Experimental Study of Salt Penetration Resistance in Concrete that Combines the Use of High-Durability Admixtures with Fly Ash or Ground Granulated Blast-Furnace Slag

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Abstract

In the authors' previous studies, the diffusion coefficient of chloride ion of concrete using fly ash or ground granulated blast-furnace slag respectively as admixtures was measured, and it was revealed that the salt penetration resistance was markedly higher than that of the normal preparation of Portland cement. In the present study, we calculated the mechanical properties and apparent diffusion coefficient of a preparation that combines each of the high durability materials in the previously reported preparation, with the aim of further improving the salt damage resistance. The results confirmed an increase in strength and decrease in the apparent diffusion coefficient for all preparations using the high-durability admixtures, showing the usefulness of such materials.

The experimental factors in the experiment were the addition of high durability admixtures (Ad) to normal cement preparation (N), fly ash preparation (FA), and ground granulated blast-furnace slug preparation (BS), the differences in the set standard strength (Fc=30 N/mm^2, Fc=45 N/mm^2), and the differences in the curing method (steam curing (S) and standard curing (W)). For comparison, we also evaluated high-strength concrete (80H) using silica fume as an admixture. (constant temperature and humidity curing (C) and standard curing (W)).

Fig 1 shows the apparent diffusion coefficient calculated by the electrode current method in one year of salt water immersion. A decrease in the apparent diffusion coefficient were confirmed at all levels of high-durability admixtures used, and an improvement in salt penetration was observed. From this result, the high-durability admixtures were believed to have become a solid concrete by the closest packing effect.
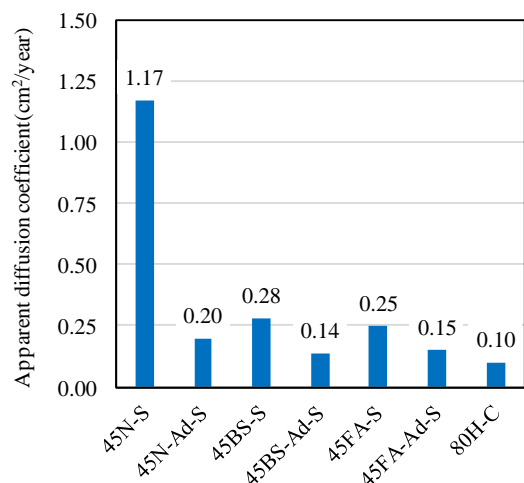

Fig. 1   Apparent diffusion coefficient

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Blast Resistance of SIFCON Using High-Fluidity Grout of Mortar Mix against Contact Detonation

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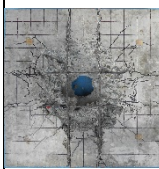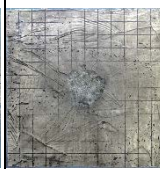E-mail: yamaguchi@arch.kumamoto-u.ac.jp
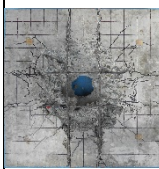
Keywords: SIFCON, mortar, clad reinforcement, contact detonation, local damage

Abstract

When designing blast-resistant reinforced concrete (RC) structures, reducing spall damage due to reflected tensile stress waves is a major problem. In a previous study, the authors clarified that Slurry infiltrated fiber concrete (SIFCON), which is manufactured by first placing fibers into an empty mold and then infiltrating them with cement paste, exhibits better spall-reducing performance than normal concrete and other fiber-reinforced cementitious composites. However, to reduce the shrinkage of the cementitious matrix and the burden on the environment during manufacturing SIFCON, it is an important task to reduce the unit weight of cement by adapting the mortar-matrix to the SIFCON.
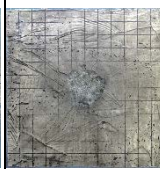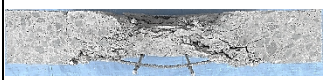
In this study, experimental investigations were conducted to evaluate the blast-resistant performance of SIFCON using high-fluidity grout in which 50% of the unit weight of cement was replaced by ground granulated blast furnace slag and containing 40-80% of small particle size aggregate in mass ratio with respect to binder. The results, showed that the mortar-mix SIFCON, shown in Table 1 (b), possessed the spall-reducing performance comparable to that the mortar-mix SIFCON. Further, to contribute to the development of the efficient technology for improving blast-resistant performance of RC slabs using SIFCON, we proposed a seamless double-layered RC slab system, in which the per-packed concrete near the rear was replaced with the SIFCON, and clarified its good spall-reducing performance, as shown in Table 1 (c).

Table 1 Damage created on the specimens after contact detonation tests using 200 g charge explosive

	(a) Normal concrete	(b) Mortar-mix SIFCON	(c) PPC-SIFCON
Left: Detonation side Right: Back side			
Cross-section			

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Nonresponse Bias in Mixed-Mode Surveys for Disaster Recovery : Case of Mashiki following the 2016 Kumamoto Earthquake

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Keywords: mail-back survey, interview survey, non-respondents, delayed response, nonresponse bias

Abstract

This study analyzes the non-respondents of mixed-mode surveys distributed in Mashiki following the 2016 Kumamoto earthquake. In this survey, additional interview survey was conducted for non-respondents in mail-based survey. We found that households with younger head-of-households, households with children living in temporary housing, and households in post-disaster public-funded rental housing considering housing relocation, tend to delay the response or to be non-respondent in mail-based survey.

We also investigated nonresponse bias of this survey. The main objective of this survey was to predict the demand for disaster public housing. We made two scenario analysis to investigate the nonresponse bias in estimating the demand. Our findings indicated that the demand might be overestimated in both two scenarios. In particular, demand by temporary housing tenants was more overestimated than those by post-disaster public-funded rental housing tenants.
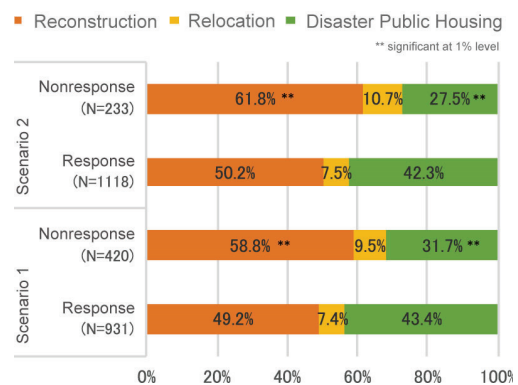
Fig. 1 Results of scenario analysis to investigate the non-response bias in predicting demand for disaster public housing.

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Effects of Oblique Weir with An Opening on Bed Deformation And Flow Structure

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Keywords: oblique weir with an opening, river bed morphology, local Scouring, sand bar, three-dimensional turbulent flow, cellular secondary currents
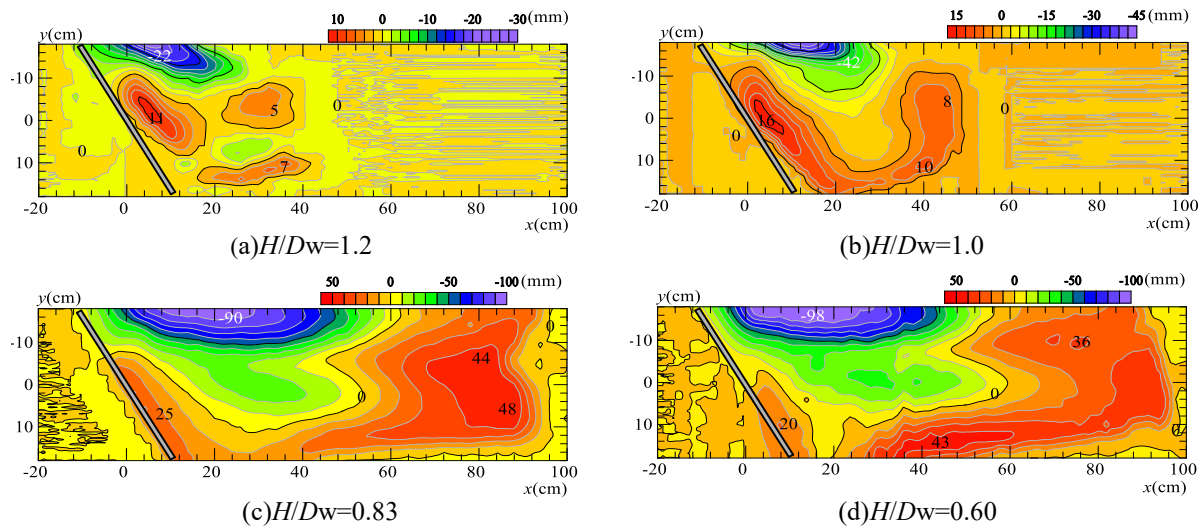
Abstract

Figure 1   River bed scouring and deposition of oblique weir

   Figure 1 shows the contour of the riverbed scouring and deposition of oblique weir, with an average flow velocity U_m=20 cm/s. In addition, the numerical values of contours are expressed in mm from the initial flatbed bed. The oblique weirs show stronger asymmetry in the transverse direction than the rectangular weir. The scouring at the oblique non-opening weir concentrates along the left bank and the scales and depth of the scouring increases with decreasing relative overflow depth H/D_W. These results indicate that overflow orthogonally to the weir axis as the weir changes flow direction. And as the relative overflow depth H/D_W increases, the cross-sectional area overflowing the weir will increase and the flow velocity will decrease. The maximum scouring depth increases as the relative overflow water depth decreases, and it reveals that it reaches approximately twice the water depth h at $H/D_W = 0.60$ and $H/D_W = 0.83$. In addition, the falling distance of scouring is within twice the length of the weir, and it increases as the relative overflow depth H/D_W decreases. Sand bars develop directly in downstream along the oblique weir, the vicinity of the right bank and downstream of the left bank scour and is widely distributed as compared with scouring developed in the left bank. The maximum deposition thickness is about half the maximum scour depth and increases as the relative overflow depth H/D_W decreases.
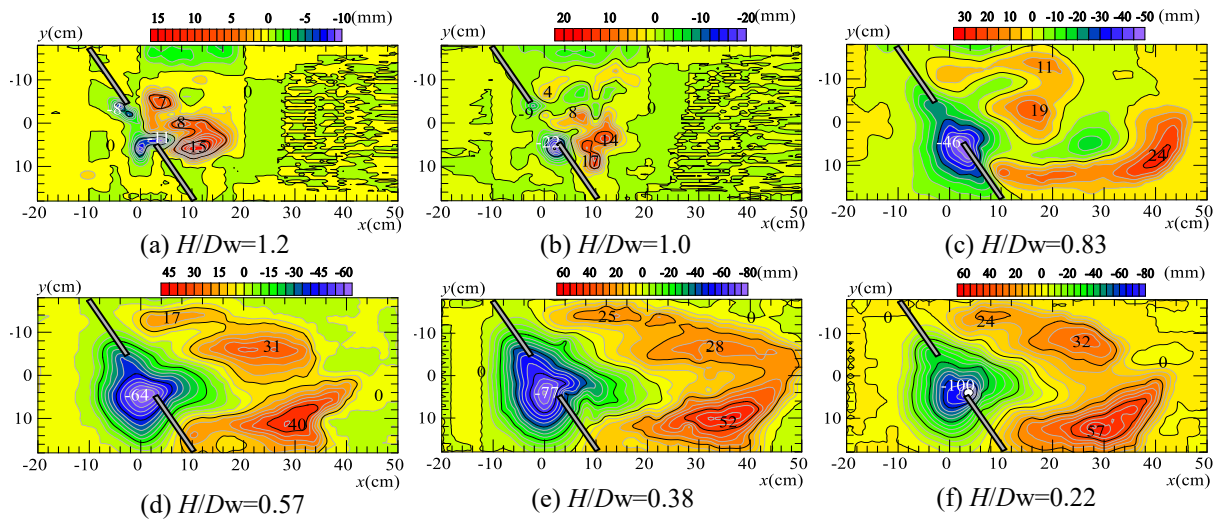
Figure 2 Contour of the river bed scouring and deposition of oblique weir with an opening.

Figure 2 shows the contour of the riverbed scouring and deposition of oblique weir with an opening. The river bed in the oblique weir with an opening has weaker asymmetry than the oblique non-opening weir. The local scouring which occurred near the left bank in the oblique non-opening weir caused the scouring position to shift from near the riverbank to the center of the channel by setting an opening in the weir and the area spread and depth of scouring was relative It increases as the flow depth H/D_W decreases. The position of maximum scouring depth appears at the tip of the weir on the right bank side. It is inferred that descending flow accompanying the horseshoe vortex formed at the front of the weir is stronger at the tip of the weir at the right side and local scouring becomes larger than that at the tip of the left side dam due to the flow field asymmetry. The remarkable sandbar in the oblique opening weir occurs at three places along the center of the descending flow channel and its left bank, and it is similar at any relative overflow depth. In general, the height of the sandbar in the right bank is the largest, which is small in the order of the center of the waterway and the left bank.

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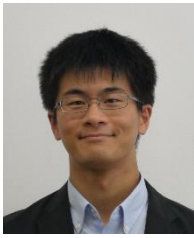
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A Machine Learning Method for Monitoring Ground-level PM$_{2.5}$ Concentrations

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Abstract

The remote sensing products of aerosol optical depth (AOD) from satellite have been widely employed to predict the spatiotemporal distributions of PM$_{2.5}$ as an alternative to ground-based monitoring stations. As environmental big data prevails, machine learning methods have become viable options for handling complicated nonlinear relationships among environmental variables. In this study, we propose a machine learning model named RSRF model based on random forest combined with AOD to estimate daily ground-level PM$_{2.5}$ concentrations in the Beijing-Tianjin-Hebei Region during 2015-2017. Meteorological and air pollutant variables are chosen as auxiliary predictors. The developed RSRF model shows better prediction accuracies of annual and seasonal PM$_{2.5}$ concentrations than other machine learning methods. The results indicate that the prediction ability of AOD is relatively weak in autumn and winter than air pollutants. As a result, more direct emissions data should be considered in predicting PM$_{2.5}$ concentrations. The proposed model will be helpful to better characterize the spatiotemporal PM$_{2.5}$ distributions, quantify the relationships between PM$_{2.5}$ and related variables, and provide decision support for air pollution control management during haze periods.

Fig.1 The geographical location of the study area

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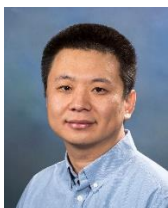
Xiaodong Zhang is a Professor at Shandong University. He received his B.S. and M.S. degrees at Tsinghua University, and his Ph.D. degree at University of Regina, Canada. His research areas cover hydrology and water resources, climate change, environmental systems analysis, machine/deep learning, and uncertainty quantification.

Verification of the Preservation Effect of the Aquo-Siloxane Method towards Porous Rock Materials

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Abstract

Kyushu Research Institute for Cultural Properties Inc. and Kumamoto University have introduced a new method, the Aquo-Siloxane method, to protect stone heritage sites. The application procedure of the method is very simple and it has been applied to several stone heritage sites. Here, one-dimensional diffusion tests using potassium iodide solution were conducted on two types of porous rock samples, Berea sandstone and Kimachi sandstone. The Aquo-Siloxane treatment was applied to the rock samples, and its inhibitory effect on diffusion phenomena was verified. The characteristic point of this study was that the diffusion phenomena was visualized using a μ-focus X-ray computed tomography (CT) scanner, and the density distribution inside the rock sample was quantitatively evaluated. When the Aquo-Siloxane treatment was applied, it was found that density increment resulting from diffusion was suppressed by nearly 1/2 to 1/3 of that without treatment in both the rock samples.
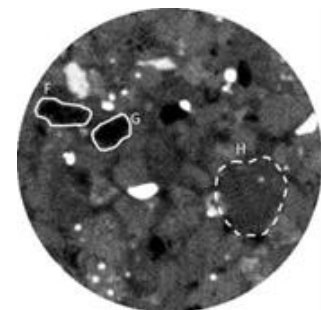
(a) Initial
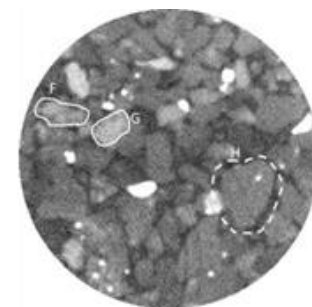
(b) 15 minutes

Fig. 1 X-ray CT images of Kimachi Sandstone during 1D diffusion tests.

Kentaro Fujita received Bachelor's degree from Kumamoto University in 2018. He is currently a master course students of Kumamoto University. His research topic is a verification of preservation effect of Aquo-Siloxane method towards weathered rocks using X-ray CT scanner system.

Akira Sato received doctorates degree in mechanical engineering from Tohoku University in 1998. He is currently associate professor of Kumamoto University. His specialty is Rock Mechanics, and he focuses on analysis of material flows in porous media by X-ray CT method.

Residential Preference Analysis of Households in Mashiki Temporary Housing Using Group-Based Discrete Choice Model and Decision Tree

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Keywords: the 2016 Kumamoto earthquake, temporary housing, group discrete choice model, decision tree

Abstract

Several residents in Mashiki Town who lost their houses in the 2016 Kumamoto earthquake had to live in temporary housing. We conducted an interview survey of these temporary housing tenants from June to November 2016 and collected data (N=1,196) on their residential preference. We found that 58% wanted to rebuild their housing at the previous location, 15% considered living in disaster public housing, and 17% said they had "no idea" about their residential preferences. We also found that suburban residents had a higher tendency to rebuild their housing than did urban residents. This study employs two advanced methods to analyze residential preference: group-based discrete choice model and decision tree. While the former reveals the effects of each household member's situation on their residential preference (e.g., possibility of driving a car), the latter analyzes homeowners of single households to identify the combination of conditions explaining residential preference. For example, single households who have been single before earthquake, drivers, and in their 50s are less likely to rebuild their home.

Moving date: The date that the households moved into temporary housings.
Driving or Non-driving?: Whether the households have a member who can drive a car.
Single/ Non single: Whether the households are single, or not.
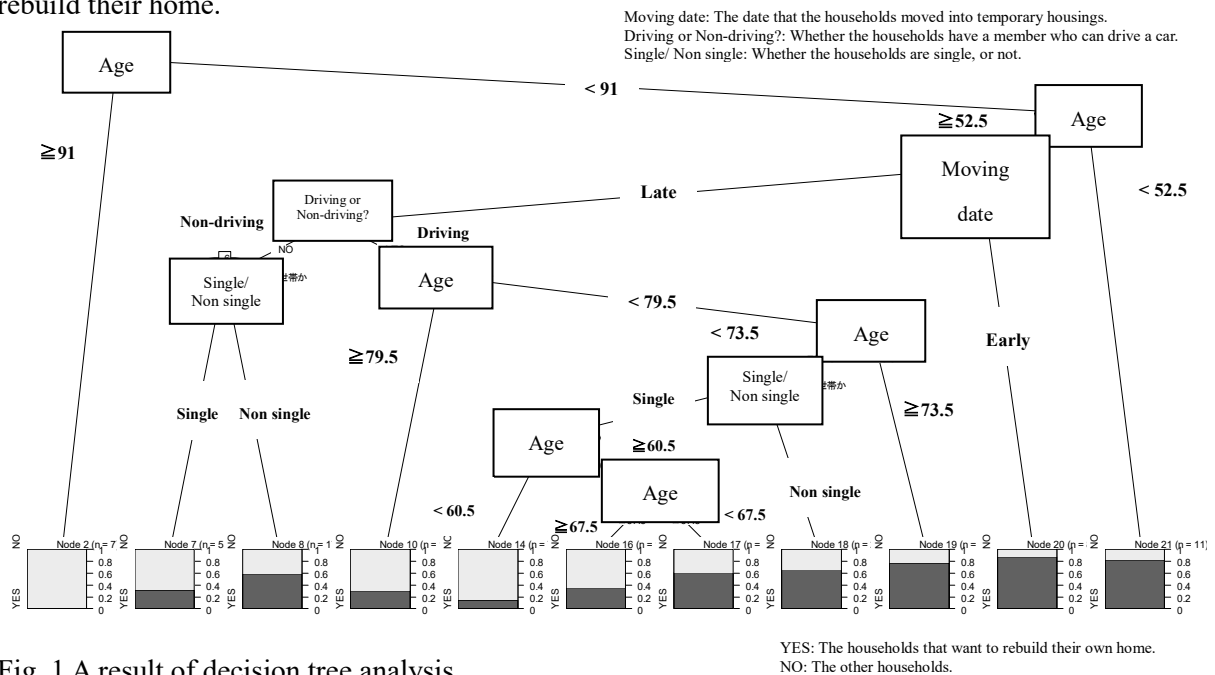
Fig. 1 A result of decision tree analysis

YES: The households that want to rebuild their own home.
NO: The other households.

Hajime Watanabe received his B.Eng. in civil engineering from Kumamoto University 2017 and is now a M.Eng. student at Kumamoto University. His research interests analysis of the residential preference of inhabitants in Mashiki Town damaged by 2016 Kumamoto earthquake.

Study on High-strength Support System of Confined Concrete in Underground Engineering with Complex Conditions

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Abstract

Surrounding rock control is a big challenge in underground engineering. The following main reasons lead to the traditional support failure in underground engineering. Surrounding rock deformation is large and lasts longer with a large extent of damage; all anchor bolts are in severely damaged surrounding rock zone without reliable adhesive basis; and conventional U-shaped steel arch unevenly contacts with surrounding rock without sufficient bearing capacity. To address aforementioned issue, a concept of "high-strength and integrity support" is put forward; a support system of confined concrete is developed; and a full scale in-door comparative test is conducted on its core component – confined concrete arch and also on the conventional steel arch. The research shows the bent and damaged legs of conventional steel arch result in dramatic reduction of bearing capacity of arch. The square steel confined concrete arch with similar steel content has a bearing capacity of 2.15 times of that of U-shaped steel arch and still has a higher post bearing capacity even after the arch is deformed dramatically. Additionally, comparative analysis is made on surrounding rock control mechanism and the mechanical properties of support system of confined concrete, and comparative tests are conducted on site. The results show that no yield and damage occurs on the test section of confined concrete support and the deformation of surrounding rock is small. Therefore, the high-strength support system of confined concrete is proved to be effective on surrounding rock control.

Fig.1 Large deformation of surrounding rock

Fig.2 Field application of confined concrete support

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Intelligence and Evolution: Design of Next Generation Intelligent Transport Management System for Jinan

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Abstract

This research presents the system framework and some key features of a next generation intelligent traffic management system designed for the city of Jinan. The system focuses on the more intelligent abilities of detection, analysis, decision-making and evaluation. With the combination of large amount of transport and urban management-related data from various government agencies and private sectors, the system aims at the automation and intelligence on better understanding the trip demands and patterns, as well as providing real-time or semi-real-time response to recurrent and non-recurrent congestions. For such a system whose phase-1 cost reaches almost 200 million Chinese Yuan, some challenges and key features include: 1) the smooth integration of the advanced functions of the new system with other old systems developed in the past decade in the city; 2) a mechanism of self-evaluation on the analysis results and the generated comprehensive transport management strategies; and 3) a way for the system to evolve so as to improve its efficiency once more data and evaluation results have been accumulated.

Key words: intelligent traffic management; system evolution; massive data fusion

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Extracting heat from composting of biosolid

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Keywords: Composting, heat recovery, energy utilization

Abstract

Composting process is essentially a method of using microbes to convert solid waste into stable and safe substances and to reduce environmental pollution problems, which mainly uses microorganisms to convert organic solid waste into non-toxic, clean and stable organic fertilizer under aerobic conditions for soil amendments and agricultural production; However, most people overlook the other advantage of composting, which is the heat generated during the composting process. According to the study, carbohydrates, proteins and fats are decomposed and utilized by microorganisms during the composting process, and the average energy release is about 20.0 MJ/kg.

Fig. 1   Graphical abstract of the composting process

Actually, due to the need of the growth and reproduction of microorganisms, will utilize organic-rich waste carbon and nitrogen sources, an exothermic reaction occurs under the action of cell metabolism can make compost temperature up to 80□. Considering that this part of the heat is recovered and used, which will not only solve the problem of environmental pollution but also alleviate the crisis of available energy, that is the so-called waste energy utilization. The recovered heat may be used for heating greenhouses, district heating, etc.

Therefore, this study summarizes the research progress of compost heat recovery in the past 10 years, mainly including the mechanism of composting heat production and its influencing factors, some experimental results and theoretical research on the utilization of composting heat, and the problems of recovering heat from the composting process. It aims to provide a basis for the treatment and energy utilization of organic waste.

Author 1 Yang ZENG received his MS in Environmental Science and Engineering from Tongji University and AgroParisTech, and his Ph.D in Chemistry from University of Rennes I. After post-doctoral research at Iresta and INRA, he moved to Shandong University as an associate professor in 2016. His research addresses the composting of organic waste and biogenic sources-derived trace gases, particularly reactive nitrogenous compounds.

Route choice behaviors and traffic characteristics on parallel urban major arterials

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Abstract

This study analyzes vehicle route choice behaviors and traffic characteristics on three parallel urban major arterials during peak and non-peak hours in the city of Jinan. The route choices have been identified with license plate data with timestamps from several checkpoint locations along the arterials. With a fuzzy C-means model, the research clusters traffic states and develops the classifier to identify traffic congestions. The study further explores the vehicle composition and identify frequent commuters under various traffic conditions with a K-means clustering model. The analysis results can provide useful reference on future traffic management strategies that can better balance the travel demands on those parallel routes.

Keywords: traffic characteristics; traffic checkpoints data; congestion identification; traffic composition; vehicle route choice behavior

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Congestion Prediction for Fixed Urban Zones with a Neural Networks Model

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Abstract

Effective prediction of the start and the duration of traffic congestion in urban zones is crucial for improving real-time traffic management. As the traffic congestion at one intersection can easily spillback to nearby intersections during peak hours, understanding the congestion evolution and traffic characteristic changes in a zone can be very helpful to identify potential indicators and their relations that can contribute the prediction of the congestions. This study first identifies some key factors using actual and simulated data from several very busy urban zones which include about 15 to 30 intersections, and then proposes a BP neural networks model for the prediction of congestions. The neural networks model has been trained with traffic parameters from checkpoint locations in those zones and verified with the start time and duration time of congestion for the predicted day from statistic results. The results show that the model has achieved satisfied performance for real-world implementation.

Keywords: prediction; traffic congestion; key factors; BP neural networks model

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Travel Time Variation and Impact Factors: A Case Study of Busy Urban Segments in Jinan, China

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Abstract

This study attempts to find out potential impact factors that contribute to travel time variations on several busy urban segments and then explore the relations of those factors. The potential impact factors including road location area type, road type, time period, and others. 12 segments located in different areas have been selected for this study, including commercial areas, residential areas and office areas. The segments are located on elevated roads, arterial roads and secondary roads. The study uses hypothesis testing to analyze the potential general characteristics of travel time distribution. The results can support further analysis of travel time reliability in Jinan City.

Keywords: travel time variation; urban segments; hypothesis test

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Investigating Bias by Proxy Response in Open-Ended Questions

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Keywords: proxy response, open-ended survey data, social survey, bias

Abstract

In social surveys, a response by one other than the target sample is called a "proxy response," and poses several widely recognized problems in data analysis. However, current attempts to systematically analyze the proxy response bias are insufficient. Hosotani et al. (2018) proposed a method to analyze the problem using a group-based choice model of response behavior that could investigate the bias in trip rates. This study aims to investigate the bias in open-ended survey data. We analyze the open-ended data in a supplemental survey to the 2012 Kumamoto Person Trip survey using the method proposed by Hosotani et al. (2018). The results indicate that the number of characters in an open-ended response decreases in conjunction with the probability that the response is given by a proxy respondent. We also found that the featured words in an open-ended response differ depending on the probability that the response was given by a proxy respondent.
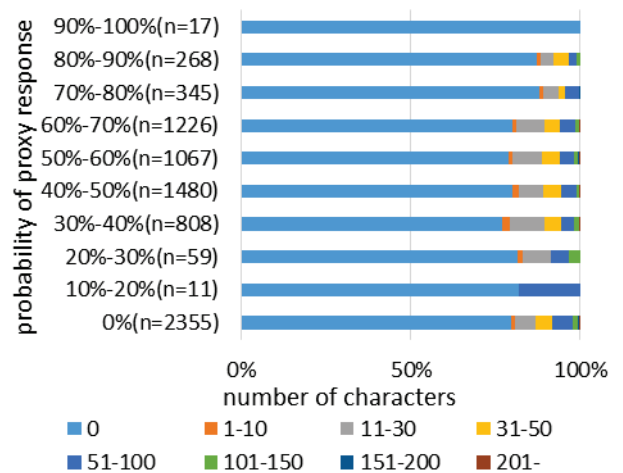
Fig. 1 Character-number distribution in open-ended data by probability of proxy response in 2012 Kumamoto PT survey.

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Increase in Traffic Accidents after the 2016 Kumamoto Earthquake

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Abstract

After natural disasters, drivers are forced to drive in stressful situations, and the number of traffic accidents may increase. After the 2016 Kumamoto earthquake, many evacuees stayed overnight in their cars, after which their driving would have suffered because of the fatigue from that situation. However, few studies have examined this issue.

In this study, we reveal the change in the number of traffic accidents after the 2016 Kumamoto earthquake. We examined traffic accidents resulting in injury or death separately from those resulting in property damage using data provided by Kumamoto prefectural police. We found that 1) the number of accidents resulting in injury or death decreased, despite the earthquake, but that accidents resulting in property damage increased after the earthquake; and 2) the number of accidents resulting in property damage increased even more in the more heavily damaged areas. Although this study is based on aggregated macro data, an investigation using micro data will be effective in revealing useful findings in a future work.
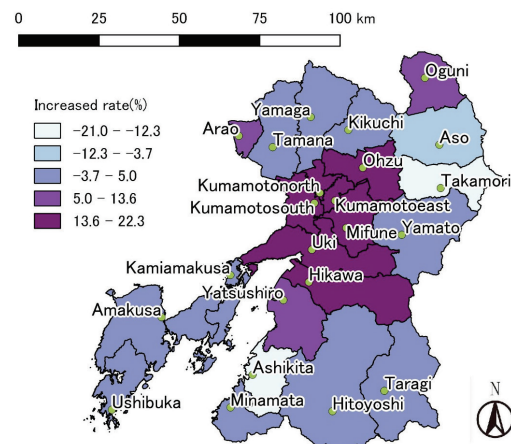
Fig.1 Increased rate of traffic accidents resulting in property damage (2016/2015)

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Topic Modeling Approach to Analyze Students' Activities on Kumamoto University Campus Using Smartphone-Based Survey Data

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Keywords: travel behavior survey, GPS, smart phone, topic model, pattern mining

Abstract

GPS-based tracking data of students on university campuses can be useful for examining various campus issues, including illegal bicycle parking and where to position parking lots. Existing studies attempt to extract behavior patterns from GPS-based data; some studies have applied topic modeling to this problem. However, the application of this method to small-scale areas (e.g., a university campus) has been limited to date. In this study, we apply topic modeling to the data collected via a smartphone-based GPS survey at Japan's Kumamoto University in autumn 2016. We successfully found several travel patterns among students on campus using topic modeling. These patterns can be explained by individual attributes, demonstrating the usefulness of this method. Only tracking data are needed for such an analysis, indicating that in the future, we may infer the individual attributes of tracking data using the topic modeling method.
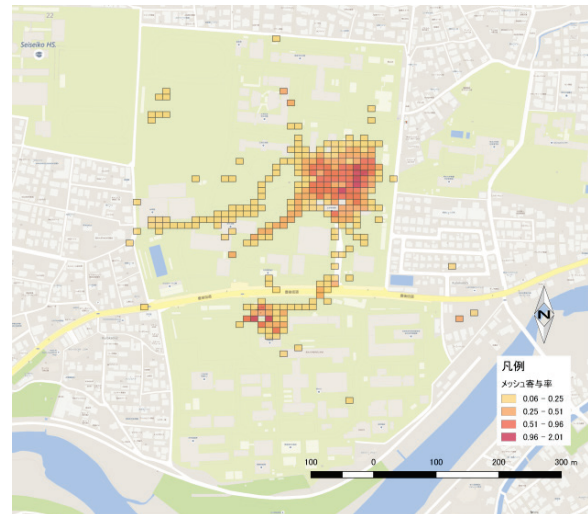
Fig. 1 An example of behavior patterns extracted by topic modeling.

aki is now a B.Eng. student at Kumamoto University. His research ude travel behavior analysis.

ruyama graduated from the University of Tokyo with his PhD in rked at the University of Tokyo as a research associate and a JSPS fellow at University of Texas at Austin. He has been an associate Kumamoto University since 2008.

Comparative Analysis of the Rate of Households with Every Member Out-of-Home (HEMO) using Kumamoto Person Trip Surveys in 1984, 1997, and 2012

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Keywords: PT-survey, households with every member out-of-home, Kumamoto Metropolitan Area,

Abstract

In Japan, the Person Trip (PT) survey has more than 50 years of history as a household travel survey and has contributed to studies in a range of practical and academic contexts. Most existing studies using the PT survey have focused on travel behavior, but the present study focuses instead on the out-of-home situation. Because the PT survey records all trips by every member of a household, it enables us to calculate the rate of households with every member out-of-home (HEMO) at a given time. Using this information, this study aims to compare and analyze the rates of HEMO gathered via the Kumamoto PT surveys in 1984, 1997, and 2012. The results demonstrate that the HEMO rate has consistently increased over the years, and the recent increase is large. Moreover, the HEMO rate tends to differ among households occupying different demographic categories.
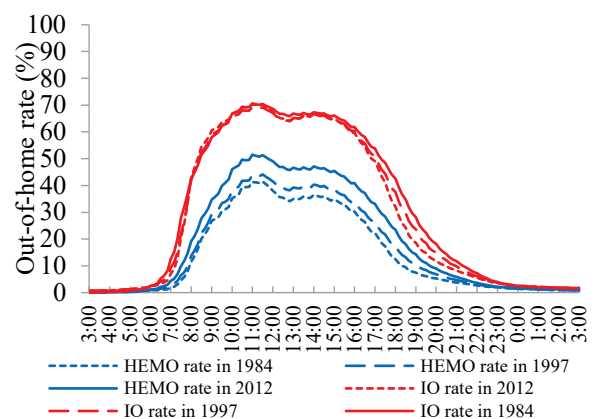
Fig. 1 Change in individual out-of-home rate (IO rate) and rate of households with every member out-of-home (HEMO rate) in 1984, 1997, and 2012 by the Kumamoto Person Trip survey.

Tatsuya Fukahori is now a B.Eng. student at Kumamoto University. His research interests include travel data analysis.

Takuya Maruyama graduated from the University of Tokyo with his PhD in 2004. He worked at the University of Tokyo as a research associate and a JSPS postdoctoral fellow at University of Texas at Austin. He has been an associate professor at Kumamoto University since 2008.

Topic Modeling Approach to Analyze Visitors' Activities on Downtown Using Smartphone-Based Travel-Survey Data

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Keywords: travel behavior survey, GPS, smart phone, topic model, pattern mining

Abstract

Recently, GPS-based travel surveys have been used to provide basic data for planning public policy. Compared with traditional paper-based travel surveys, GPS-based travel surveys can reduce respondents' burden and provide accurate data without relying on respondents' memories. However, tracking data collected via GPS-based survey generally do not include semantic information such as trip purpose, trip mode, and individual attributes. To this end, this study aims to develop a method to estimate semantic information from GPS-based tracking data using topic modeling, focusing specifically on individual attributes. Topic modeling can infer latent topics from documents. In this case, we regard individual attributes in the travel survey as the "topics" of "documents." Applying topic modeling to a travel survey, we can estimate individual attributes as travel patterns. We apply this method to analyze a smartphone-based visitors' activity-travel survey data conduced in downtown Kumamoto in 2013. The extracted travel patterns can be explained through individual and trip attributes. These results indicate that, in the future, we can infer individual attributes of GPS tracking data via topic modeling.
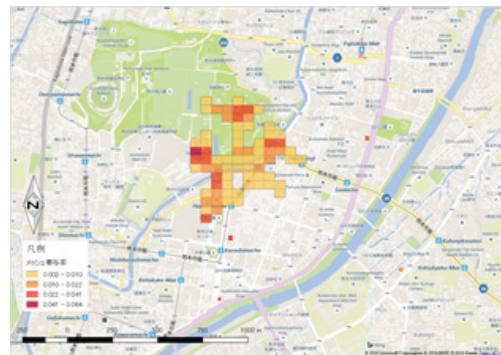
Fig. 1 An example of travel patterns extracted by topic modeling. We infer this represents a tourist travel pattern because it includes some known sightseeing spots such as Kumamoto Castle.

Tomoki Kawano received the B.E.degree in civil engineering from Faculty of Engineering, Kumamoto University, Japan, in 2017. He is currently a second - year master's student. His research interests include behavior modeling and data mining in several domains such as travel behavior analysis and natural language processing.

Takuya Maruyama graduated from the University of Tokyo with his PhD in 2004. He worked at the University of Tokyo as a research associate and a JSPS postdoctoral fellow at University of Texas at Austin. He has been an associate professor at Kumamoto University since 2008.

Analysis of Visiting Place and Staying Time in Downtown Kumamoto Using a Discrete-Continuous Choice Model

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Keywords: travel behavior survey, GPS, smart phone, MDCEV model

Abstract

Capturing and analyzing visitors' travel behavior by GPS (Global Positioning System) data has been shown to be effective in the planning and implementation of measures to revitalize downtown areas of local cities. This study proposed a multiple discrete-continuous extreme value model of visiting place and staying time choice in a downtown area. We applied this model to data from a visitor's behavior survey conducted by smartphone application in downtown Kumamoto, during the weekends in November and December of 2013. Existing studies have developed visualization methods of these data, and the present study proposed a new advanced analysis framework. Downtown Kumamoto was divided into 10 zones, and visitors' time spent in each zone was analyzed with the multiple discrete-continuous extreme value model. The results reveal the features of each zone in terms of visitors' gender, age, travel mode to the downtown area, and visiting purpose.
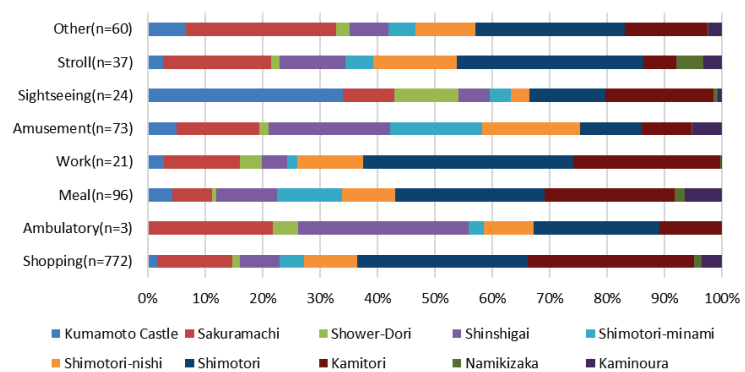
Fig. 1 Staying time distribution in each zone by visiting purpose for downtown Kumamoto. in a day

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Takuya Maruyama graduated from the University of Tokyo with his PhD in 2004. He worked at the University of Tokyo as a research associate and a JSPS postdoctoral fellow at University of Texas at Austin. He has been an associate professor at Kumamoto University since 2008.

The operation improvement of the community bus using only the data obtained from the bus location system and the conventional questionnaire

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Abstract

In Japan, the number of bus users continues to decrease with the peak in the 1970s. The number of routes and the frequency of operations have been reduced, and the convenience of the bus is decreasing. Bus location system and smart card system, which are systems for improving the convenience of route buses, have been introduced in the 1980s and 2000s, respectively. Research on methods to analyze various data obtainable from these systems and to utilize the results for operation and management has recently begun.

In this research, we propose a method to clarify not only the operation but also the actual situation of utilization by fusing the data obtained from the bus location system, the

Fig. 1 LETTER BUS route map

smart card system, and the conventional questionnaire targeting the community buses in rural areas. Data obtained from these three systems each have other, more useful data can be obtained.

In this study, we analyzed the improvement of the operation of the community bus using only the data obtained from the bus location system and the data obtained from the conventional questionnaire conducted to the passengers. We focus on a community bus called LETTER BUS which is operated in Kohshi City. Since the bus location system is introduced in this community bus, locus data by GPS can be obtained. We estimated the arrival time and departure time at each bus stop from this data. By comparing these times with the regular timetable, we were able to find the delay location and delay time. From the conventional questionnaire, we clarified the age of users, frequency of use, purpose of use. We could obtain the accurate number of passengers between getting-on and getting-off bus stops. We improved the timetable using information obtained from these two data.

By fusing data obtained from these two systems, it became possible to conduct a deep analysis on the actual situation of the user and the operation. By fusing data obtained from these two systems, it became possible to conduct a deep analysis on the actual situation of the user and the operation.

Nana Amafuji received the B. E. degree in civil engineering from Faculty of Engineering, Kumamoto University, Japan, in 2018. She is currently a first-year master's student. Her research interests analyzing various data obtainable from these systems and to utilize the results for operation and management.

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The acute toxicity of polystyrene nanoplastics to *Chlorella vulgaris*

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Keywords: polystyrene nanoplastics, acute toxicity, Chlorella vulgaris

Abstract

   Recently, nano-plastics (micro-plastics) has been a great concern as an emerging pollutant, as well as the impact on physiological and biochemical function of organism. Two types different charge of nanoplastics (PS and $PS-NH_2$) were synthesized in the laboratory by emulsion polymerization. The two kinds of materials were characterized as nano-spherical by TEM and SEM image. In this study, mechanism for toxicity of polystyrene nanoparticles (PS) and amino modified polystyrene ($PS-NH_2$) on model microorganism *chlorella* was investigated. The type of different charge nanoplastics were tested for acute toxicity of *Chlorella* for 96 hours. The EC50 (96 h) of PS for *Chlorella* was 101 mg/L, while the EC50 (96 h) of $PS-NH_2$ for *Chlorella* was 1.47 mg/L. Subsequently, the intracellular nanoplastics were localized by transmission electron microscopy. It was found that $PS-NH_2$ accumulated more in *Chlorella*, which may be one of the reasons for the greater toxicity of $PS-NH_2$. It is known that the surface of $PS-NH_2$ is positively charged, and the surface of PS is negatively charged, while the surface of the cell membrane is negatively charged. $PS-NH_2$ particles are more likely to enter into the *Chlorella* due to the attraction of charge, which may cause the higher inhibition in $PS-NH_2$ group.
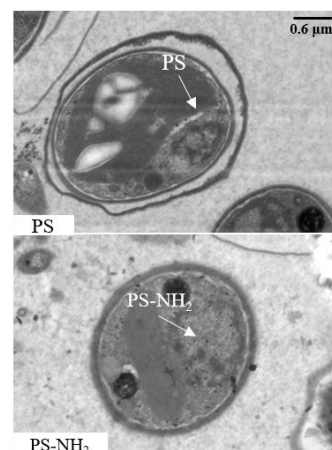
Fig.1 TEM images of *chlorella* treated with PS or $PS-NH_2$.

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An experiment on the effect of surrounding sound on acoustic comfort in conversing in multi-group conversation space

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Abstract

Restaurants or cafes can be categorized as "Multi-group conversation space (MGCS)" where more than one group are conversing within the group. In this study, an impression evaluation experiment was conducted with the purpose to investigate the interaction of the levels of background music (BGM) and speech. BGMs of three kind of genre and tempo and surrounding conversation speeches with three levels of the ratio of conversation to music volume (CMR) were presented to subjects in a quasi-MGCS set up in an anechoic room. The subjects answered questions about impression of the space orally, and the answering voices were recorded for obtaining their sound pressure levels. As a result, the conditions with high CMR and with BGMs of "pops" tended to be evaluated negatively, which implied that surrounding voices affected negatively for the subject in conversing. Also the voice levels were relatively high in the conditions with BGMs of "pops".

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A measurement of power levels of sound sources in various activities in child daycare

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Child daycare facilities,power level

Abstract

There are various sound sources in the daily actibities in child daycare facilities and it is necessery to understand their power levels for the optimum acoustic design, such as sufficient sound insulation for quietness and short reverberation time for good speech clarity in the facilities. In this study, reverberation time of actual daycare rooms and sound pressure levels in various activities of a 3 to 5 year old children group were measured and the power levels were estimated from those values using Eyring's formula. The target activities were greeting, singing, dancing, free play, lunch and playing Japanese drum. As a result, the A-weighted sound power level per 10 children ranged 85-88 dB for free playing voices, 80-94 dB for singing and so on, and the highest was the sound of playing Japanese drum at 102 dB.

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Uplifting Phenomena in the Sliding and Outer bay of Multi Storied Steel Frames Equipped with Friction Dampers at the Column Base

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Abstract

  This research aims to establish a design method in case that friction dampers are installed at the firs story's column bases of a steel structure. The friction dampers have two effects on seismic behavior of the frame under the strong earthquake. The first is a damping effect that dissipates energy by sliding the damper. Second is an effect like a seismic isolation that cuts energy input to buildings. Because it is assumed that the structure does not completely connect the column base and the foundation of the frame, it is possible for such the frame that not only the friction damper slides during a large earthquake, but also the uplift of the frame base occurs. However, the problem such as the increase of the horizontal displacement of the upper stories while the column bases leave from the foundation is concerned. It is also known that the uplift phenomenon occurs on the outer columns of the frame. Consequently, it is thought that the phenomenon depends on the shape ratio that is defined by the ratio of the height of the building and the outer bay length. In this research, a model of steel frame with the friction dampers at the bases was examined by varying the value of the shape ratio. As a result, it was clarified that the value of the maximum uplift displacement becomes large when the value of the shape ratio takes large. Also, the maximum uplift displacement tends to be smaller by increasing the number of bays.
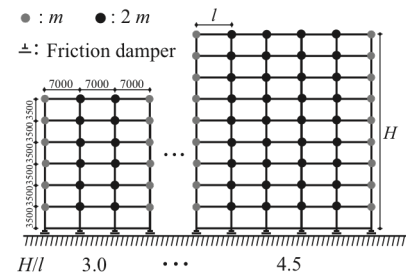
Fig. 1 Analytical frame

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Seismic Response Analysis of A School Gymnasium with Steel Roof due to the 2016 Kumamoto Earthquake

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Keywords: Steel roof structure, Earthquake damage survey, Earthquake response analysis, Anchor bolt, Bearing

Abstract

Almost all gymnasiums are built with steel members because they have long span roofs. The school gymnasium is often assumed as an evacuation facility at the time of disaster, although many cases have been reported that structural damages occurred in the building at the time of a strong earthquake and could not be used as an evacuation facility. Many school gymnasiums were affected by the Kumamoto earthquake (2016) in Japan. The target of this research is focused on the school gymnasium that

Fig. 1 Analysis model

was damaged by the Kumamoto earthquake. Figure.1 is an analysis model. The damage of this gymnasium was due to the fact that the north side gable wall deformed out of plane and damage occurred at the steel roof supports on the top of the wall. Especially, the damage in bearings between the roof edge made of steel and the top of the R/C column was dealt with as the main problem. A 3D computer simulation of the damage process was conducted using actual design data. As a result, it was found that the building twisted by its eccentricity in the floor plan, and the central part of the north gable wall deformed out of plane. Comparison between the anchor bolt's proof stress and the shear stress generated during the earthquake response was conducted. The anchor bolt did not have enough strength against under the phenomenon.
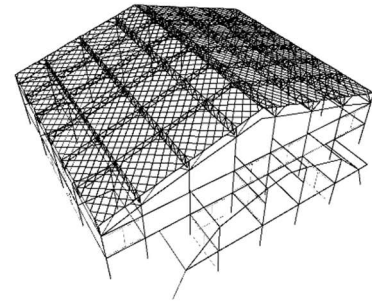
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Survey of Damage of School Gymnasiums after the 2016 Kumamoto Earthquake

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Keywords: Earthquake damage, Evacuation facility, Steel roof structure, School gymnasiums

Abstract

This research focused on the affair of partially restricted usability of School gymnasiums as evacuation facility due to the 2016 Kumamoto earthquake. The situations of the school gymnasiums in and around Kumamoto city were investigated by using the answers from the local governments to a questionnaire with respect to the kinds and the places of damages, as well as whether the buildings could be continuously used as an evacuation facility after the earthquake. It was clarified that fifty gymnasiums located in the area recorded a seismic intensity of six or more on the Japanese scale. Fig. 1 shows estimated seismic intensity and distribution of the unusable gymnasiums.

They could be divided into three categories that are the aged steel structures, the large sized R/C structures, and the structures with slight damaged in sub-members. The damaged elements of the aged steel structures were mainly the steel braces, and also the siding walls and the ceiling of canopies. It seemed that the principal of the school made the judgement for keeping continuous use through their check by eyes. As for the large scaled R/C gymnasiums, there was no conspicuous damage in the mainframe, although the earthquake caused not only

Fig.1 Estimated seismic intensity and Distribution of the unusable gymnasiums

the damage of buckling or breaking of the steel braces in the steel roof but also the damage of the supports of the steel roof.

In order to continuous use of the gymnasiums as the evacuation facility, it is necessary that the suitable reinforcement and the renovation prevent the evacuees from falling of the sub-members such as the siding walls and the ceilings that may give them anxiety or discomfort.
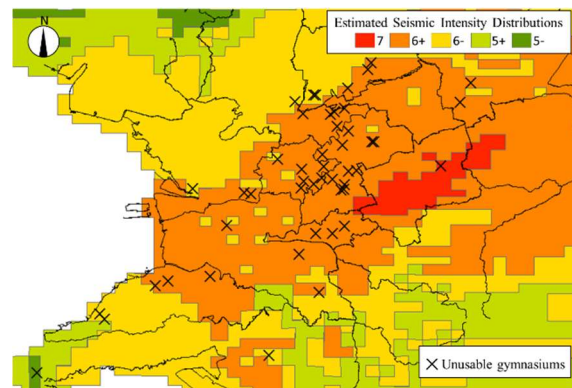
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Effect of Hyper-Concentrated Sediment on Flow Resistance Characteristics and Flow Field in an Open Channel with Closed-Packed Spherical Roughness

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Keywords: hyper-concentrated flow, Non-Newtonian properties, PIV, PSA solution, spherical roughness

Abstract

This paper shows that effect of hyper-concentrated sediment on flow resistance characteristics and flow structure in an open channel with closed-packed spherical roughness. Hyper-concentrated sediment flow has been observed in Yellow River and mud flow. It has been causing river engineering problems such as local scouring and deposition. It often shows Non-Newtonian properties because it made up of a large amount of clay and /or silt particles suspended in water. However effect of hyper-concentration sediment had on fully developed turbulent structure remains poorly understood concerning. In this paper, we experimentally investigated resistance characteristics and flow structure in an open channel with close-packed spherical roughness. Flow pattern was measured by using Particle Image Velocimetry (PIV). And reproduction of hyper-concentrated sediment flow used poly sodium acrylic (PSA) solution because PSA has viscous similar properties as Kaolin suspended flow, and the advantage of enabling measurement using the PIV method. PSA solution concentrations of 300 mg / ℓ and 800 mg / ℓ correspond to kaolin sediment volumetric concentration of 6% and 10%, respectively.

Table 1 Resistance coefficient

	Clear Water	300 mg/ℓ	800 mg/ℓ
Resistance coefficient C_f	0.047	0.022	0.089
C_{fPSA}/C_{fw}	1.0	0.47	1.9

The total resistance coefficient is defined as the ratio of total resistance to the inertia of fluid and is expressed by following equation.

$$Cf = 2\left(U_*/U_m\right)^2 \tag{1}$$

where $U_* = (ghi_0)^{1/2}$; g is gravitational acceleration; i_0, flume slope; and U_m, cross-sectional mean flow velocity. Table 2 shows the total resistance coefficient C_{fPSA}/C_{fw} of the PSA solution with respect to the total resistance coefficient C_{fw} of clear water. The result showed that the resistance coefficient in the PSA solution of 300mg/ℓ was 0.47 times larger than that in the Clear Water, and the resistance coefficient in the PSA solution of 800mg/ℓ was 1.9 times larger than that in the Clear Water.

Figure 1 shows the color contour of the main flow velocity on the Ridge Line (RL). From Figure 1, the acceleration zone is seen upstream from the top of the roughness and the deceleration zone is seen in
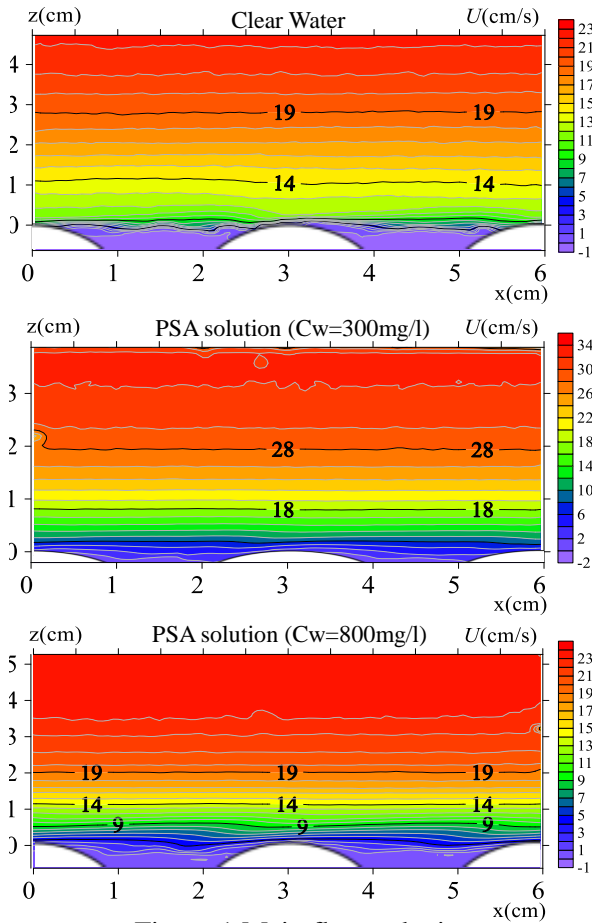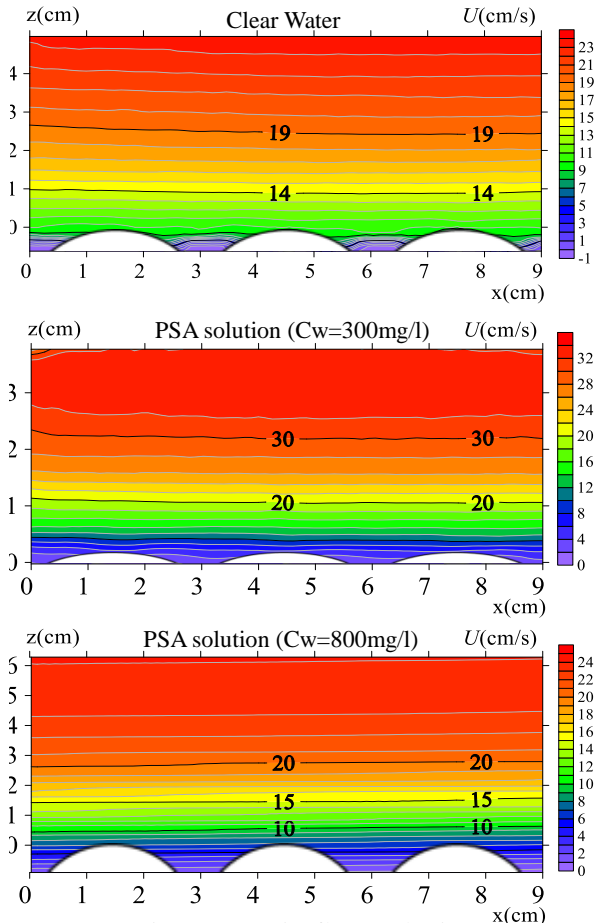
Figure 1 Main flow velocity
(RL)

Figure 2 Main flow velocity
(TL)

the downstream. It is also confirmed that the change in the vertical direction of the main flow velocity decreases in the vicinity of the water surface at the PSA solution concentration Cw=300mg/l and Cw=800mg/l. Therefore, a plug flow is formed in the vicinity of the water surface at the PSA solution concentration Cw=300mg/l and Cw=800mg/l. Plug flow is a flow in which the same speed is bundled.

Next, Figure 2 shows the color contour of the main flow velocity on the Trough Line. From Figure 2, it is also confirmed that the change in the vertical direction of the main flow velocity decreases in the vicinity of the water surface at the PSA solution concentration Cw=800mg/l. The magnitude relationship of the main flow velocity on Trough Line is $U(800\text{mg}/\ell)<U(300\text{mg}/\ell)<U(\text{CW})$.

As shown above, the main flow velocity in each measurement line is $U(800\text{mg}/\ell)<U(300\text{mg}/\ell)<U(\text{CW})$. The main flow velocity decreases as the PSA solution concentration increases. The main flow velocity at the PSA solution concentration Cw=800mg/l in the vicinity of the roughness is generally smaller than the main flow velocity at the clear water and PSA solution concentration Cw=300mg/l. Therefore, since momentum transport by advection is small and momentum transport of turbulence in vicinity of roughness can be neglected, it is recognized that the viscous effect is dominant.

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Examination of Earthquake Response Characteristics by the Difference of Occupancy of Fixed Columns of Steel Frame with Friction Dampers

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Keywords: Steel Structure, Friction Damper, Seismic Response, Slip Behavior, Column Base

Abstract

Many buildings have been suffering with severe earthquakes in Japan such as the 2016 Kumamoto earthquakes. Now a day, the seismic-isolation system is adopted for reduction of damage caused by strong earthquakes. This research is concerned with vibration control system with passive friction dampers equipped at the bottom of a steel frame. The friction damper slips to dissipate the seismic energy while the frame laterally slides under the earthquake. The cost of construction of the new system can be lower than that of the conventional seismic-isolation system because the friction damper is provided by only changing the

Fig.1 Residual slip amount

construction of the column base. Although, there is a problem that the frames with friction dampers generate residual slip after the earthquake. It is known that the amount of residual slip can be reduced by fixing the outer column in the first story according to previous studies by the authors. Moreover, the residual deviation by slip could be much reduced by using the high strength steel for the fixed columns. However, the case of 5-bay, 3-story frame have only been studied in previous studies. Therefore, the frames that have more bays was prepared for getting adequate numbers of fixed columns through a series of numerical studies. Figure 1 shows a graph of the residual slip amount and fixed column occupancy. Finally, it was found that the appropriate occupation of fixed columns to all the columns in the first story of the frame was 30%.
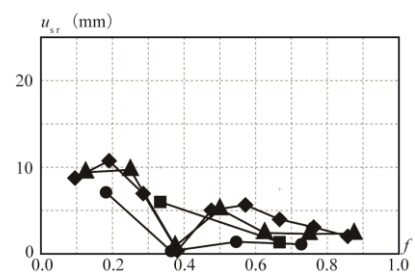
Daiki HIRATA

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Study on Seismic Behavior of Steel Frame with Stick Damper Mechanism

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Abstract

This paper describes a passive vibration control design of braced multi-storied steel frames with a stick damper mechanism using rotational frictional dampers. The rotational friction damper dissipates energy by the rotational motion of the friction material under kinematic movement. In the case of applying the rotational friction damper, it is easy to maintain the condition of friction surface, and it can be stable slip proof stress obtained. It is supposed that the amount of energy absorbed by the rotational friction damper incorporated in the structure depends on the amount of the rotational angle of the damper due to the deformation of the frame under lateral force such as an earthquake. Generally, the frame in which the intermediate story is damaged is judged to be dangerous, but if the story can ensure sufficient ductility with enough load-carrying capacity, it is considered that it is possible to design to avoid collapse even under a strong earthquake. It is well known that the damage is apt to concentrate the weaker stories in a frame under strong earthquake, so that the frame cannot show enough its earthquake resistant performance. Even though it has high toughness, improvement of design can be expected by incorporating a stick damper mechanism in order to reduce the ultimate horizontal load-carrying capacity. The stick damper mechanism can obtain more rotation rather than a single rotational damper. This paper concludes the mechanism is effective on vibration control of the steel frames.
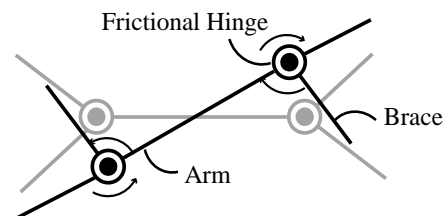
Fig. 1 Stick damper mechanism

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Comparing Victims Living In and Outside Their Hometown of Mashiki After the 2016 Kumamoto Earthquake

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Keywords: 2016 Kumamoto earthquake, residential choice, temporary housing

Abstract

It is important to support the reconstruction of housing for households that have moved out of their hometown after a large-scale disaster. The purpose of this study was to compare the households living in and outside their hometown of Mashiki after the 2016 Kumamoto earthquake and describe their demographic characteristics, concerns, and needs.

The results indicate that single households living within Mashiki tend to live in constructed temporary housing regardless of their age, but single households living outside Mashiki have different trends based on their age; elderly, single households live with relatives or acquaintances and single households that are working-generation live in post-disaster publicly funded rental housing. Finally, we conducted a correspondence analysis using open-ended questions and found that households living within their hometown request the prompt restoration of infrastructure regardless of their income, and those living outside their hometown are seriously considering future housing options as their income increases.
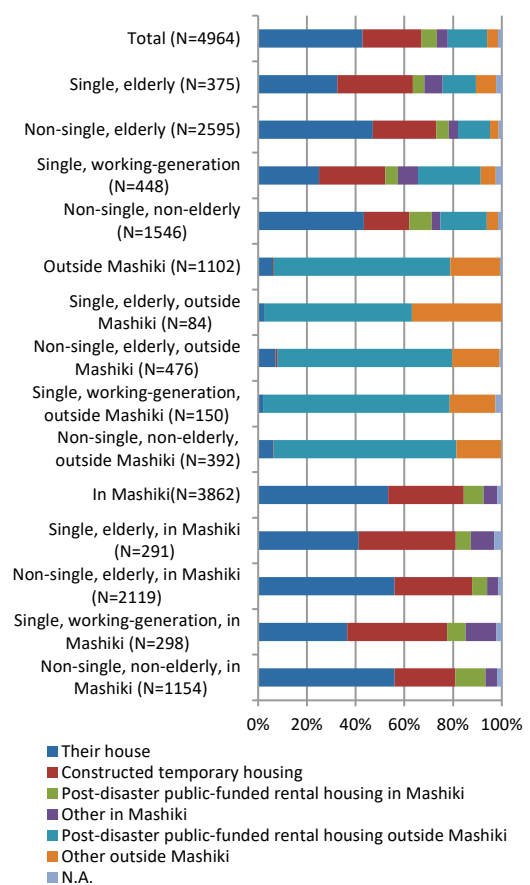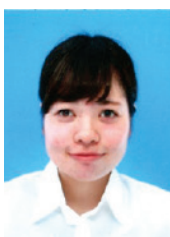
Fig. 1 Current housing distribution of households damaged by the 2016 Kumamoto earthquake by their categories.

About the authors

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Housing Repair Method Choice and Use of Emergency Repair Systems in Mashiki following the 2016 Kumamoto Earthquake

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Abstract

Various systems have been established to support disaster victims after natural disasters, and an analysis of their usage would help improve the support system. The emergency repair system for partially destroyed houses aids in closing evacuation centers proactively and reducing the demand for temporary housing and public housing following a disaster. However, there are many problems associated with the system such as inadequate financial support. In the 2016 Kumamoto earthquake, households with partially damaged homes were offered temporary housing to live in—the first such attempt in Japan—which may have led to an increase in the demand for temporary housing. In addition, it is possible that houses that were repairable were dismantled (Figure 1).

In this study, we focus on the utilization and operation of the emergency repair system after the Kumamoto earthquake, and clarify the actual conditions and problems from both the residents' and government's point of view. Finally, we discuss the need for future system improvements based on the survey results.
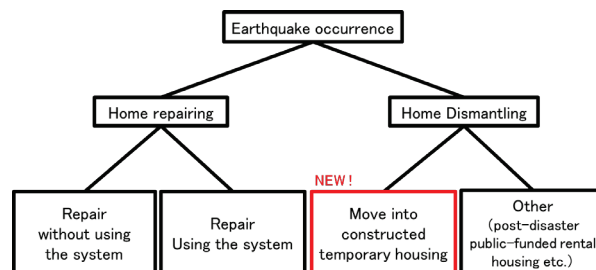
Fig. 1 Housing repair choice process for partially destroyed houses in the 2016 Kumamoto earthquake

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Takuya Maruyama graduated from the University of Tokyo with his PhD in 2004. He worked at the University of Tokyo as a research associate and a JSPS postdoctoral fellow at University of Texas at Austin. He has been an associate professor at Kumamoto University since 2008.

Combination of First-order and Second-order Structural Design of Steel Building Focused on Learning Support System

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Keywords: Steel Structure, Structural Design, Learning Support System

Abstract

This paper describes an combination of the first-order and second-order structural design systems of multi-storied steel frame focused on a learning support system. Conventional computer programs for the structural design have been useful tools for the engineers. However, those have the function that they give the engineers only one solution against a problem with only one set of assumed structural members. Therefore, the conventional computer programs are not well suited to cultivate the novices. In a series of the past research by the authors, the authors have been developing a computer-assisted system based on a new design concept that authors defined as designable space shown in Fig. 1. The system has a mechanism in which designers can determine just one design solution out of multiple design solutions by themselves. The design support system of the steel frame has two types, first-order design and second-order design,
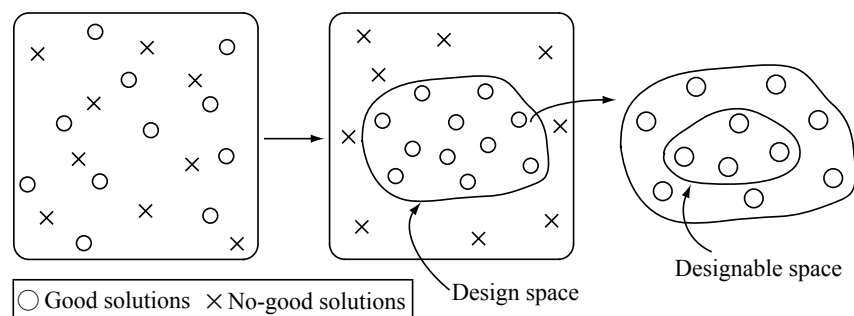

| ◯ Good solutions   ✕ No-good solutions |

Fig. 1. Design space and designable space

and each system is independent. Both designs are usually done successively and it is important to understand the design flow of the steel frame. The system makes them smart the designers that understand the flow of the structural design of the steel frames, and it enables them to acquire a pertinent solution to design problems. Finally, it was confirmed that this system has an efficient mechanism for the novices learning by design examinations.

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Investigation of damage of steel school buildings with suspended ceiling in the 2016 Kumamoto earthquakes

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Abstract

This paper presents the results of time history analysis of steel school buildings damaged by 2016 Kumamoto Earthquakes. A comparison between three buildings in the same site with different plans and directions employed to investigate the seismic behavior of floor and ceiling system. These three-story buildings were built in 1982 after the introduction of Japanese current seismic design code. Based on the past seismic requirements after the construction, the seismic reinforcements for suspended ceilings were made in 2012. The failure of ceiling systems occurred in North building created debris hazard. In comparison with North Building, The damage of other two buildings occurred in smaller events. The deformations and the accelerations on the floors obtained from the analysis of three buildings were compared with each other. These standardized school buildings with suspended ceiling system have the same structure and facilities. As shown in the Fig. 1, 3D-FEM models depending on these building axes and the structural components were created. Using these FEM models, the damages of the ceilings have been compared with the analysis response on the locations in the buildings. Maximum acceleration of the floors in the North Building is larger than other buildings.
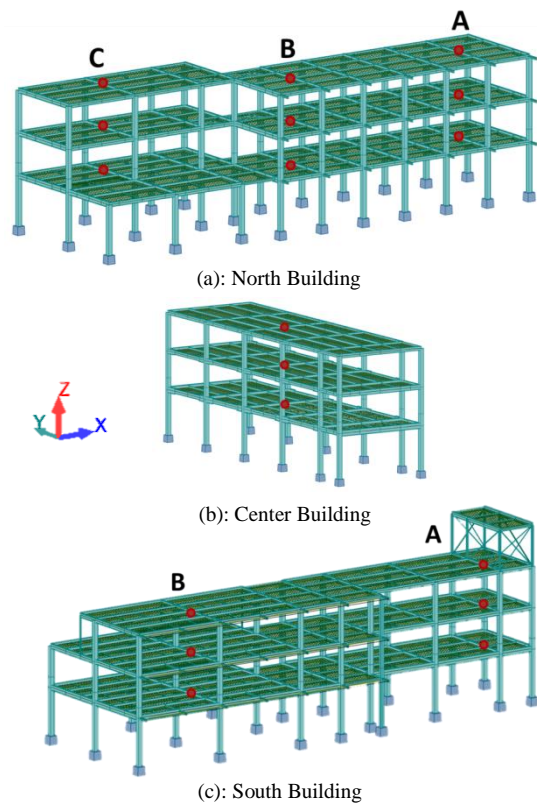
(a): North Building

(b): Center Building

(c): South Building

Fig. 1 3D-FEM model

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Comparative Analysis of Optimization Carsharing Station Placement

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Keywords: Carsharing, Optimal Station location, Genetic Algorithm, simulation analysis

Abstract

This study aims the comparative analysis of optimal carsharing station allocation due to the difference of urban of structure and traffic characteristics by the genetic algorithm which incorporated carsharing operation simulator and, focuses one-way type carsharing which has higher convenience. In other abroad cities where one-way type carsharing is implemented, they have a problem what unbalanced them, fleet vehicles assemble in the specific area.

In Japan, one-way type carsharing has not been implemented because there are legal problems. Meanwhile, in oversea cases, many cities have been introduced, but there are cases that cities have been stopped carsharing services due to cannot keep them revenues, However, expected to implement it by improving these problems. Furthermore, the Efficient operation is required for the carsharing operator.

We guess optimal station allocation is also different because each city has different urban structure and traffic characteristic. Therefore, we aim to reveal that difference of optimal carsharing station location due to urban structure and traffic characteristic. Detail results and analysis will show at the oral presentation.
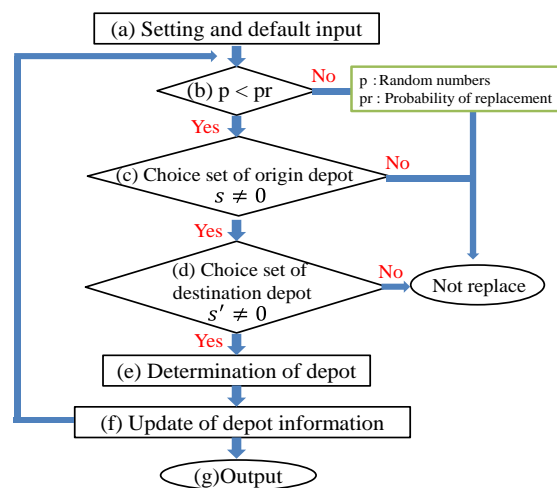
Fig. 1 Simulation Flow

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THE HELLENISTIC SCENE BUILDING OF THE THEATRE AT MESSENE

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Keywords: Hellenistic architecture, Theatre, Scene building, Restoration, Reused block

Abstract

The Hellenistic scene building at the Messene Theatre, it is particularly noteworthy that the majority of the foundation of the Roman scene building was constructed by reusing blocks from the previous building. Based on our recent survey of 2016, these reused blocks appear to have been extracted, modified, and incorporated into the new structure in a systematic manner. This paper reports on the analysis of the original form of the Hellenistic scene building of the Messene Theatre, which is believed to have consisted of two parts: a *proskenion* consisting of a 26.5-m-long Ionic colonnade with wooden *pinakes*, and a *skene* with three *thyromata* to provide costume-changing space for actors. Through the analysis, it was also clarified that the Roman scene building was constructed by systematically reusing the architectural blocks of the Hellenistic scene building. The normal Ionic column drums of the *pulpitum* appear to have been transported from another building, most likely the Arsinoe Fountain.
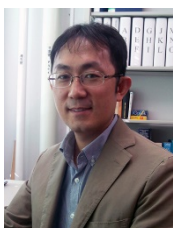
Roman stage of the Messene Theatre

Aerial view of the Theatre at Messene

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Study on stone joint technique in Hellenistic and Roman period in Greece

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Abstract

In ancient Greek architecture, dowels were used to fix vertical joints of members. The object of this study is to analyze the dowels, which were used for twelve buildings built in Hellenistic and Roman period in Attica region. In this study, the author define that Hellenistic period is from the death of Alexander the Great (B.C. 323) to formation of the Roman Octavian regime (B.C. 31), and Roman period when the activity of construction was very active is until 2nd century AD. As a result, the author defines DA/PA as the proportion of Dowel area (DA) to Parts area (PA). Our research clarifies that the proportion of dowel traces to the surface area of the material decreased as the surface area of the member increased. In addition, as the time went down, the surface area of the member increased, probably due the earthquake.
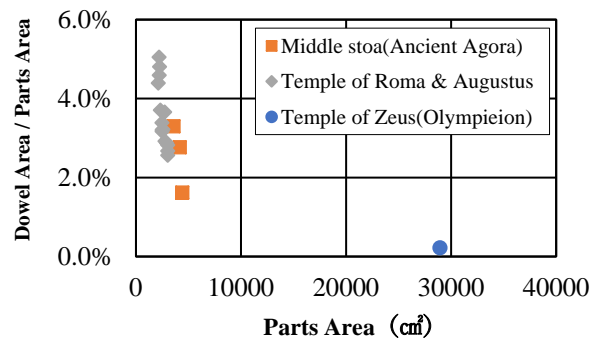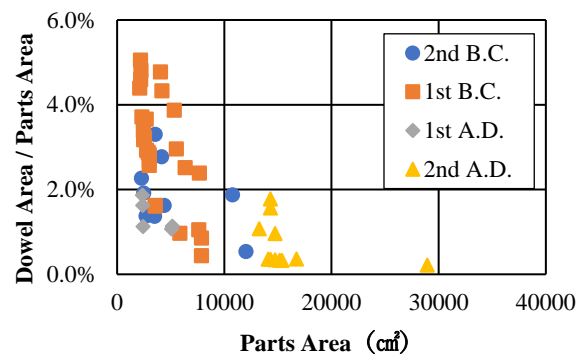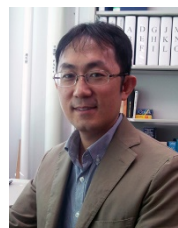
Fig. 1 transition of parts area and DA/PA (Drum)

Fig. 2 transition of parts area and DA/PA (Age)

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