

# Electrochemical Repair Methods for Deteriorated Concrete Structures

## Professor Takao Ueda



Fig.1 A concrete structure damaged by chloride attack

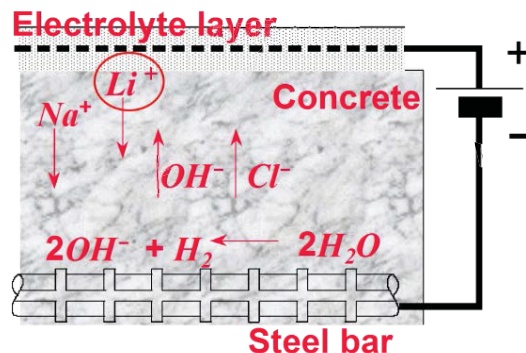


Fig.2 Principle of electrochemical repair methods

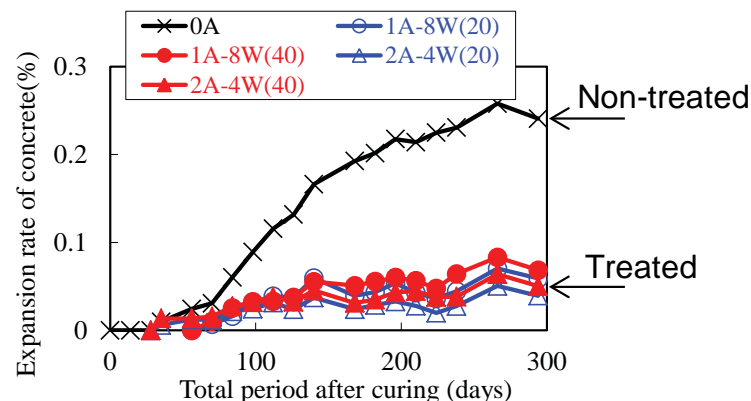


Fig.3 Suppression of concrete expansion due to applying electric current

### Content:

Reinforced concrete structures have been regarded as so excellent type of infrastructure because of their high durability guaranteed by the adequate design and construction. However, these days, a part of such structures have showed premature deterioration due to severe attack of environmental factors. Fig.1 shows an example of structures heavily damaged by the chloride attack supplied by sea water.

As the effective an repair method against steel corrosion in concrete as shown in the case of chloride attack, the electrochemical repair method has been focused. The principle of this method is shown in Fig.2. Electrochemical migration of ions in concrete or penetration of alkali solution into concrete results in improvement of the durability of structures.

Recently, our research team has tried electrochemical penetration of lithium ions which can suppress concrete expansion and cracking due to ASR. Fig.3 shows successful suppression effect achieved by the proposed electrochemical method.

Keywords : chloride attack, ASR,  
electrochemical repair methods

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# Seismic Design of Wooden Buildings

## Professor Hiroki Ogawa



Photo. Damage of the dwellings caused by the Kumamoto earthquake in Mashiki Town

Table. Change of the seismic criterion in the Building Standards Act

Year	Establishment and Revision	Main changes about the wooden building
1950	Establishment of the Building Standards Act	Establishment of the structural calculation and the wall quantity rule
1981	Revision: New seismic criterion	New rule of the structural calculation: correspondence to a big earthquake Revision of the wall quantity rule
2000	Revision: New seismic criterion 2000	layout of the structural wall Foundation depending on bearing capacity of soil Metal joint at capital and the column

### Content:

#### 1. Damage investigation of wooden buildings in the earthquake

By the Kumamoto earthquake generated in April, 2016, damage occurred in much wooden building by strong shaking with a seismic intensity of 7. Our group performed field works about the damage of the wooden buildings just after an earthquake. As a result, we confirmed heavy damage such as the collapse to buildings with the problem in a foundation and proof stress elements.

#### 2. Method of the seismic design of wooden buildings

In the case of a general wooden buildings by the conventional method of construction of 2 stories, a the simple structural design method is adopted by specification code in the Building Standards Act.

- (1) Foundation depending on bearing capacity of soil
- (2) Quantity and layout of the structural wall
- (3) Metal joint at capital and the column base by the position of the column

Keywords : Architectural planning

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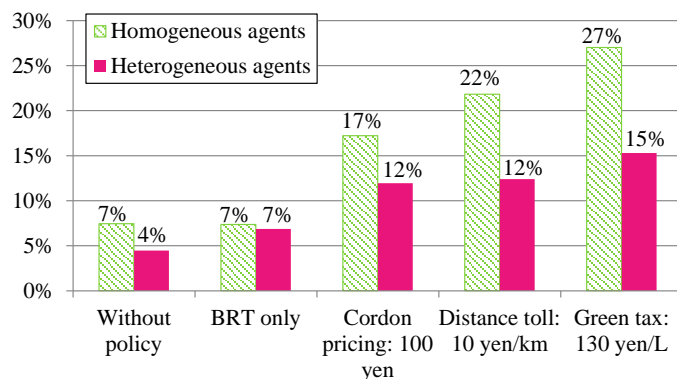
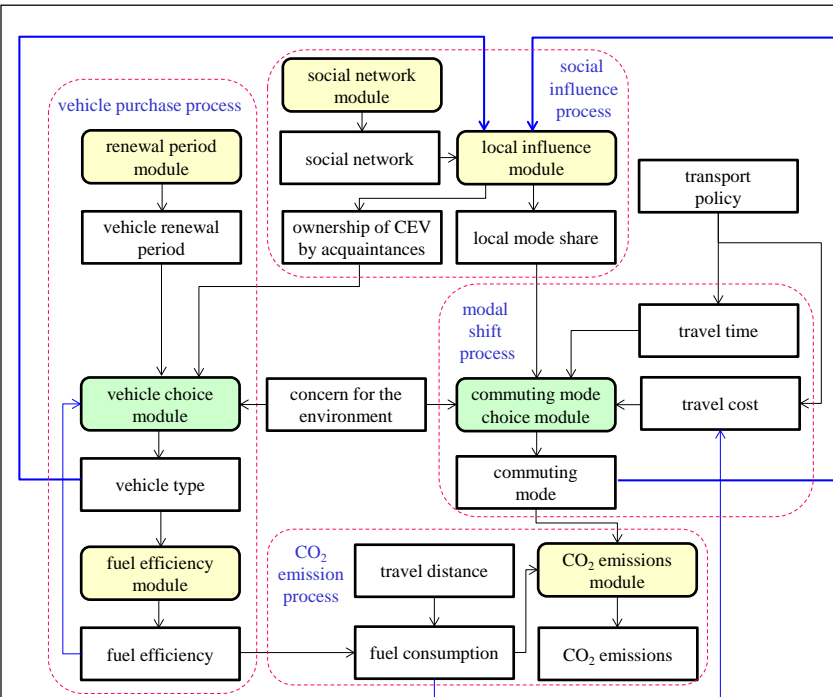
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# Simulating Social Influences on Sustainable Mobility Shifts

## Professor Masashi Okushima



### Content:

The research question is how much do heterogeneity and local interaction influence mobility shift with the policy for sustainable transport. A multi-agent mobility shift simulation model that considers heterogeneity and local interaction is developed. For this purpose, the stated preference (SP) for mode change and purchase CEV policies is investigated via a questionnaire survey. The proposed multi-agent simulation model includes the decision process of the agent regarding mobility shift, the social influence process in the social network, and the CO<sub>2</sub> emission process. The decision process for commuting mode is modeled using the hierarchical Bayesian method mainly to describe the heterogeneity of the influence of the local mode share. The day-to-day dynamics of commuting mode choice and the purchase of CEVs corresponding to the transport policy are estimated using the proposed multi-agent simulation model.

The results confirm that the heterogeneity of influence on social conformity should be considered in the modeling of modal shift as both conformity effects and non-conformity effects are observed. However, the assumption of homogeneous commuters might cause estimates that are too high, since the heterogeneity of commuters decreases the share of the sustainable transport mode. Furthermore, the green tax policy is confirmed to be suitable for maximizing the reduction rate of CO<sub>2</sub> emissions, as pricing based on fuel consumption maximizes reduction efficiency.

**Keywords :** local interaction, mode choice, hierarchical Bayesian modeling, multi-agent simulation, pricing policy

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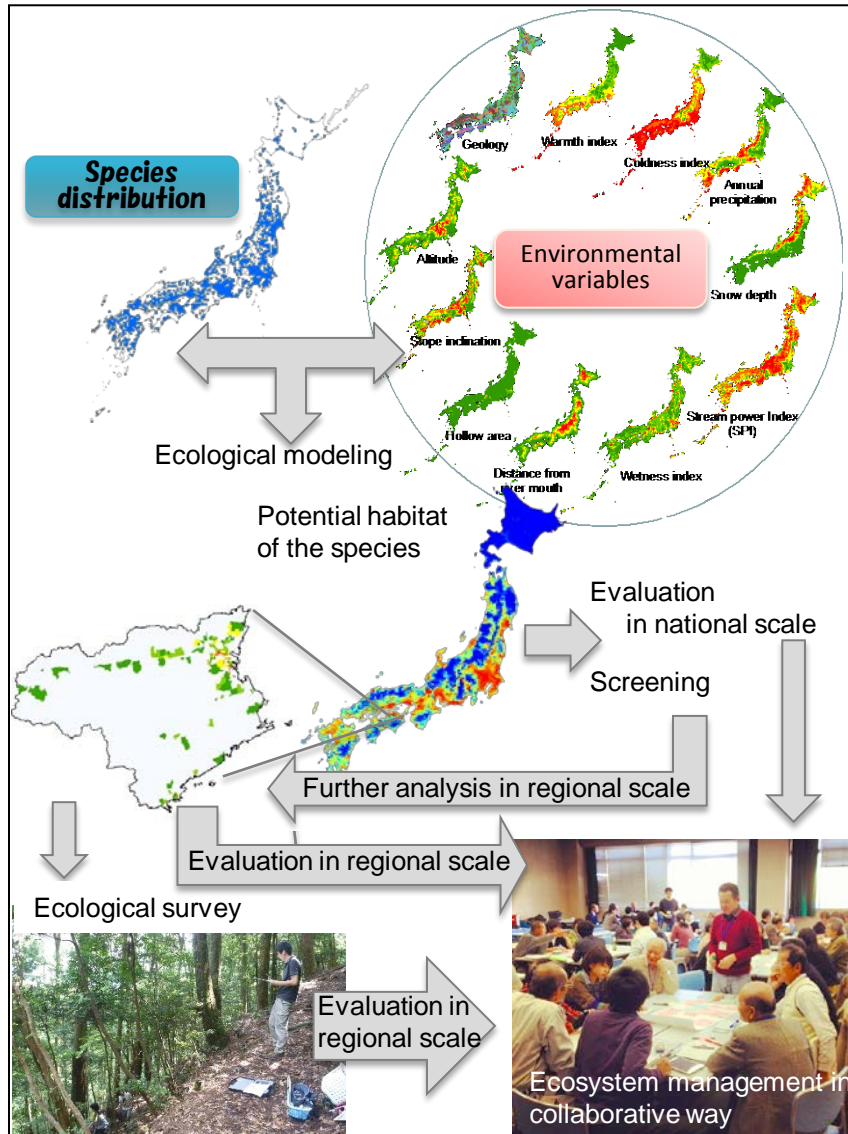
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# Spatial evaluation and planning for ecosystem management

## Professor, Mahito KAMADA



### Content:

1. Evaluation and planning of ecosystems based on estimation of potential species distribution
  - National scale
  - Regional scale
2. Ecological survey in various ecosystems designing the method of conservation and restoration of ecosystems as regional resources
  - Forest (Natural, semi-natural, artificial, bamboo)
  - Grassland
  - Agricultural area (Paddy field and irrigation channel)
  - River
  - Wetland
  - Mangrove swamp, etc.
3. Way of collaboration for ecosystem management
  - Network of human resources
  - Management of collaborative process

Keywords : Ecosystem Management, Landscape Ecology

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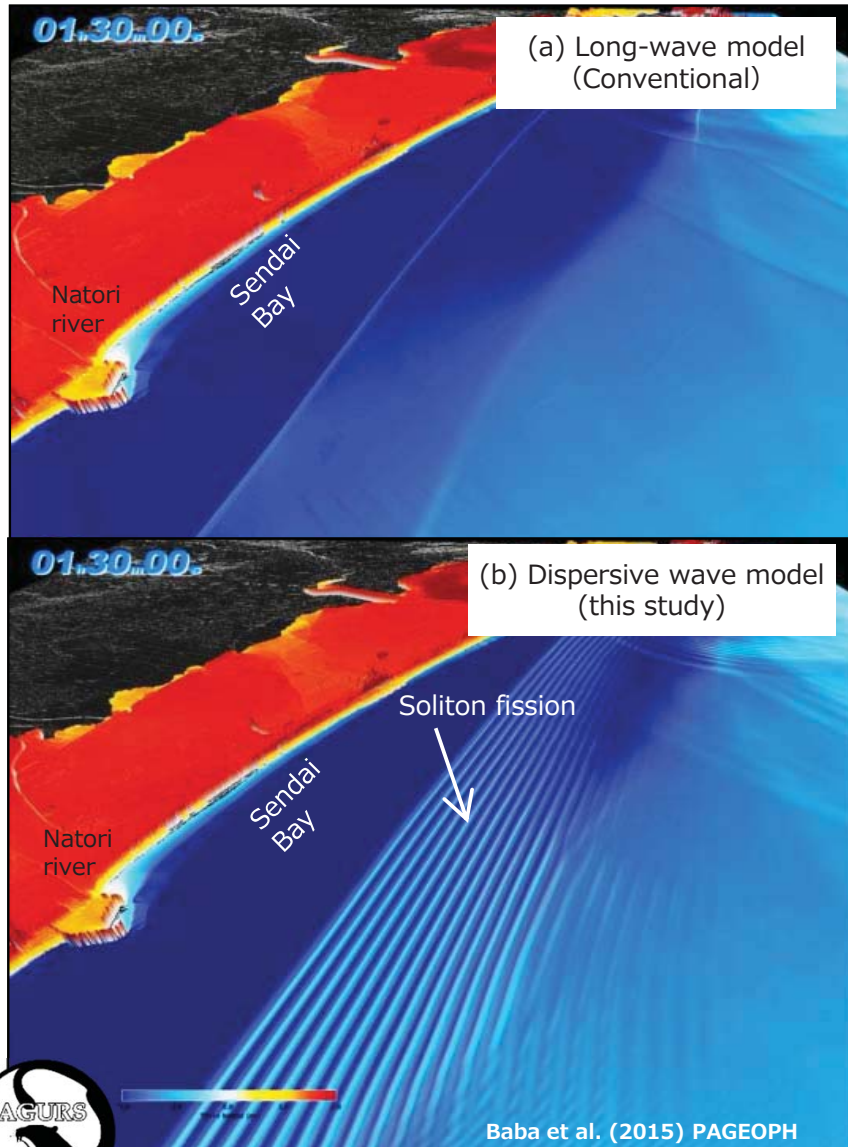




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# Accurate and High-speed Tsunami Simulation

Professor Toshitaka Baba



Sea-surface fluctuations near the Sendai coast 90 minutes after the earthquake occurred simulated with (a) the nonlinear long-wave equations and (b) the nonlinear dispersive wave equations.

A great subduction zone earthquake could occur along the Nankai trough accompanied by a great tsunami. It may cause a severe disaster such as that we have been experienced in the 2011 Tohoku earthquake. In order to mitigate the tsunami damage, physical behavior of tsunami should be investigated by a broad field of study.

We develop an accurate and high-speed tsunami simulation software called JAGURS which was optimized very much on high-performance parallel computers such as the K computer and the Earth Simulator in Japan. JAGURS is not only high-speed, but also more accurate than the conventional tsunami software. The figures are sea-surface fluctuations simulated with (a) the long-wave equations and (b) the dispersive wave equations near the Sendai coast 90 minutes after the 2011 Tohoku earthquake. We can see dispersive wave trains (soliton fissions) in (b) but not in (a). Actually, in the area, the soliton fissions were recorded from a helicopter. We also investigate a real time tsunami prediction system by a combination of high-speed calculation and cutting-edge seafloor tsunami observation networks.

Keywords : Tsunami, Numerical simulation,  
Nankai subduction zone

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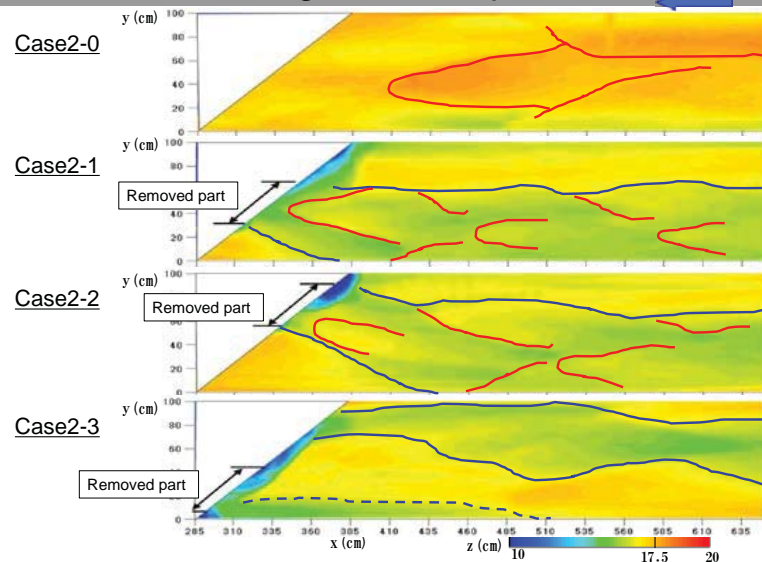


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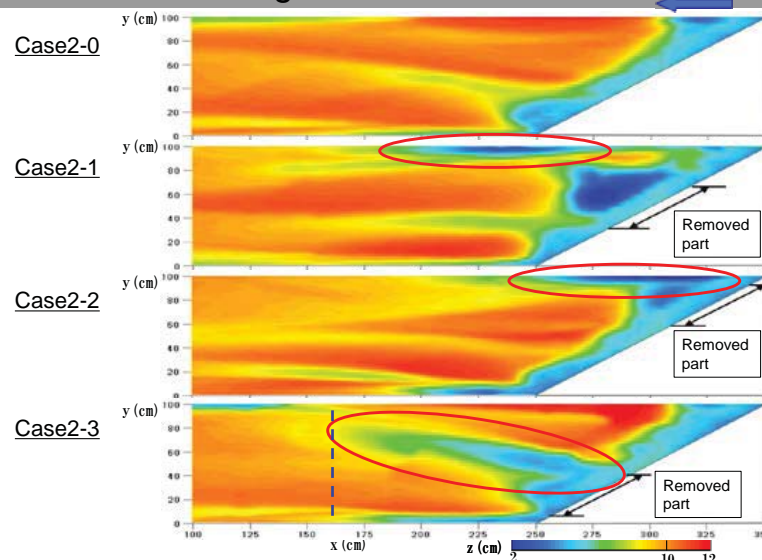
# Bed Evolution Around Partially Removed Falling Works

Professor MUTO, Yasunori

Bed configurations: Upstream



Bed configurations: Downstream



## Content:

Dams and falling works usually contribute river bed stabilisation, but they at the same time bring some defects on river environments, such as yielding a still water section, depositing sediments there, and preventing fish migrations. Several engineering schemes can be considered to improve such a situation, i.e. full removal, height reduction, redesigning such as slit-type, etc. These schemes, however, naturally cause bed degradation in the upstream reach and abrupt increase of sediment supply in the downstream reach, then it possibly leads to channel instability. Owing to the lack of information on river bed change following dam removal or falling works improvement, these schemes have not widely adopted in real rivers.

A series of experiments were conducted to study effects of falling works improvement on scouring and bed evolution around it. Water surface profiles, velocity distributions and bed configurations at an equilibrium condition were measured.

Keywords : Falling works, Partial removal,  
Experiment, Bed evolution,  
Velocity distribution  
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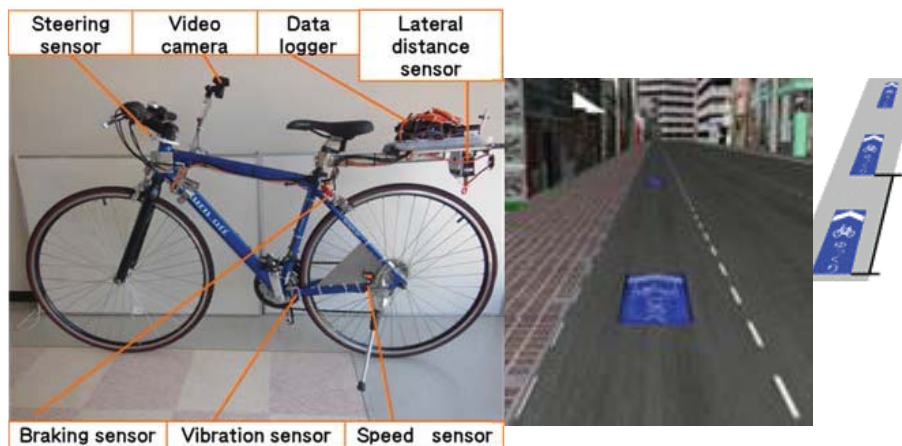
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# Analysis Systems for Bicycle Behavior and Safety Facilities

## Professor Hideo Yamanaka



Cooperated bicycle/driving simulator



Probe Bicycle

Repeated colour sign system

### Content:

Japan is one of the top bicycle friendly countries as the transport mode for urban areas. It is not so safe for bicycles to riding on sidewalks on both directions. Studies on bicycles are not enough comparing with that on motor vehicles. Our study aims to make clear the effects by road design, signs, warning system for bicycle safety by developing the following methods for analyzing their behavior.

1) Bicycle simulator with wide visions : We analyze effects by warning system and road markings in order to decrease bicycle intersection accidents. Cooperated bicycling and driving simulator system is also developed for the analysis of conflicts in junctions

2) Probe bicycle: It can measure speed, braking, steering, vibration, and overtaking speed and lateral distance of vehicle aside automatically in order to evaluate level of service for bicycles.

3) Eye movement analysis system : By using Eye-mark recorder (EMR-9) which can measure eye movement during cycling, we analyze the effects on gaze behavior by the factors such as old people, junctions, bus stop, night time and so on.

Keywords : Road design, Bicycle facilities, Traffic safety

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# Non-Destructive Testing for Concrete Structure

## Professor Takeshi, Watanabe

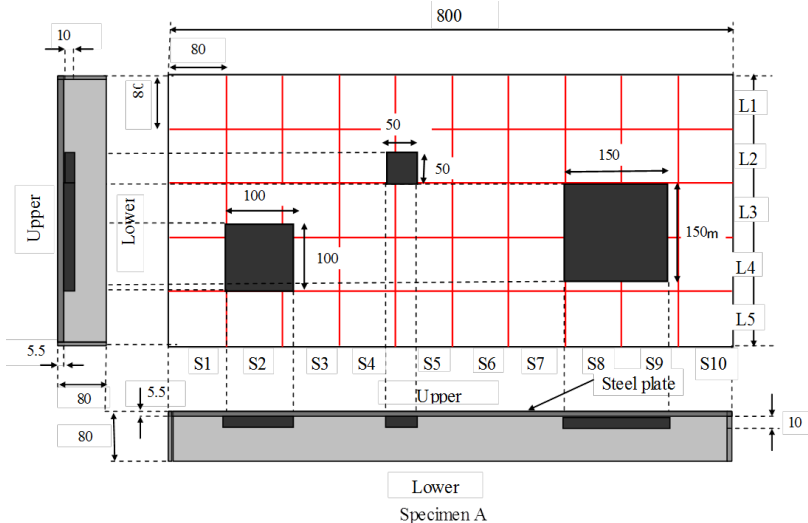


Fig.1 Specimen of steel-concrete composite

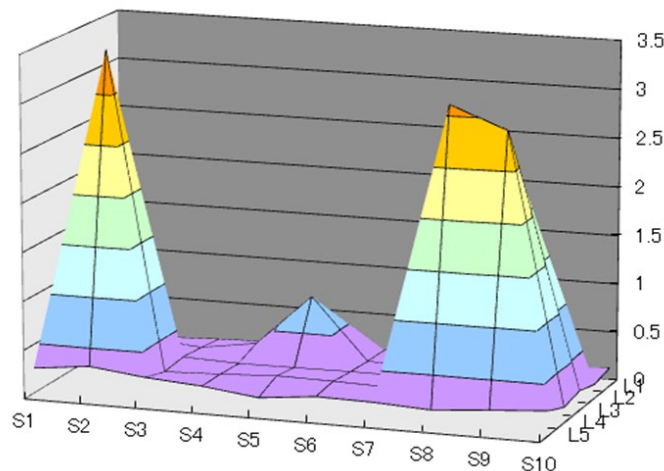


Fig.2 Visualization of defect in the specimen

### Content:

Maintenance of concrete structure is important for civil engineering. Non-destructive test is powerful tool to identify defect and damage of structure. In addition, there are increasing hybrid structure and repaired structure. Non-destructive test is expected to evaluate condition of the structures.

Recently, recycle concrete and self-healing concrete are studied. For clarifying quality of these concrete, we try to use nondestructive method.

Our laboratory results are shown as follow,

- PC grout condition
- Detection of defect in steel-concrete composite by Impact test
- Check rebar corrosion condition by UT
- Evaluation of self-healing effect of fly-ash concrete by UT

Keywords: <Concrete, NDT, By-product, Durability >

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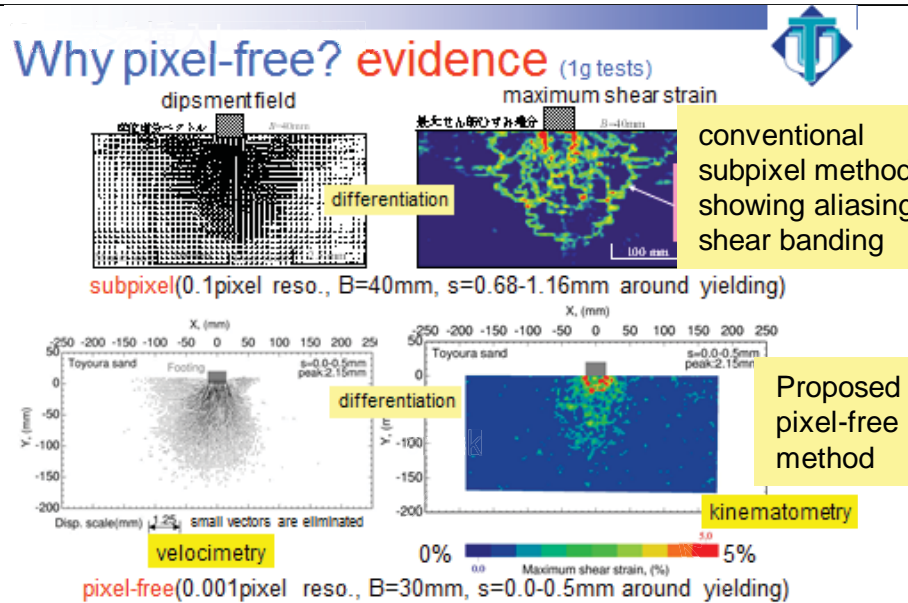




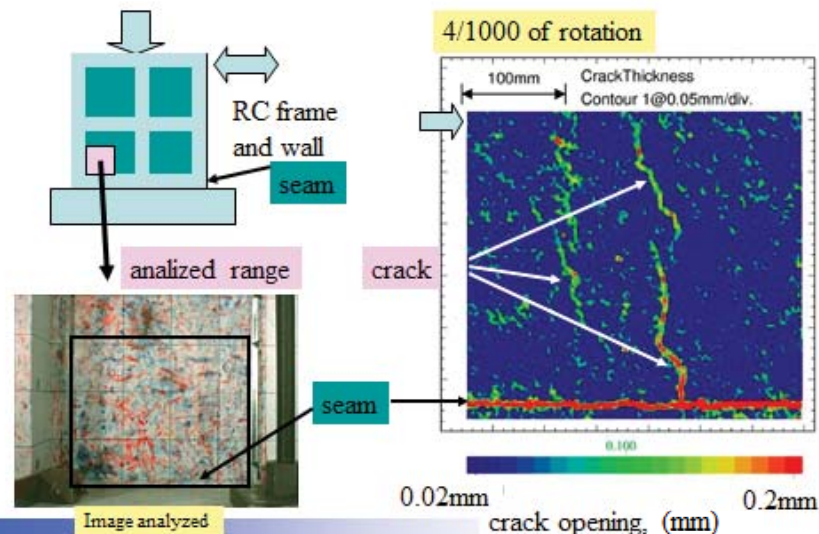
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# Surface Kinematometry by Pixel-free Image Processing for Geotechnical Model Tests

Assoc. Prof. Katsutoshi Ueno



## Crack opening due to cyclic combined loading



Kinematometry is a newly coined word, which means a method to obtain kinematic information, i.e., movement and deformation, especially strains of geotechnical objects. A new precise matching algorithm was developed. The algorithm provides completed pixel-free measurements, which can eliminate accumulation of errors produced in successive photometry analysis. Errors in strain calculation arising from the discrete structure of conventional raster image data are also avoided by means of this pixel-free algorithm having a 0.001 pixel of resolution.

Accuracy of the algorithm was examined by using both artificially deformed images and actually translated images. The results showed that the errors were less than 0.2 pixels for artificially deformed images within 20% of strain, while 0.05 pixels for translated images.

Figures presented here are examples of the applications: shear banding under strip footing and crack opening in reinforced concrete structures subjected combined cyclic loading.

K. Ueno et al. (2014): Surface kinematometry by image processing for geotechnical model tests, Physical Modelling in Geotechnics, Vol. 1, pp. 337-343, CRC Press.

Keywords: deformation and failure characteristics of soil, kinematometry  
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# A study on evacuation planning for the elderly and disabled facilities

Associate professor

Junko Kanai



Sendai  
Airport



Fig.1 Elderly facility broken by the tsunami of March 11, 2011

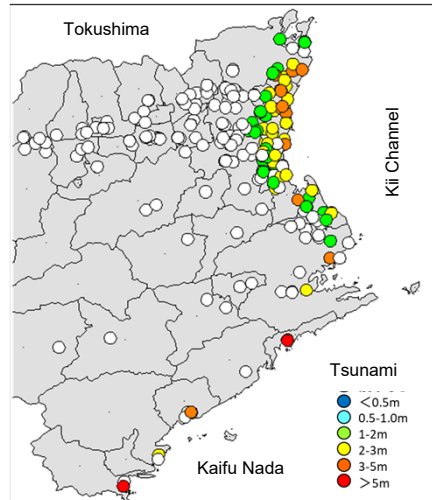


Fig.2 Tsunami risk of elderly facilities in Tokushima

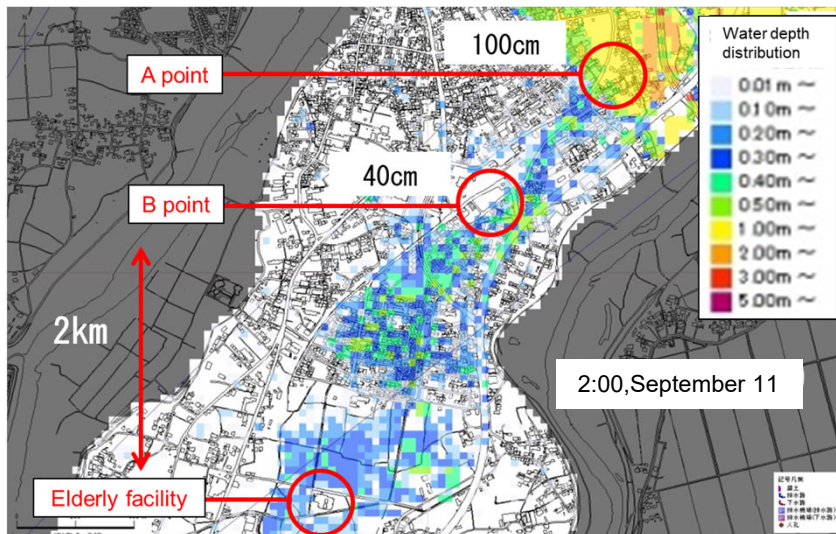


Fig.3 Estimation of evacuation judgment by Kinu River flood analysis

## (1) Purpose

We propose a method to improve the effectiveness of the evacuation plan at facilities, in order to reduce the delay of the elderly and the disabled.

## (2) Research target

- Facilities for the elderly and disabled, affected by past earthquakes, tsunamis, and floods, Child welfare facilities, schools, etc.

## (3) Method

- Behavior analysis by interview survey
- Analysis of damage situation by site reconnaissance and flood analysis
- Analysis of current situation of questionnaire survey

## (4) Research Papers

- The location characteristics of the social welfare facilities in Tokushima and the present condition of tsunami disaster measures
- Appropriate decision method of evacuation judgment at flood in welfare facilities for the elderly
- Evacuation Behavior of Facilities for the Elderly in the Heavy Rain of July 2018

Keywords: < elderly , disabled , evacuation plan >

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# A METHOD FOR ESTABLISHING STAGE-DISCHARGE RATING CURVE USING RAINFALL, WATER LEVEL DATA AND RUNOFF MODEL

Associate professor Takao Tamura

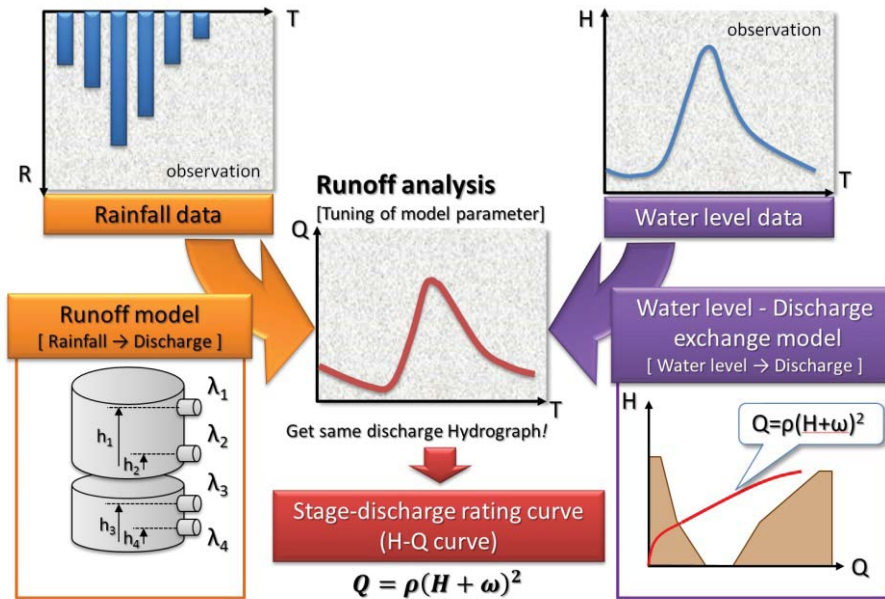


Fig.1 Method of making H-Q curve by using runoff model, rainfall data, and water level data

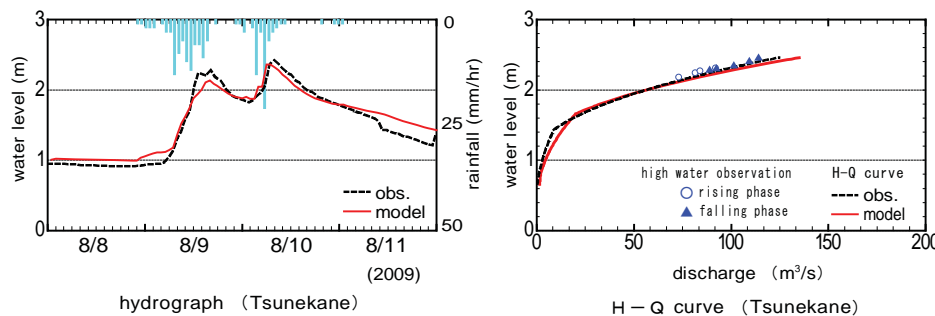


Fig.2 Comparison between H-Q curve made from runoff model and observed flow rate

## Content:

Making stage-discharge curve (H-Q curve) that uses calculating river flow rate is very time-consuming. Then, a H-Q curve making method that used the observed rainfall, the water level data, and the runoff model was developed. A quadratic function that represented the  $H$ - $Q$  relation in the river channel was built into the runoff model. When the observed water level hydrographs during a flood event was reproduced by the model, the H-Q curve was established. (Fig.1)

The method was applied to some water level and flowing quantity observation stations in Shikoku in West Japan. The established H-Q curve was compared with the H-Q curve based on the runoff observation. The error margin of the established H-Q curve and the observed was about 10% or less. (Fig.2)

The proposed method can be used to verify and adjust the observed H-Q curve that may lead to an unsatisfied water budget of rainfall and discharge for the basin.

**Keywords:** stage-discharge curve(H-Q curve), runoff model, rainfall data, water level data, water budget

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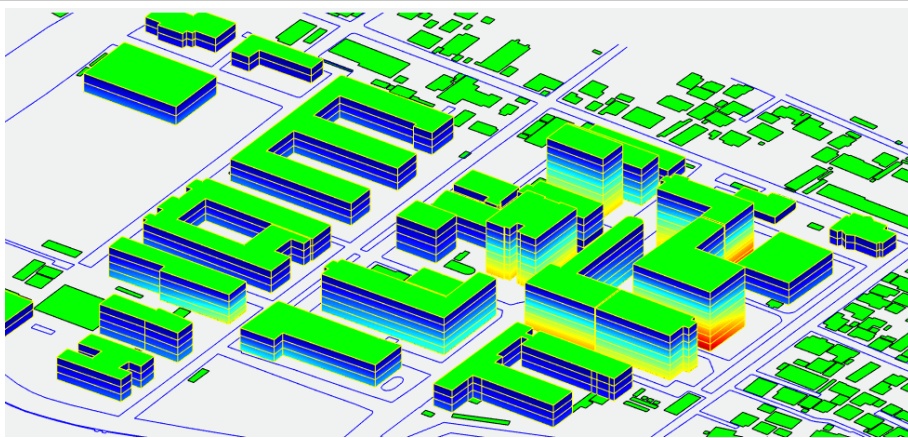




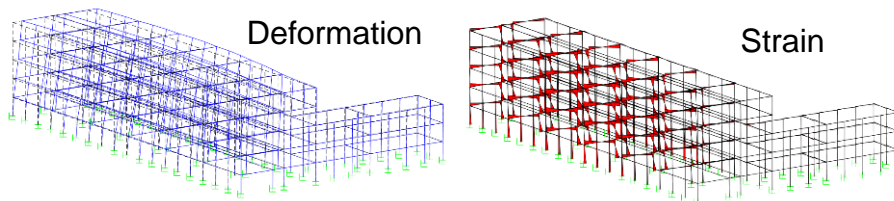
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# Structural Response Simulation for Earthquake and Tsunami

## Associate Professor Narutoshi Nakata



Regional Earthquake Simulation (Tokushima University)



3D Detailed Earthquake Simulation (Civil Eng. Building)



Seismometer on a  
Single-Board  
Processor



Structural Testing in Hybrid  
Simulation

### Content:

My research activities are directed toward disaster mitigation with a primary focus on development of structural simulation techniques and emergency disaster information system. Currently, I am working on the integration of seismological network and regional earthquake simulation that can provide prompt estimates and assessment of structural conditions after earthquakes and tsunamis.

### Ongoing research projects include:

- Development of GIS-based structural modeling techniques that enable modeling of large number of structures and regional earthquake simulation
- Visualization techniques for structural damage and conditions in high-fidelity simulation
- Development of seismological network using single-board processor like raspberry pi
- Hybrid simulation techniques that combine numerical simulation and experimental study

Keywords : Earthquake Engineering,  
Structural Dynamics

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# Analysis Methods for Japanese construction company's Bidding-Strategy

## Associate Professor Susumu Namerikawa

### 1) 36 factor keywords and an example of the analysis

	日本 (2010)	米国 (論文1, 1988)	英国 (論文2, 1993)
a. 工事の種類	Type of job	Project type	Project type
b. 工事の場所	Location of project	Project location	Project location
c. 工事の難易度	Degree of difficulty	Risk involved owing to the nature of the work	Risk involved owing to the nature of the work
d. 工事の規模	Size of job	Project duration	Project duration
e. 材料・機材費の変動リスク	Type and no. of equipment required available	Risk in fluctuation in material prices	Risk in fluctuation in material prices
f. 設計・積算の完成度	Designer(AE)/Design quality	Completeness of the documents	Completeness of the documents
g. 工事の支払い条件	Project cash flow	Project cash flow	Project cash flow
h. 工率・アップの確保	Rate of return	Rate of return	Rate of return
i. 対象工事の魅力	Need for work	Need for work	Need for work
j. 発注者の評判	Owner	Owner/promoter client identity	Owner/promoter client identity
k. 契約の種類	—	Type of contract	Type of contract
l. 入札の準備期間	Duration	Tendering method (selective, open)	Tendering method (selective, open)
m. 入札の時期	Time of bidding (season)	Tendering duration	Tendering duration
n. 入札のリスク	Degree of hazard	—	—
o. 競争相手の数	—	Number of competitors tendering	Number of competitors tendering
p. 競争相手の競争性	Competition	Competitiveness of competitors	Competitiveness of competitors
q. 当該工種の過去の実績	Your strength in the industry	Experience in such projects	Experience in such projects
r. 現在の市場全体の発注量	Overall economy (availability of work)	—	—
s. 現場労働者の雇用条件	Labors environment (union, non-union, cooperative)	Availability of labour	Availability of labour
t. 下請けの仕様の必要性	Portion of work to be subcontracted	Portion subcontracted to nominated subcontractor	Portion subcontracted to nominated subcontractor
u. 下請け確保の可能性	Reliability of subcontractors	—	—
v. 会社の経営状況、財政目録	—	—	—
w. 手付・持ち手・工事量	current workload	Current work load	Current work load
x. 企業費用見越りの確実性	Uncertainty in the estimate	Reliability of company cost estimate	Reliability of company cost estimate
y. 資格保有職員のタイプと数	Type and number of supervisory persons required available	Availability of qualified staff	Availability of qualified staff
z. 通関手・配管予定技師者の確保可能性	—	Type and number of supervisory persons available	Type and number of supervisory persons available
aa. 配管予定技師者の確保可能性	General overhead	General (office overhead)	General (office overhead)
ab. 一般管理費等の確保	Capital requirement/availability	—	—
ac. 資金調達	—	—	—
ad. 経理・経費	—	—	—
ae. 発注者履歴と自社履歴の乖離	—	—	—
af. 標準・数学的モデル	—	—	—

### 2) An example of the statistical analysis of the bidding data

Dependent Variable: log(predetermined) n=8344										
Method: Least Squares										
	Standardizing Coefficient	t	p value	Collinearity-related statistic		Standardizing Coefficient	t	p value	Collinearity-related statistic	
	$\beta$			Tolerance	VIF	$\beta$			Tolerance	VIF
C		10.620	0.0000 ***				10.842	0.0000 ***		
log(WIN)	0.988	539.941	0.0000 ***	0.996	1.004	0.988	540.518	0.0000 ***	0.996	1.004
PARTICIPAN	0.048	26.283	0.0000 ***	0.998	1.002					
PRE_PARTICIPANTS						0.051	27.966	0.0000 ***	0.995	1.005
UNIT x 2007	-0.002	-0.844	0.3988	0.994	1.007	0.000	-0.057	0.9547	0.994	1.007
UNIT x 2008	-0.003	-1.641	0.1009	0.992	1.008	-0.002	-0.974	0.3301	0.990	1.010
UNIT x 2009	-0.004	-2.107	0.0352 **	0.993	1.007	-0.005	-2.680	0.0074 **	0.993	1.007
UNIT x 2010	-0.005	-2.811	0.0050 ***	0.994	1.006	-0.007	-3.588	0.0003 ***	0.993	1.007
R			0.9874					0.9877		
R-squared			0.9749					0.9755		
Adjusted R-squared			0.9749					0.9755		
S.E. of regression			0.0301					0.0296		
Durbin-Watson test			1.5656					1.5755		

### 3) An example of Multi-Agent Simulation: MAS result



### Content:

Public procurement system such as Overall-Evaluation dynamically has been changed on public works in Japan. However some characteristics of Bidding-Strategy and procurement system have not enough clarified.

We analyze the influence that the change of the public procurement system gives to the Bidding-Strategy of the construction company.

1) Question paper survey of Japanese construction company's bidding behaviors : In order to know the consciousness of Japanese construction company's bidding behaviors, a question paper survey is conducted which is similar to three previous experiential study papers of U.S. and U.K. The questionnaires are made to unique to Japanese domestic circumstances. The main questionnaire is the importance evaluation to 36 factor keywords in two situations: one is for the determination of participation in and, another is the price determination (percent markup) for the bid.

2) Monitoring bidding data : In this study, we try to monitoring bidding data between accumulated estimation method and the unit price estimation method. The bidding data were special period. It has two patterns to method of calculating predetermined. As a result, in the case of accumulated estimation method increase participants and decrease win bit rate. The other way around, decrease participants and increase win bit rate. So we make a revolve equation to method of calculating an estimate price and check the effect of the unit price estimation method. We showed that the unit price estimation method has effect of decrease predetermined.

3) Simulation model focused on Biding-Strategy: This study attempt to analysis for a system dynamics and mechanism of Overall-Evaluation by developing new simulation model focused on Biding-Strategy, to propose some improvement scenario.

Keywords : Public procurement, Bidding-Strategy, bidding data

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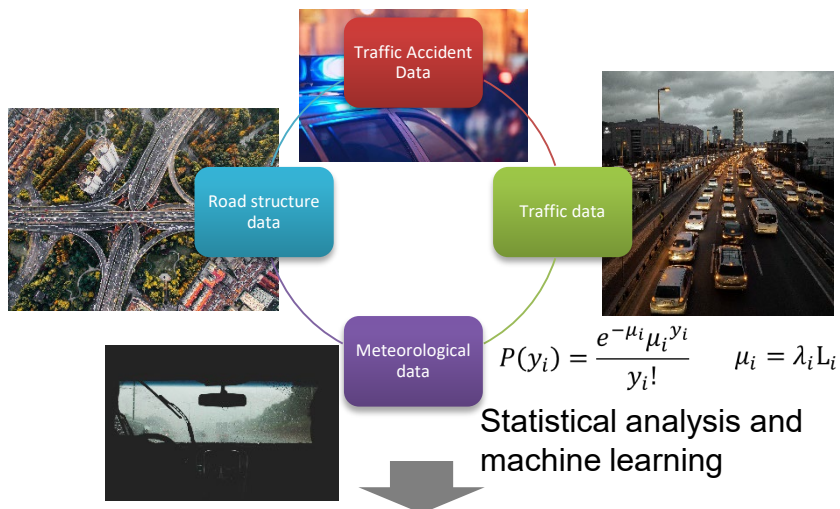
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# <Research aimed at solving urban and regional transportation issues by utilizing a variety of transportation data>

<Associate professor> <Satoshi HYODO>

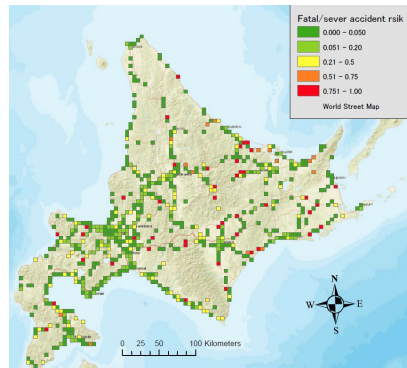
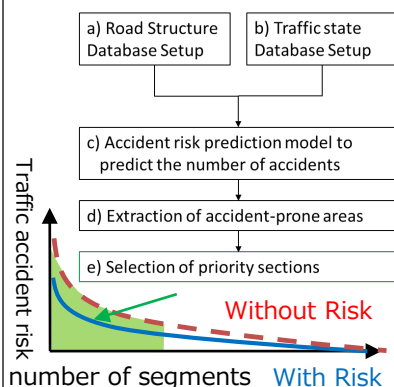
## Research : Research on traffic accident risk

Analyze the risk of traffic accidents by utilizing various observation data



○ Used to determine priorities and evaluate countermeasures

○ Example of visualization of estimated traffic accident risk by GIS



## <Research Summary>

In cities and regions, there are various traffic problems and issues such as traffic congestion and traffic accidents.

Our laboratory is conducting research on transportation behavior for transportation planning and policy making, research on theory building for design, operation, and control to realize smooth and safe transportation services, research on disaster transportation management, and research on how to improve regional transportation service levels by utilizing various types of transportation data. We are also conducting research on disaster traffic management and on how to improve regional traffic service standards.

Specifically, based on approaches such as machine learning and statistical analysis, we are working on research themes such as clarifying the actual situation of traffic accident risks and understanding traffic phenomena using various traffic observation data such as vehicle detector data, probe data, traffic accident data, and people flow data.

## Research Theme:

- Research on traffic safety and traffic accident risk
- Research on traffic phenomena
- Research on traffic behavior for traffic planning and traffic policy making
- Research on disaster traffic management

Keywords : <Traffic safety, traffic data, traffic accident risk>

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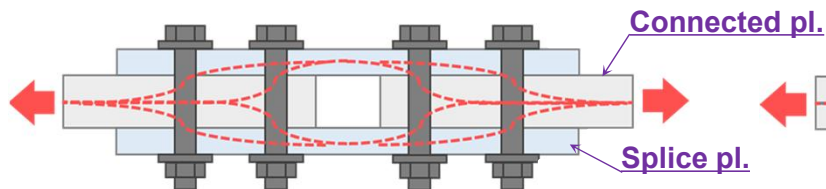
Faculty of  
Science and  
Technology  
Tokushima University

# Repair of corroded steel members with Bolted Doubler Plates

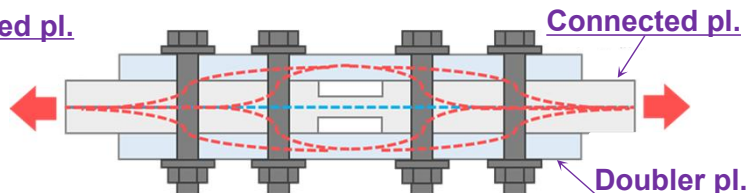
[Steel Structures, High-strength  
Bolted Connections, Repair]

Associate professor

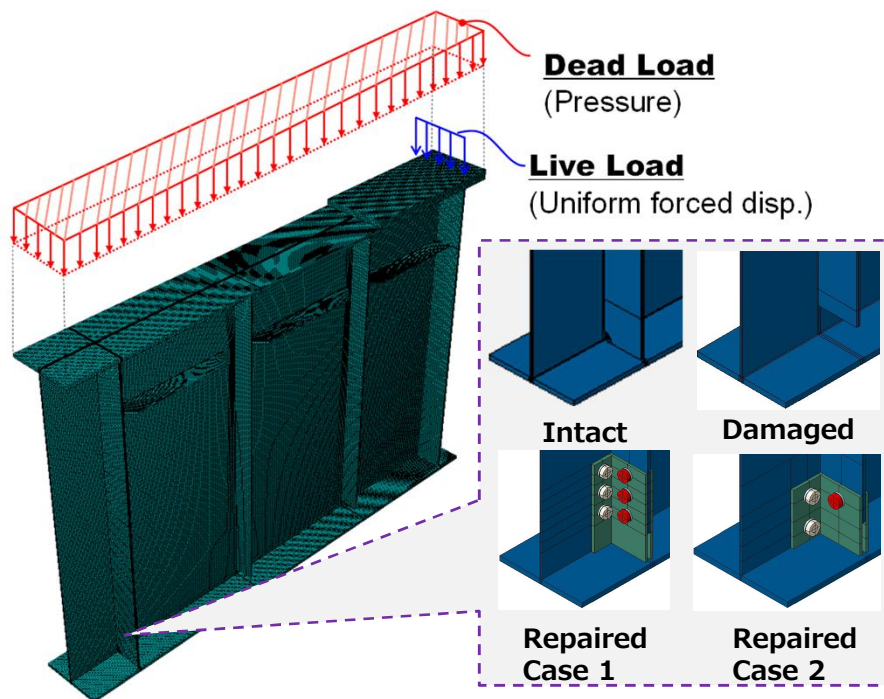
Hitoshi MORIYAMA



Load transfer mechanism of joints



Load transfer mechanism of repaired members



Investigation of mechanical behaviour of repaired girder end



Application examples of  
focused repair method

## 【Backgrounds】

Resistance of corroded members becomes less than expected in the design as its plate thickness reduces when the deterioration is progressed. To recover the resistance up to or more than that of sound state is required by their repair. Considering workability, cost effectiveness and weldability on site, repair with high-strength bolts and doubler plates is usually conducted. However, mechanical behaviour of repaired members including the corroded part has not been elucidated.

## 【What our group are currently investigating】

1. To elucidate load transfer mechanism of repaired members with high-strength bolted doubler plates.
2. To establish the repair design criteria as well.
3. To develop new blind bolt enabling the one-sided repair when a workspace is restricted and targeted members have closed-section.
4. To compare the mechanical performance of proposed and existing blind bolts.



One of existing blind bolt

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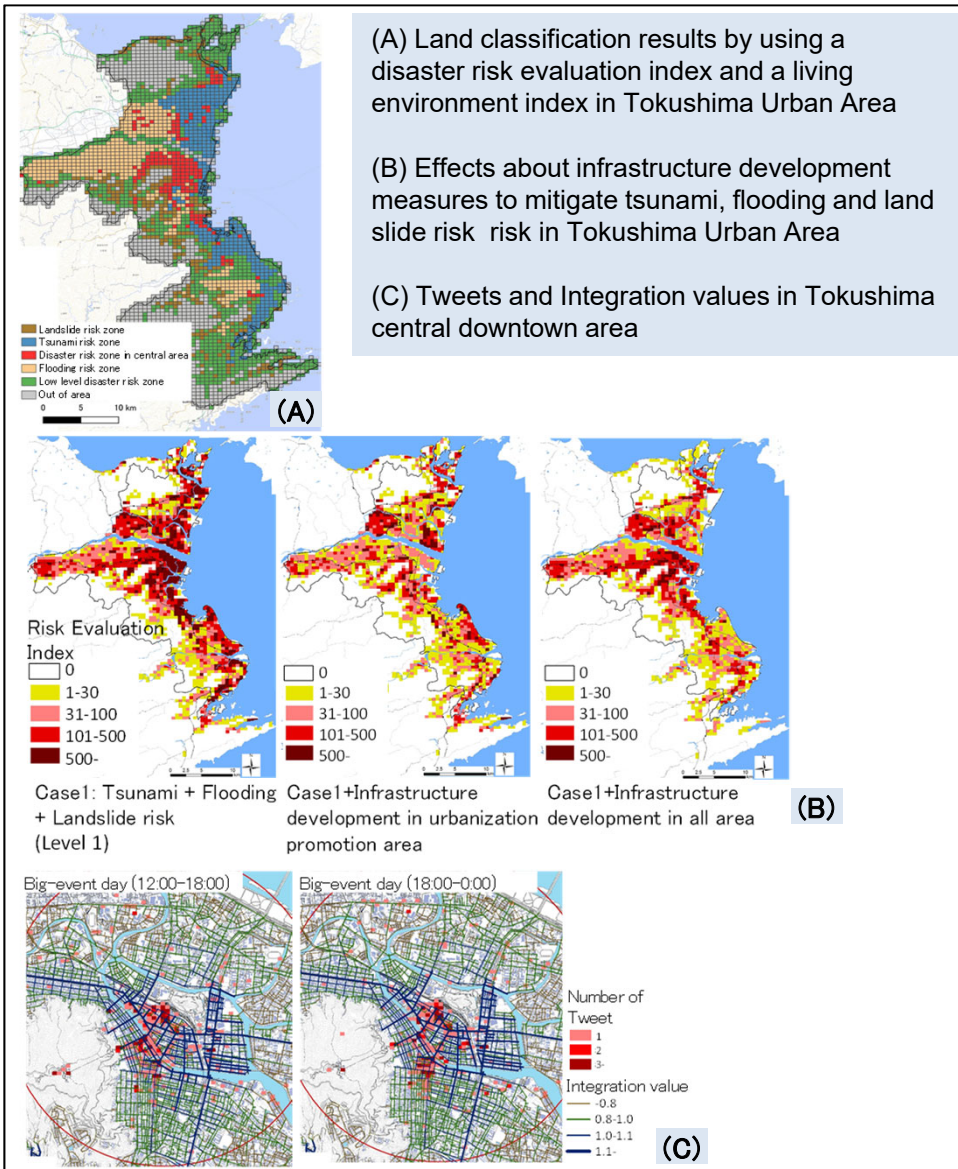
HP: <https://researchmap.jp/moriyama-hitoshi>



**Our research group collect case studies on repair design and retrofitting work in-situ as well.  
If you need support, please feel free to contact me.**

# Sustainable Urban Planning and Design by GIS

Associate Professor Kojiro Watanabe



## 1. Land use planning for sustainable city

Spatial planning and land use strategy focused on sustainable land use in Japanese provincial cities.

## 2. Urban design utilized regional characteristics

Spatial analysis and planning method for city center and historical district in Japanese provincial cities.

## 3. Planning support tools utilized spatial analysis and information technology

Data collection, analysis and visualization for suitable decision making about city planning and urban design.

In my research project, data-oriented planning and design method is focused on.

Keywords: Urban Planning and Design, GIS, Land Use Planning, Disaster Mitigation, Green Infrastructure, Area Management, Urban design for historical area, Simulation, Spatial Information Science

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