically vulnerable buildings and houses,

• Do not make vulnerable buildings and houses,

• Evaluate seismic safety of existing buildings and houses and retrofit, and

• Conduct quick inspection and restore of damaged buildings and houses.
Recommendation-2

2) Utilizing excellent technologies developed in the 20th century for real practices,

- Prepare various types and levels of seismic design codes for various types of new buildings and houses,
- Develop evaluation standards and retrofit guidelines for various types of existing buildings and houses, and
- Establish guidelines for inspection of damaged buildings/houses, and train qualified inspectors.
Recommendation-3

3) Not only most sophisticated seismic design and construction technologies but also suitable level of technologies considering building use, life cycle, economic condition etc. be developed and implemented. However, the concepts should be the same.
Discussions in Cluster 4 (Jan. 18, 05)

- Improvement of seismic safety of buildings and houses is one of the most important issues for disaster reduction.
- Adoption of seismic design codes, evaluation and retrofit guidelines is urged.
  
  Implementation is also very important.
- Priorities due to building uses be considered for effective implementation. (schools, hospitals, houses)
- Action Plan is important such as:
  
  To retrofit all vulnerable hospitals by 20xx.