Asia-Pacific
Economic Cooperation

2008/TFEP/WKSP3/022

Development of Seismic Damage Assessment Analysis

Submitted by: Korea

Workshop on Large-Scale Disaster Recovery in APEC
Taipei, Chinese Taipei
22-23 September 2008


Development of Seismic Damage Assessment Analysis

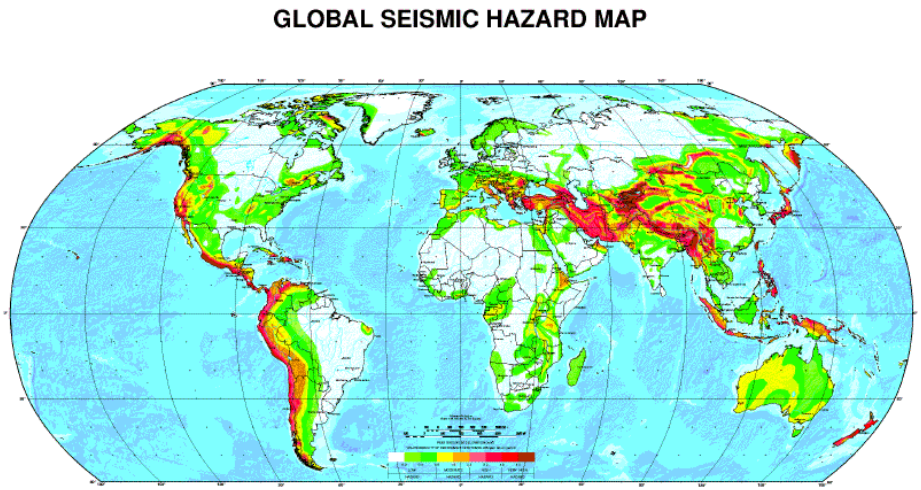
23 Sept. 2008

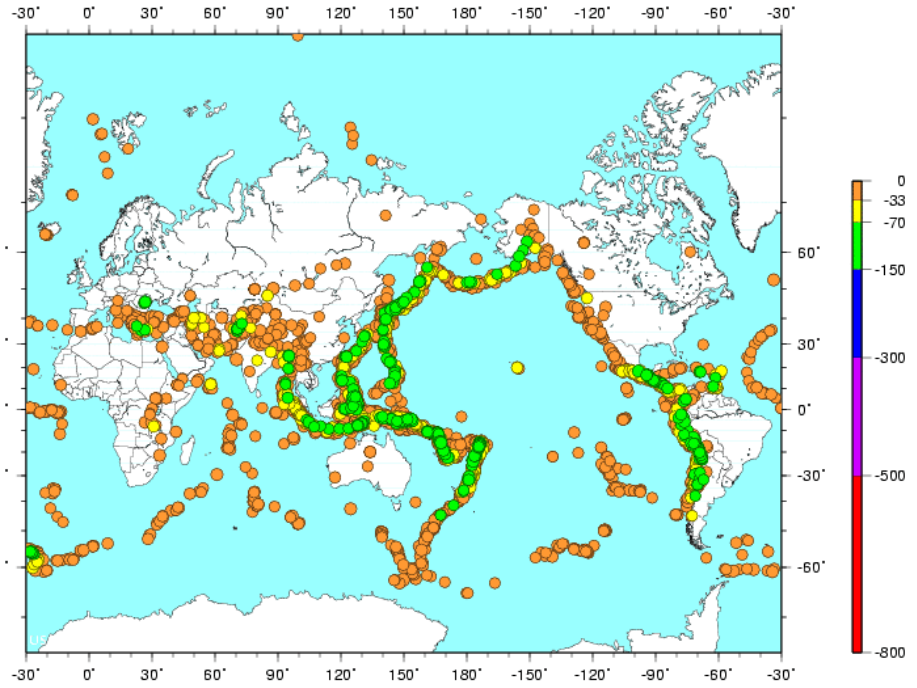
Byung-Cheol PARK

National Institute for Disaster Prevention, Republic of KOREA

처음 페이지로 이동

Seismicity of the World



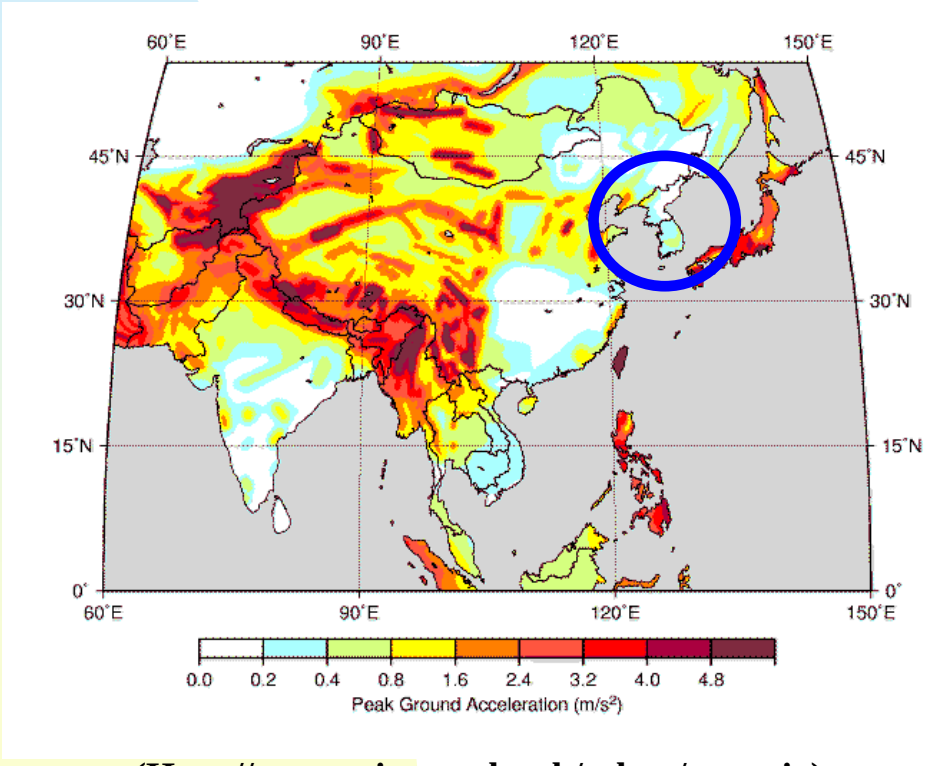


M ≥ 6.0 (1978 ~2008. 7)

처음 페이지로 이동

Seismicity of the Korea Peninsula

Seismic Hazard Map for Eastern Asia
(Global Seismic Hazard Assessment Program)



(Http://www.seismo.ethz.ch/gshap/eastasia)

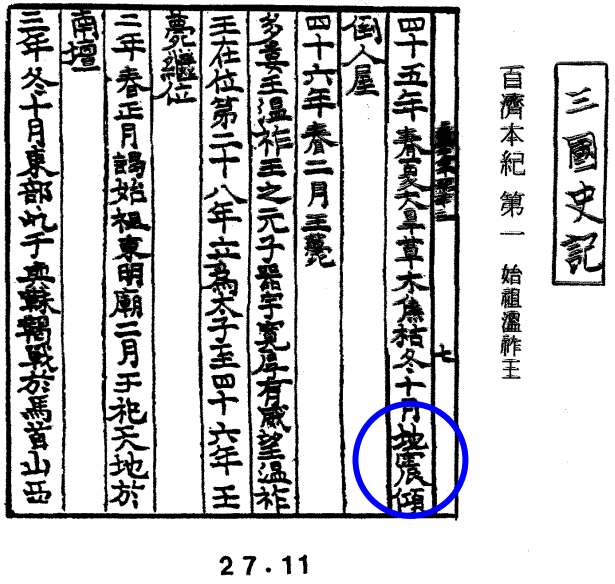
Moderate Seismicity

Region

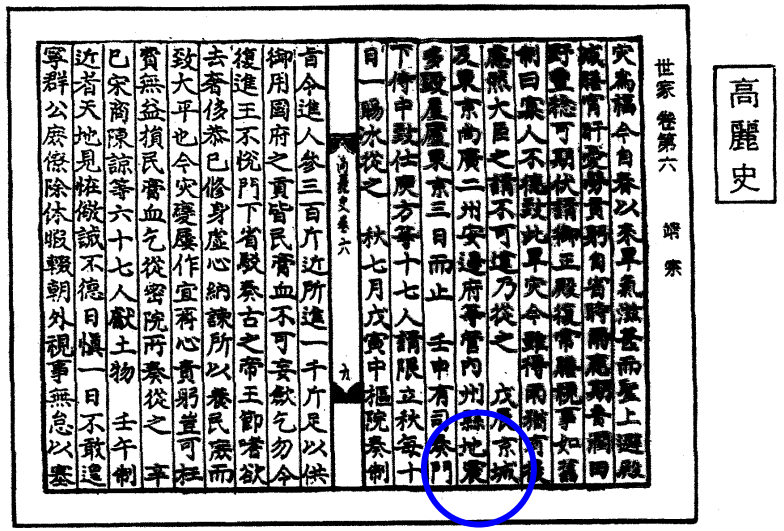
처음 페이지로 이동

Seismicity of the Korea Peninsula

Historical Records about Earthquake Activities



27.11



1036.7.23

<三國史記> Sept. 27

Ground shaked and houses are collapsed.

<高麗史> 23 July 1036

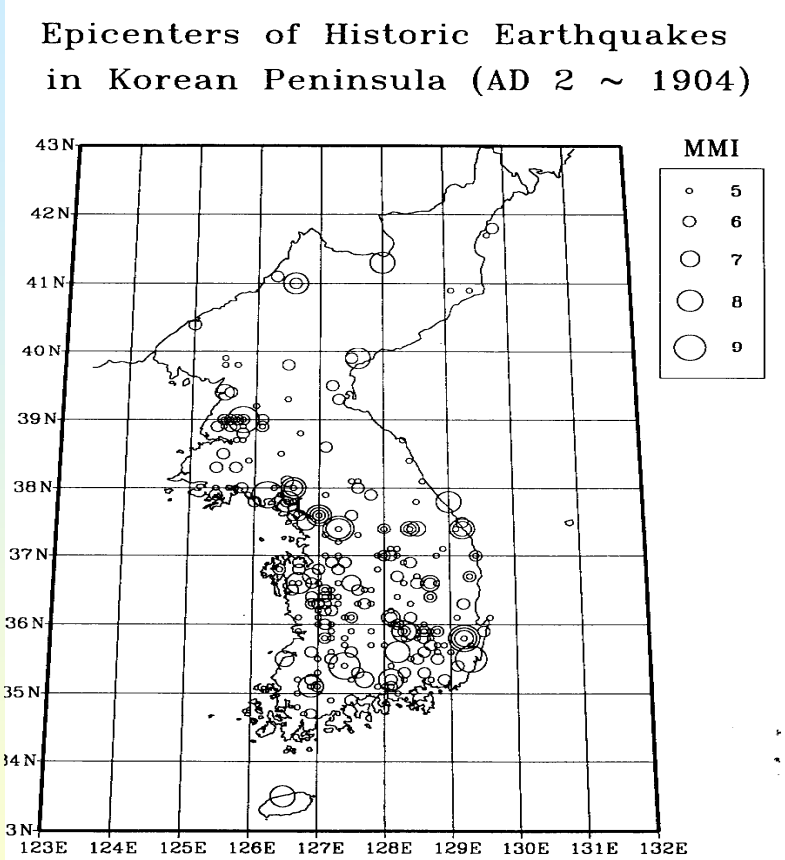
Ground shaked and wooden houses are collapsed in Gaesung and Gyungju. Shaking is continued for 3days.

처음 페이지로 이동

Seismicity of the Korea Peninsula

From A.D.2 to 1904

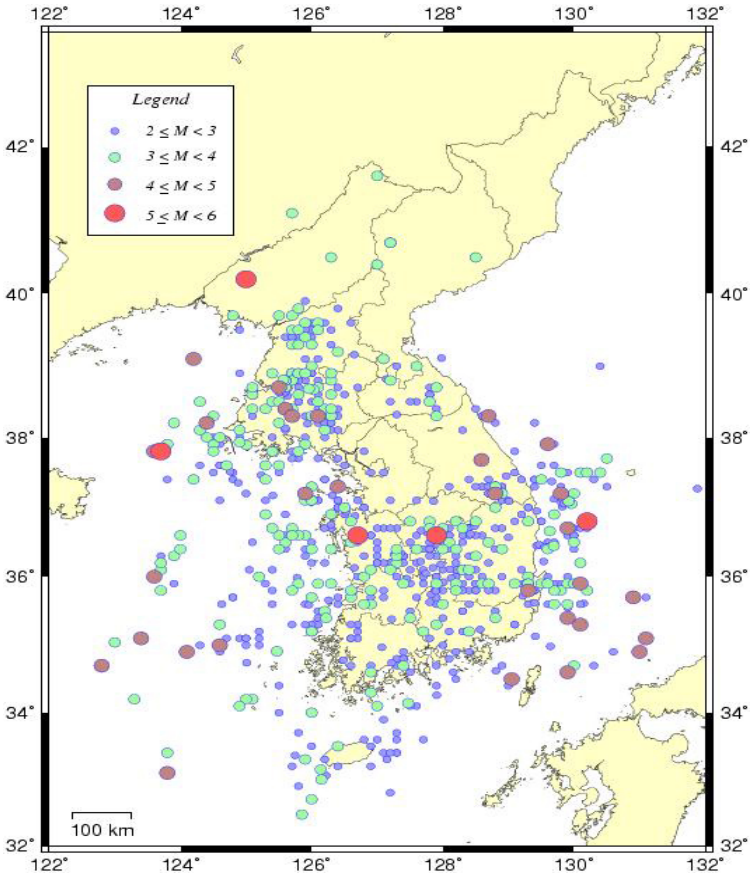
(by Historical Literatures)



Classification	Frequency
≥ MMI V	389
≥ MMI VI	168
recorded damage	45

From 1905 to 2008

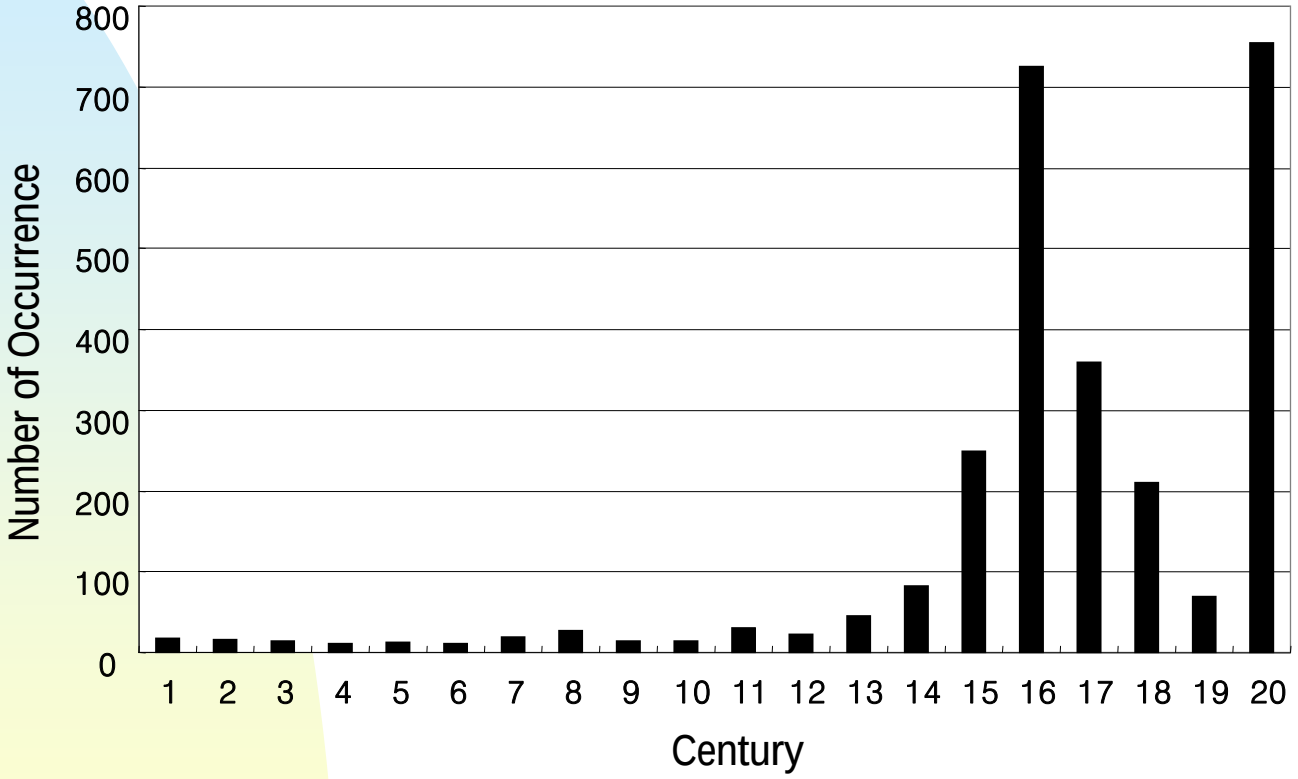
(by Seismometer)



처음 페이지로 이동

Seismicity of the Korean Peninsula

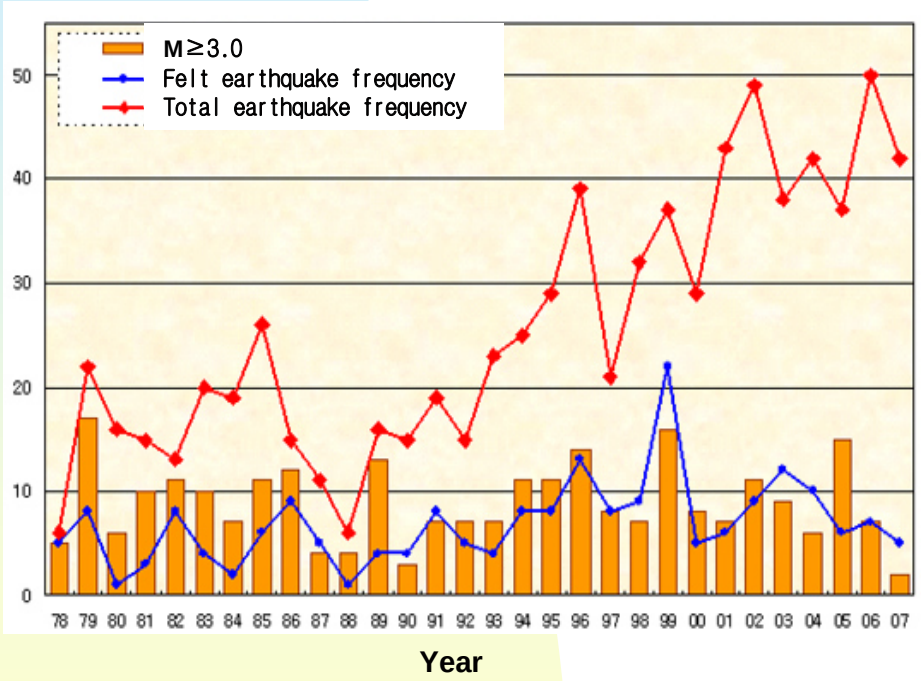
Time distribution of earthquake occurrence



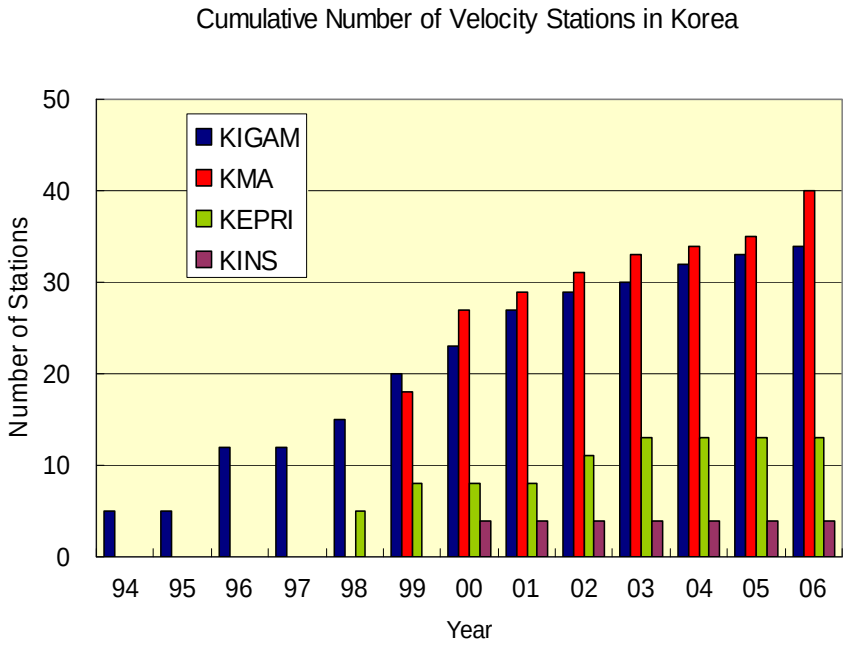
처음 페이지로 이동

Recent Earthquake Activities of Korea

It is doubtful that earthquake frequency is truly increase.
- A felt earthquake is not increase.
- Total earthquake frequency is increase with station.



Earthquake Activities (1978~2007)

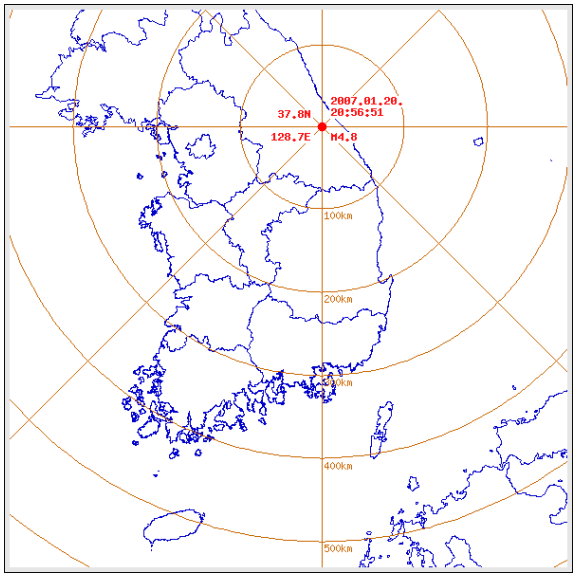


처음 페이지로 이동

Causes for Public Awareness

(1) Experience of Neighboring Countries and Korea

Tangshan Earthquake in 1976 (China)
Kobe Earthquake in 1995 (Japan)
Chi-Chi Earthquake in 1999 (Taiwan)
Odaesan Earthquake in 2007 (Korea)
Wenchuan Eqrthquake in 2008 (China)



(2) Research Results

Damage Records in Historical Literatures
Increasing seismicity in the 20th century
Characteristics of Intraplate seismicity
irregular strain in both space and time

(3) Public Opinion

On structural safety (lack of confidence)
On the fear of devastating earthquake (effect of media)

처음 페이지로 이동

Earthquake Mitigation Countermeasures

- **National Disaster Countermeasures Act (1995)**
  - **Earthquake is added to the disaster list**
  - **20 types of structures should be designed with seismic design concept**

- **National Earthquake Disaster Countermeasures Act (2007)**
  - **Comprehensive Countermeasures**
  - **from Observation, Preparedness, Response, and R&D**

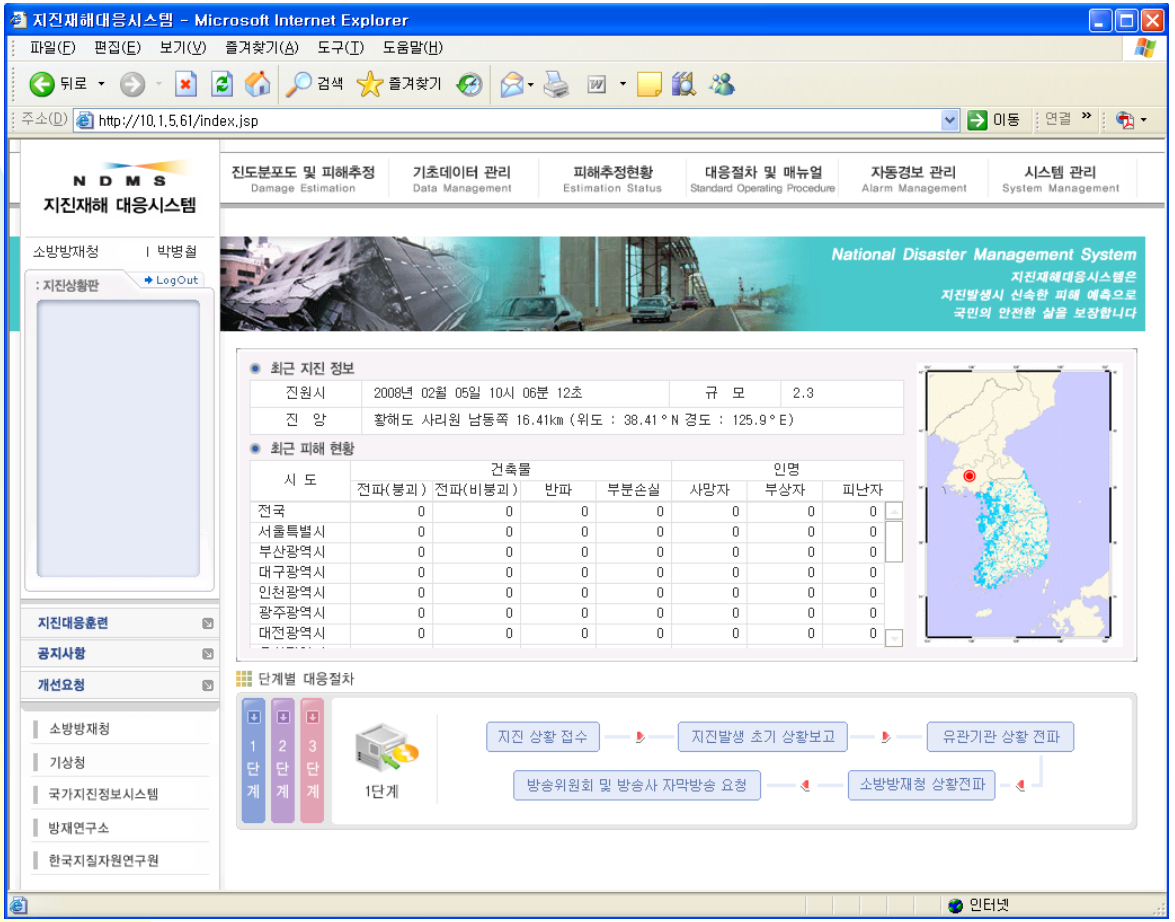
처음 페이지로 이동

Earthquake Disaster Response System in NDMS

Developed by NEMA (from 2006)

seismic damage estimation system is included

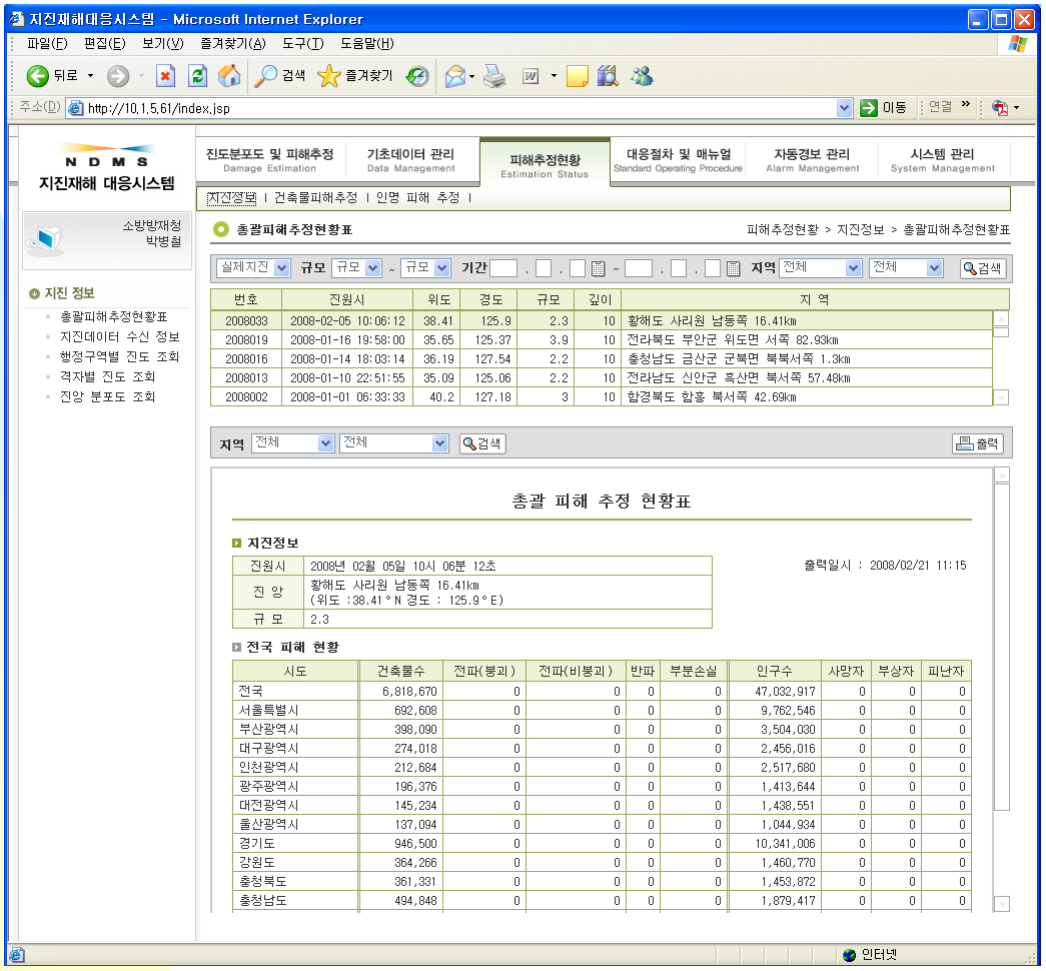
✓ Main Page



처음 페이지로 이동

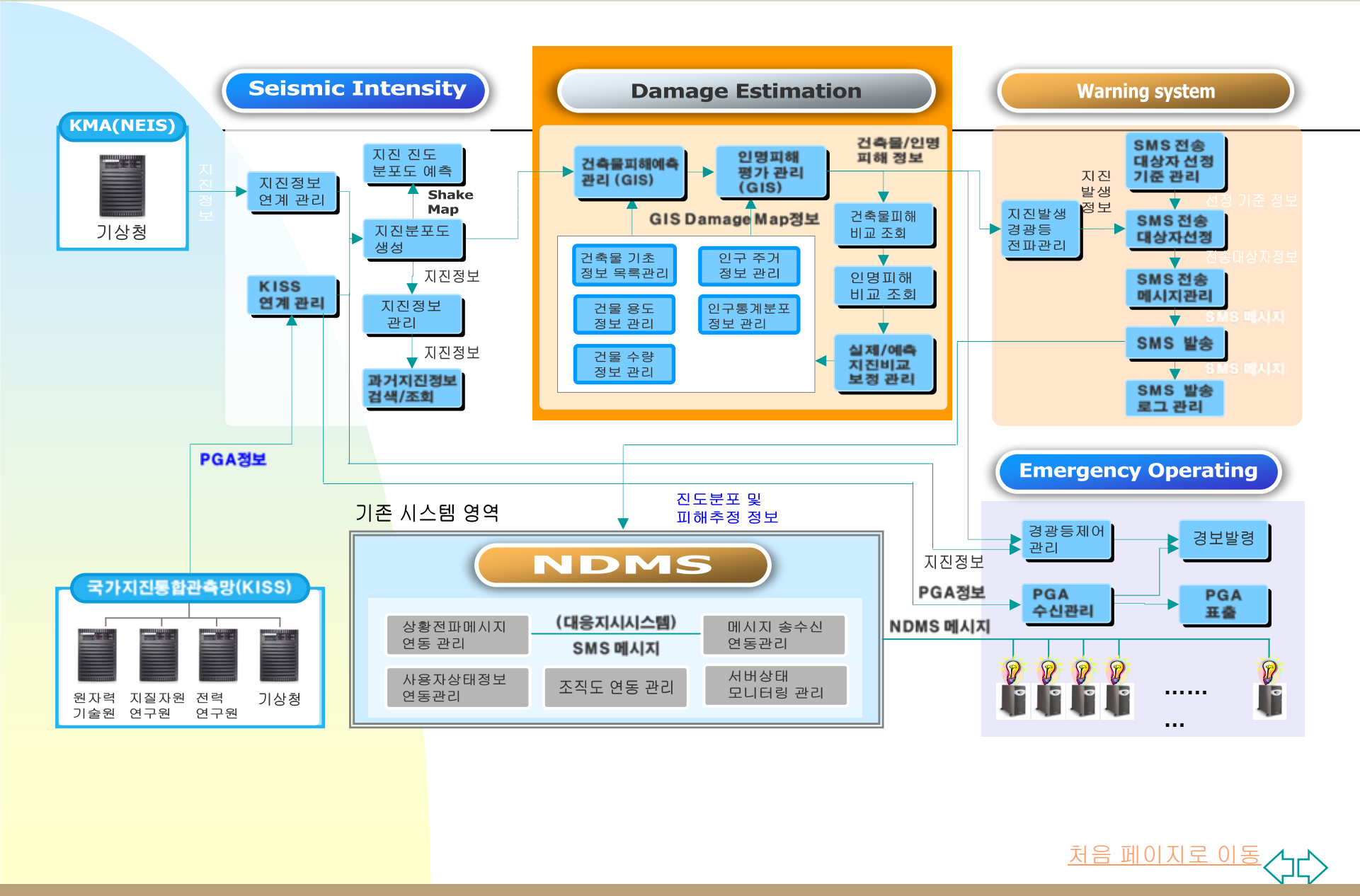
Earthquake Disaster Response System in NDMS

✓ Estimation Status



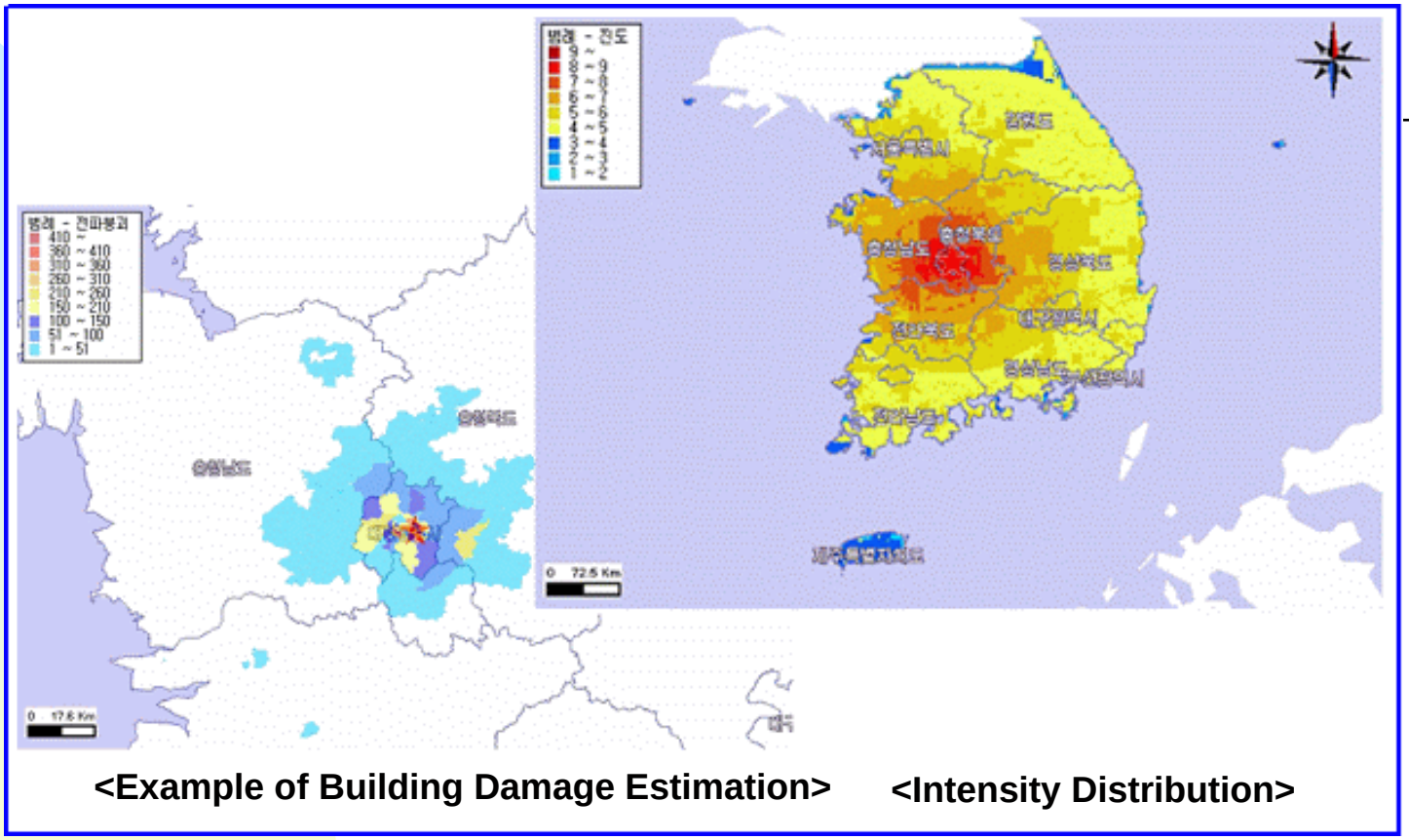
처음 페이지로 이동

Earthquake Disaster Response System in NDMS



처음 페이지로 이동

Earthquake Disaster Response System in NDMS



<Example of Building Damage Estimation> <Intensity Distribution>

The Accountability (Reliability) of the Result ?

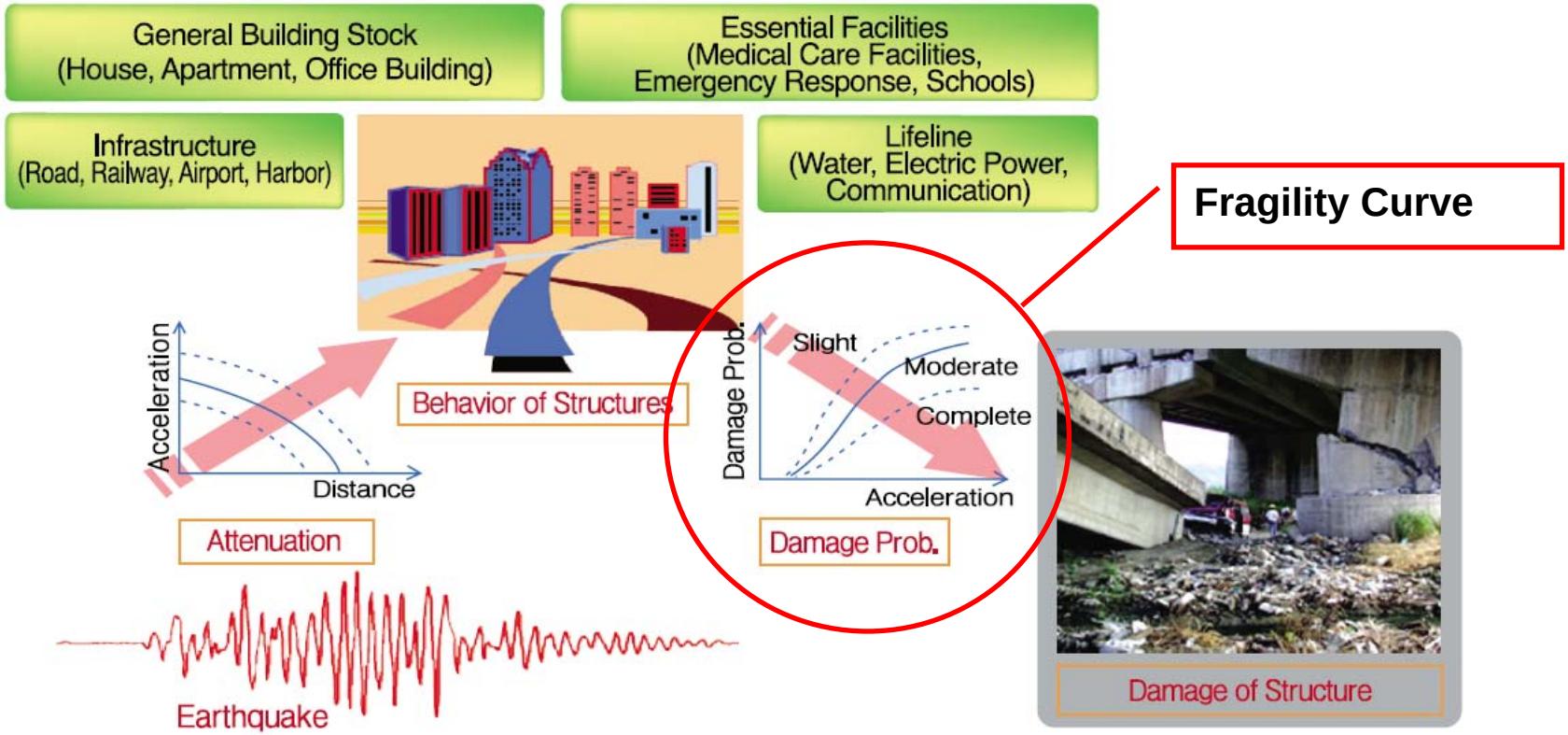
How can get the reliability ?

처음 페이지로 이동

Development of Seismic Damage Assessment Analysis

Objectives

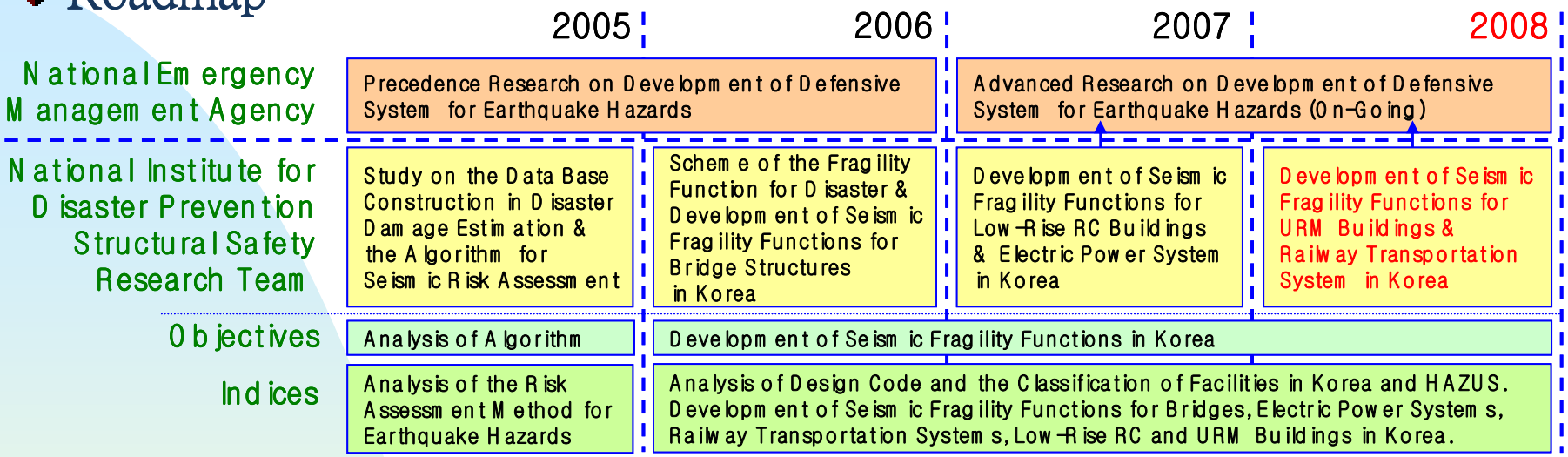
- **To estimate the structural damages of the society for effective responses and proper mitigation countermeasures in the emergency management of earthquake**
- **To develop the seismic fragility functions applicable to the structures in Korea**



처음 페이지로 이동

Development of Seismic Damage Assessment Analysis

Roadmap



Contents and Applications

- **Analyzing the algorithm of the method estimating seismic damages**
- **Strategic research for the localization of the fragility functions by analyzing the parameters**
- **Development of the fragility functions of the major kinds of structures in Korea**
- **Supporting the information on the structural vulnerability against earthquake**
- **Providing the guideline and countermeasures for maximizing the effects of the disaster mitigation efforts.**

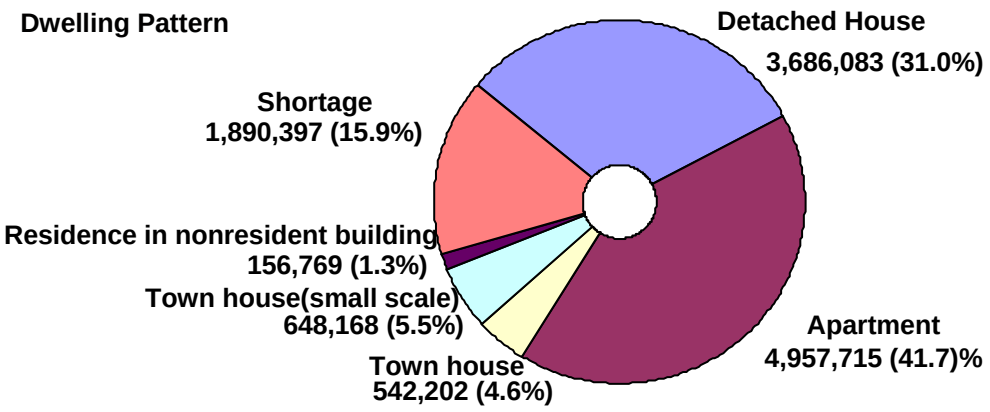
처음 페이지로 이동

Development of Seismic Damage Assessment Analysis

Development of Seismic Fragility Curves for Structures in Korea

< Structures >

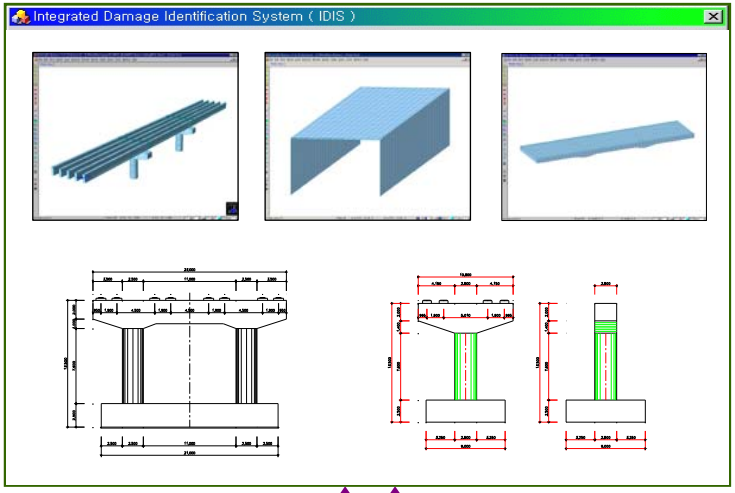
- Road Bridges (2006) with KOSHAM
- Low-rise RC buildings (2007)
- Electric Power System (2007) with KAERI
- Unreinforced Masonry Buildings (2008)
- Railway Structure (2008) with KAERI



처음 페이지로 이동

Seismic Fragility Curve of Bridge

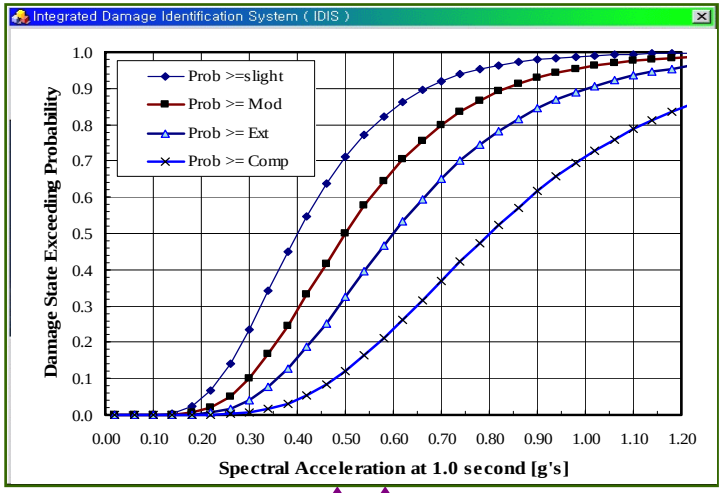
Bridges Classification



Superstructure

Substructure

Representation of Fragility Analysis Method



PGA

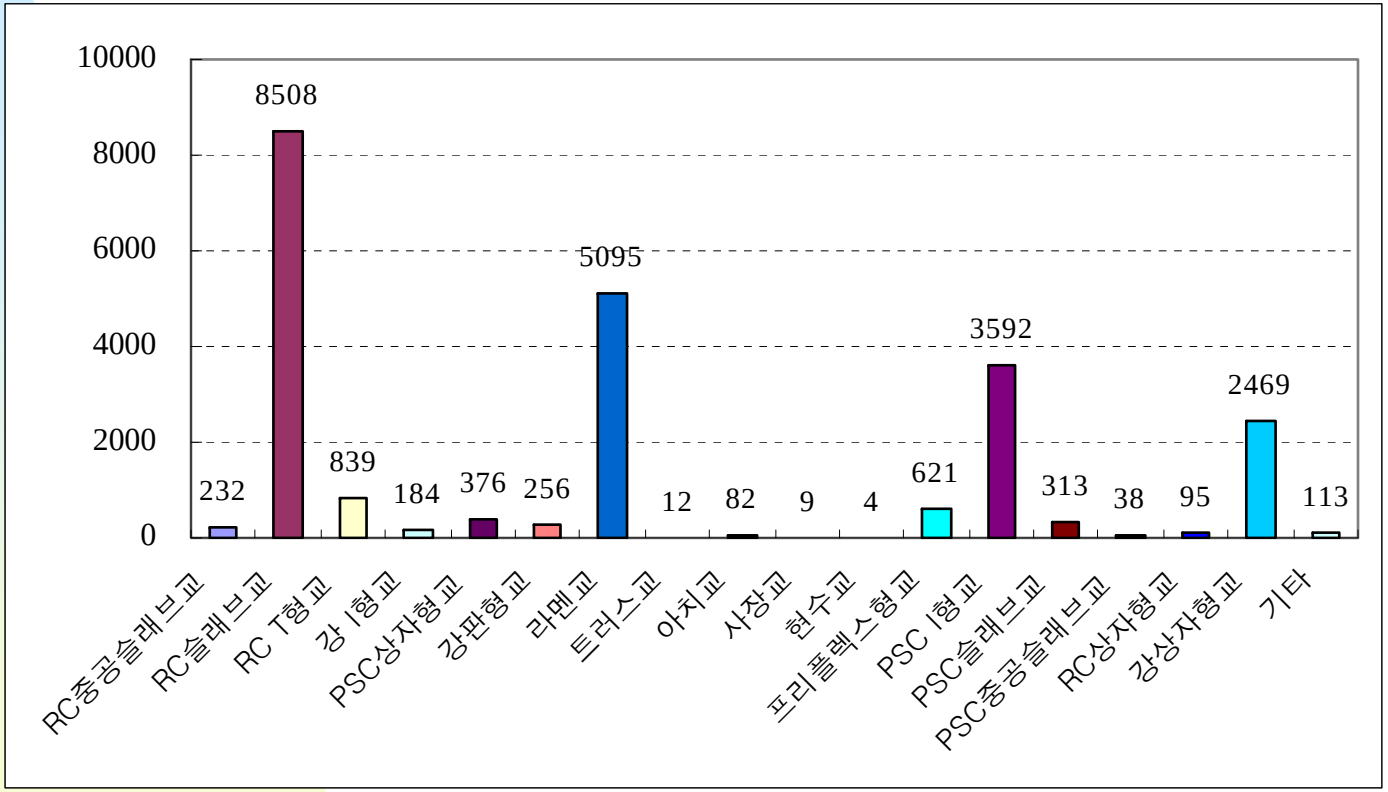
PGD

The Development of Seismic Fragility on Bridges

처음 페이지로 이동

Seismic Fragility Curve of Bridge

✓ Status of Bridges in Korea



Status by Superstructure, 2006

처음 페이지로 이동

Seismic Fragility Curve of Bridge

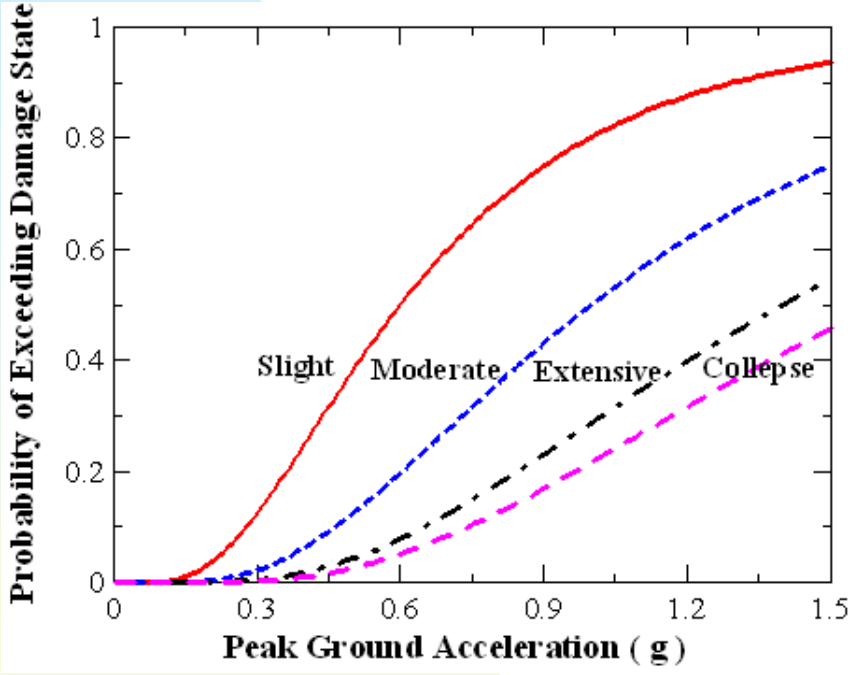
✓ Classification

Types	Super	Sub	Design	Indication
RC	RC Slab		Conventional	KHWB 01
			Seismic	KHWB 02
	RC Rahmen		Conventional	KHWB 03
			Seismic	KHWB 04
	Simple Sup.	Wall	Conventional	KHWB 05
			Seismic	KHWB 06
		Single Col.	Conventional	KHWB 07
			Seismic	KHWB 08
		Multi-Col.	Conventional	KHWB 09
			Seismic	KHWB 10
	Multi-Span	Wall	Conventional	KHWB 11
			Seismic	KHWB 12
		Single Col.	Conventional	KHWB 13
			Seismic	KHWB 14
		Multi-Col.	Conventional	KHWB 15
			Seismic	KHWB 16
PSC	PSC I Beam		Conventional	KHWB 17
			Seismic	KHWB 18
	Simple Sup.	Single Col.	Conventional	KHWB 19
			Seismic	KHWB 20
		Multi-Col.	Conventional	KHWB 21
			Seismic	KHWB 22
	Multi-Span	Single Col.	Conventional	KHWB 23
			Seismic	KHWB 24
		Multi-Col.	Conventional	KHWB 25
			Seismic	KHWB 26
Steel	Steel Box		Conventional	KHWB 27
			Seismic	KHWB 28
	Simple Sup.	Single Col.	Conventional	KHWB 29
			Seismic	KHWB 30
		Multi-Col.	Conventional	KHWB 31
			Seismic	KHWB 32
	Multi-Span	Single Col.	Conventional	KHWB 33
			Seismic	KHWB 34
		Multi-Col.	Conventional	KHWB 35
			Seismic	KHWB 36
All other Bridges				KHWB 37

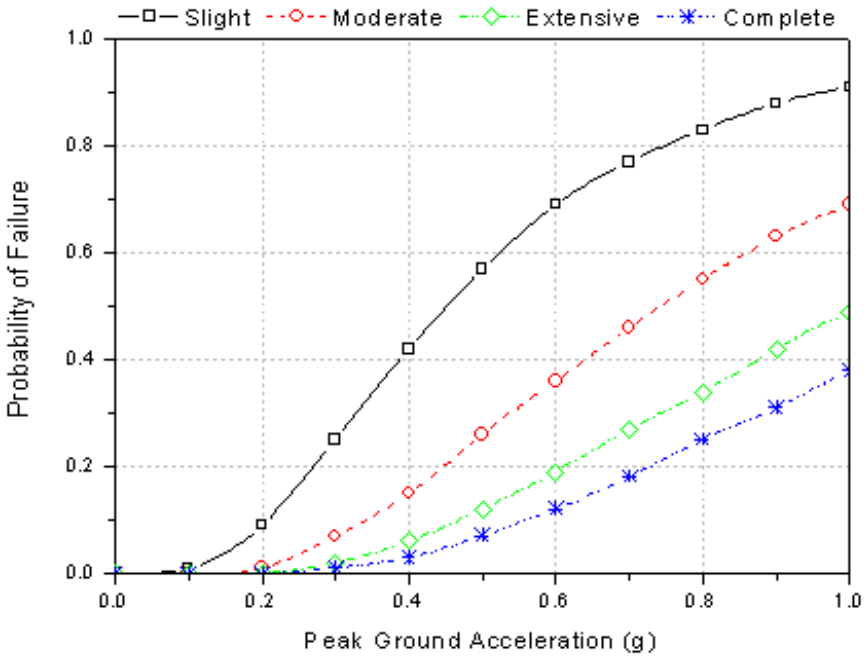
처음 페이지로 이동

Seismic Fragility Curve of Bridge

✓ Fragility Curves



PSC Box Girder Bridge



PSC Beam Girder Bridge

처음 페이지로 이동

Seismic Fragility Curve of Electric Power System

Classification of Electric Power System for Seismic Damage Evaluation

Electric System	Group	Remarks
Transmission Substation	Low Voltage Level (154kV)	154kV, 66kV, 22kV
	Medium Voltage Level (345kV)	
	High Voltage Level (756kV)	
Generation Power Plants	Hydraulic Power	Hydraulic Power, Pumped Storage
	Fossil Power	Steam Power, Internal-combustion Power
	Nuclear Power	
Distribution System	Surface System	Steal Tower, Concrete Tower
	Underground System	Underground Distribution Facility

처음 페이지로 이동

Seismic Fragility Curve of Electric Power System

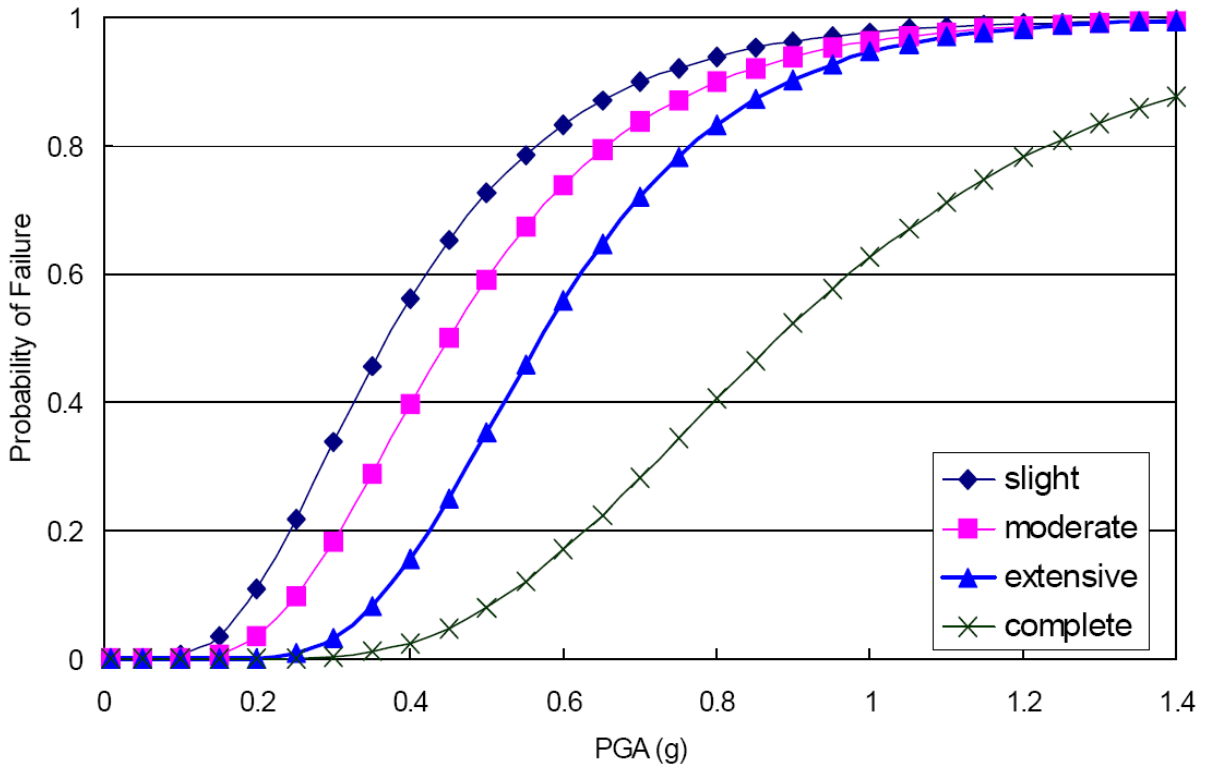
Damage State Definition for a Substation

Damage Stated	Definition	4 Bank System
Slight/Minor Damage	25% of functional damage	Failure of transformer or bushing of 1Bank
Moderate Damage	50% of functional damage	Failure of transformer or bushing of 2Bank
Extensive Damage	100% of functional damage	Failure of transformer or bushing of 4Bank
Complete Damage	Failure of all transformer Failure of all bushing	Failure of all transformer or Failure of all bushing

처음 페이지로 이동

Seismic Fragility Curve of Electric Power System

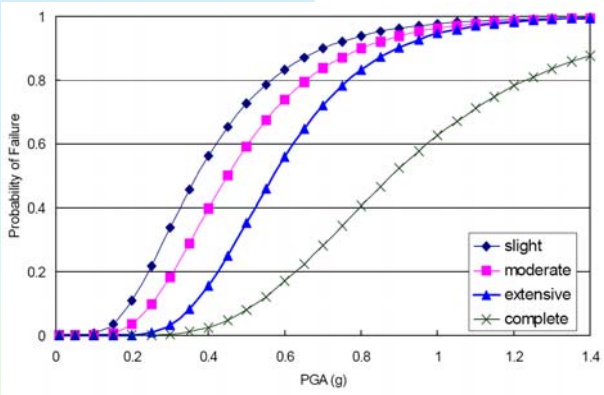
Seismic Fragility Curves for Substation System



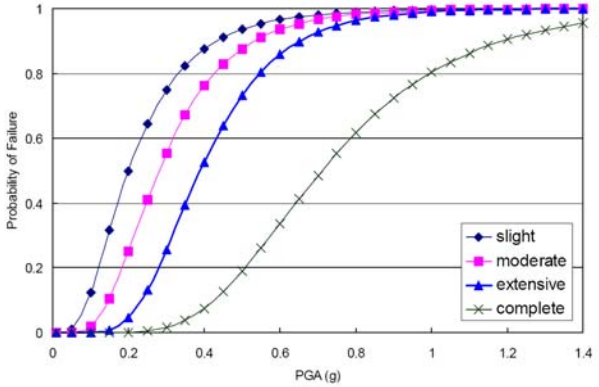
처음 페이지로 이동

Seismic Fragility Curve of Electric Power System

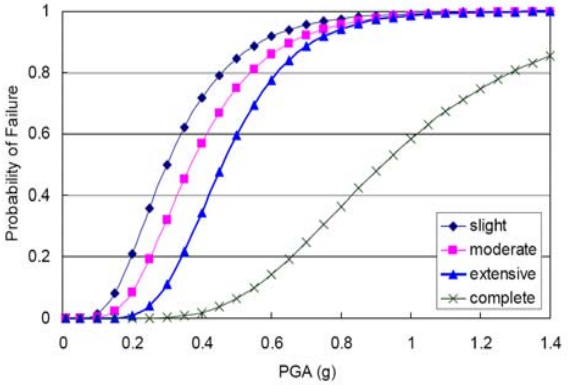
Seismic Fragility Curves for Substation System



765kV



345kV



154kV

The Accountability (Reliability) of the Result ?

How can get the reliability?

처음 페이지로 이동

Major Subject of the Earthquake Damage Assessment

- ✓ **Classification**
- ✓ **Damage Function and State**
- ✓ **Fragility Analysis**
- ✓ **Economic Value**

처음 페이지로 이동

Thank you

처음 페이지로 이동