Hydraulic and Ecohydraulic Studies in River Basins

My research areas are river engineering, ecohydraulics and environmental hydraulics. My recent research topics of interest and brief explanations of each are given below.

(1) Water flow and material cycle models river basins

We are working to develop water flow and material cycle models for river basin that can reproduce the dynamic behavior of water and materials across land, river and coastal areas. These models will enable us to evaluate the impact on various social system changes involving water and material cycles within a basin area and propose appropriate management methods. We will also study the impact of the changes in water and material cycles on the ecosystem **from the viewpoints of ecology and geochemistry**.

(2) Basin environmental management

Today, the regeneration of natural environments and harmonious coexistence between man and nature are essential for successful national land formation plans in Japan. It is therefore necessary for us to propose and demonstrate a management system with the three main pillars of the natural environment, water cycle systems, and the social environment. This involves a focus on basin areas and catchment basins, which are the basic units of the water cycle. Consequently, we plan to establish a **management cycle** consisting of the following: the creation and analysis of the GIS database on natural and social environments in the basin; problem finding and presentations of issues through workshops; a study of evaluation methods for achieving sustainability in basins; scenario setting; a trial in the area; and evaluation and policy proposals for pioneering basin environmental management.

Suspended sediment dynamics in the Nagura River Basin, Okinawa, Japan

About Researcher

AKAMATSU Yoshihisa, Ph.D.

Ph.D., 2003, Tokyo Institute of Technology

Prevention from Flood Disaster

My research areas are computational hydraulics, disaster prevention hydraulics, and environmental hydraulics. Recent research topics of interest to me and brief explanations thereof are given below.

(1) Numerical simulation for open channel flows with large eddy simulation (LES)

I have conducted **numerical simulations with LES** for hydraulic problems such as back step flows, local scour around river structures, and the secondary flow of meandering rivers.

(2) Lateral overflow from curved channels

River banks can break where rivers curve. However, existing formulations of lateral overflow have been developed for straight channels. In this study I have developed **lateral overflow discharge formulations for curved channels**. The photo shows the experimental setup for this study.

(3) Study on the use of light emitting diodes (LEDs) to purify lake water

It is very important to improve the Dissolved Oxygen (DO) concentration or low DO concentration of water columns in the lower layers of lakes. My laboratory has been developing **a DO improvement technology that utilizes LEDs**.

Experimental setup for study on lateral overflow in curved open channels

About Researcher

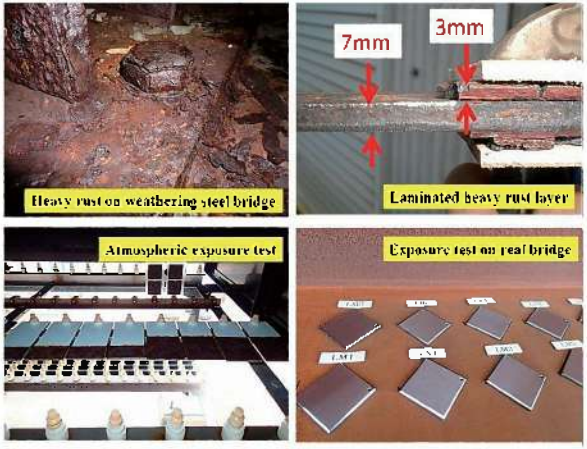
ASAI Koji, Dr.Eng.

Dr.Eng., 1995, Kyushu University

WEB ※ http://www.suri.civil.yamaguchi-u.ac.jp/index2.php?

Corrosion and Maintenance of Weathering Steel Bridges

Bridges are generally categorized into Two types: concrete and steel. For steel bridges, preventing corrosion is very important. We have studied the corrosion of and maintenance techniques used with steel bridges. In particular, for weathering steel, which has recently been widely used, we are conducting research by experiment and analysis. **Weathering steel** can provide corrosion protection without a paint layer. This makes the life cycle cost of bridges built with weathering steel lower than those with painted steel bridges. This advantage has led to an increased use of weathering steel in the structural components of steel bridges in Japan. In some cases, however, very severe surface corrosion damage has been observed. Our main objectives are 1) to clarify the **corrosive environment** under which weathering steel exhibits this phenomenon, 2) to clarify the expression mechanism of dense protective rust. These studies have been carried out by exposure tests in the field, element tests in the laboratory, and through numerical analysis. **Inspection guidance and repair techniques** for weathering steel bridges severely damaged by corrosion has also been studied in collaboration among industry, government, and academia.



Weathering steel rust and exposure tests

About Researcher

ASO Toshihiko, Dr.Eng.

Dr.Eng., 1992, Kyushu University

WEB ≫ http://www.bridge.civil.yamaguchi-u.ac.jp/index-jp.html

Long Term Durability of Cement and Lime-Stabilized Soil

Deterioration of cement and lime-stabilized soil under some natural environments has become an important issue for the **long-term durability** of improved soft ground. One study confirmed the deterioration of stabilized soil being used at the foundation of a dike constructed several decades ago and located along a **tidal river** in Japan. However, due to its short history, the long-term durability of soil stabilization by chemical methods has not been discussed. We have been carrying out the following research to help solve the problem of chemically-stabilized soil deterioration.

1) Elucidation of deterioration phenomenon with regard to stabilized soil, including the leaching mechanism of solidification components, speed of deterioration progression, and changes in strength and deformation properties. 2) Development of a method to evaluate the long-term durability of stabilized soil in marine environments. 3) Development of **new solidification materials** for ground improvement that have high durability in marine environments.

Deteriorated lime-treated clay in a marine environment

About Researcher

HARA Hiroyuki, Dr.Eng.

Dr.Eng., 2010, Saga University

Extending the Life Span of Steel Bridges by Reducing Corrosion Deterioration

Nowadays, the maintenance of road bridges in Japan has been attracting significant attention due to issues relating to their aging. There are two main materials used for bridges: concrete and steel. My research aims to extend the life span of steel bridges by **reducing corrosion deterioration** due to chloride, and proposing efficient maintenance methods based on advanced robotic technology.

Chloride anti-freezing agents are one of the main causes of serious corrosion deterioration. In order to prevent this, my research proposes the use of non-chloride anti-freezing agents. With regard to the use of such agents, the method to reduce corrosion deterioration should be clarified. To achieve this goal, we have conducted research based on a **rust composition analysis** and element analysis, and an evaluation method based on those analyses was proposed. In addition, as an efficient maintenance method, using robotic technology for inspection and analyzing corroded steel images by **machine learning** have been researched as well.

Corrosion detenoration due to chloride anti-freezing agents on a steel bridge

About Researcher

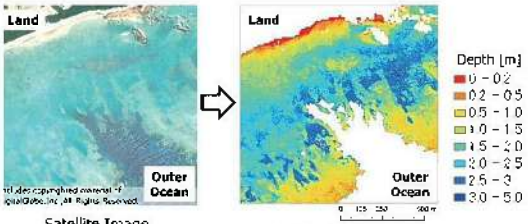
HASUIKE Rina, Dr.Eng.

Dr.Eng., 2000, Gifu University

WEB ▸ http://www.bridge.civil.yamaguchi-u.ac.jp/aso_lab/index.html

Development of Efficient Photogrammetry and Remote Sensing Methods

I have developed **data analysis algorithms** for satellite images and meteorological/environmental monitoring data for a broad range of applications: **satellite-based remote sensing** of surface solar radiation and shallow water (e.g., coral reef) topography, analyzing secular trends in surface solar radiation, and short-term predictions of air pollution. My main interest lies in refining the existing algorithms to make them more logical and sophisticated by using both physical and statistical principles.
My recent research focuses on **UAV-based photogrammetry** of topography using Structure from Motion and Multi-View Stereo techniques. In addition to efficient flight/shooting strategies for land survey applications, I have developed techniques that remove light reflection/refraction effects for through-water applications to shallow water bottoms (e.g., riverbeds).
As I belong to the engineering department, my goal is not getting funds or journal publications, but rather getting my methods widely used in society. I am collaborating with companies who are testing my methods and trying to put them into practical use.



Satellite Image (QuickBird; 2.4 m res.)

Estimated Depth Map

High resolution reef bathymetry obtained by my algorithm

About Researcher

KANNO Ariyo, Ph.D.

Ph.D., 2010, The University of Tokyo

WEB ☞ http://web.cc.yamaguchi-u.ac.jp/~kanno/

Use of Native Microbes to Solve the Civil Engineering Problems

Microbes are the origin of the life in this world. They made our planet earth as a habitable place for the human being and the other animals at the beginning. These microbes which are the tiniest creature in the world can be used to solve some of the biggest problems which are currently facing by the humanity such as **waste management problems, clean energy shortage, environmental pollution, and geo-disaster problems**. In our laboratory, the native bacteria (which is found in the place in where the problems are occurring) of Japan is using to solve these problems. The major background of my research theme is the current state of the world, the lifestyle of the people and their energy and environmental situation. Biocementation is using for **green construction**, Microbial Fuel Cell is using for **Bioelectricity generation** and Bioremediation is using for **cleaning the environment**.

Fig.1

Fig.2

Fig.3

Fig.1 Conceptual image of the research to solve the earth's problems by using native microbes, focusing on green energy, green construction, and bioremediation.
Fig.2 Biocementation of granular soil
Fig.3 Electricity generation from living plants

About Researcher

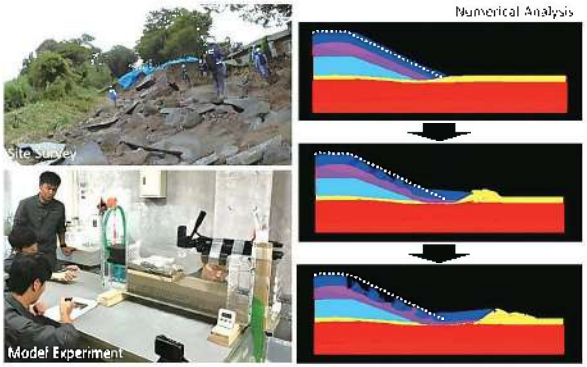
MD.Azizul Moqsud,Ph.D.

Ph.D.,2007,Saga University,Japan
Visiting Scholar(2018-19),University of California Berkeley,USA

WEB : http://ds.cc.yamaguchi-u.ac.jp/~azizul/

How does a river levee breach?
- A study on the processes of failure -

One of our research focuses is to better understand the mechanisms involved in river levee failures. A **river levee** is an essential piece of geo-infrastructure for protecting homes and fields from floods. However, under certain circumstances, levees can breach. For example, the catastrophic flooding along the Kinu River in 2015 is deemed to have been caused by the water level' s exceeding the crest of the levee, a process known as overtopping. Another example is the foundation failure seen along the Yabe River in 2012, where the levee breach is believed to have been caused by **piping** (or **internal erosion**) associated with seepage through a highly permeable layer in the foundation. These mechanisms are yet to be fully understood, and further complexity arises because levees are normally constructed from soils that are not well characterized. Therefore, we aim to clarify the conditions for and processes of levee failures through site investigations, model experiments and numerical analysis.



Clarifying the conditions for and processes of river levee failures through site investigations, model experiments and numerical analysis.

About Researcher

MORI Hirotoshi, Dr.Eng., MSc

Dr.Eng., 2010, The University of Tokyo

WEB ≫ http://web.cc.yamaguchi-u.ac.jp/~mori/

Permeable Pavement for Stormwater Runoff Management

Permeable pavement has been used in lightly trafficked areas since the mid-1970s to reduce stormwater runoff. Recent frequent occurrences of urban floods on a worldwide scale have prompted a broader application of the pavement to more heavily trafficked roadways. There are, however, still several problems to solve, including pavement durability, longtime performance of infiltration and storage, and the risk of geo-environmental pollution by seepage water. Our research aims to solve these problems through experiments, numerical analysis, and field measurements, and to establish design and maintenance methods for permeable pavement. Permeable pavement contributes to not only urban flood control but also groundwater recharge, improvement of urban heat problems, and fewer traffic accidents. Sophistication and diversification of road space is what we are aiming for.

Cyclic plate loading test of permeable pavement model under saturated condition

About Researcher

NAKASHIMA Shinichiro, Dr.Eng.

Dr.Eng., 2002, Kyoto University

Geomechanics from Micro to Macro and Its Application to Slope Stability

In many geotechnical engineering applications such as penetrometer testing, pile driving and end bearing resistance, and high earth or rockfill dams, soils may experience stresses high enough to break particles of even the strongest soil minerals. There are also many weak-grained **crushable soils** such as decomposed granite soil, carbonate sands, or volcanic ashes, for which particle crushing can be important even under low stress conditions. For these reasons, the effect of particle crushing on the deformation response of soils should not be neglected. This is true because a change in grain size distribution due to crushing may create a more drastic change in internal structure than can be achieved by particle rearrangement alone.

Recent years have seen the occurrence of serious **slope disasters** in the Chugoku region of western Japan. The surface geology of the areas of occurrence were covered mainly with a granite. The explication of a debris flow generating mechanism using decomposed granite soil was needed for future disaster prevention and mitigation. Simulating crushable soils using **DEM** has become a powerful tool that provides valuable insights into the micro-mechanical origins of soil plasticity and may lead to effective solutions.

Decomposed granite soil in debris disaster that occurred in Hofu city, Yamaguchi in July, 2009

About Researcher

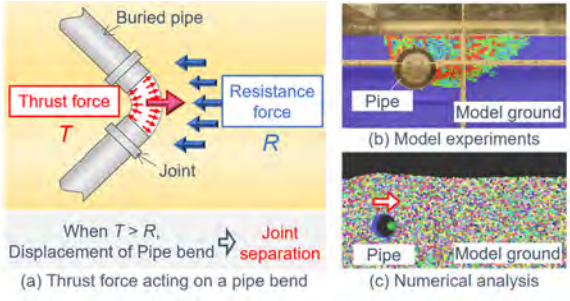
NAKATA Yukio, Dr.Eng.

Dr.Eng., 1995, Yamaguchi University

WEB ≫ http://geotech.civil.yamaguchi-u.ac.jp/staff/nakata/index.html

Interactions between Pipes and Soil for Making Stable Buried Water Pipelines

Japan has approximately 700,000 km of water pipelines that support the stable water supply. The long pipelines have been aging, and there is an urgent need to take disaster mitigation measures, which calls for repairing and reinforcing pipelines. From a structural viewpoint, one of the weakest parts of pressure pipelines is the **pipe bend** due to unbalanced forces, referred to as **thrust forces**, produced depending on the magnitude of internal water pressure. The resistance force from the surrounding soil is expected to resist the thrust force. However, if the resistance force is insufficient, the pipe bend may become displaced, causing the joints to separate and water to leak. Therefore, it is essential to accurately understand the relationship between the thrust force and the resistance force in order to ensure pipe bends are stable. My research investigates **interactions between pipes and soil**, particularly the mechanism of thrust resistance force generation, based on the results of model experiments and numerical analyses. I am also working on developing countermeasures to ensure that there is resistance force against thrust force.



Model experiments and numerical analyses are conducted to investigate the relationship between thrust force and resistance force.

About Researcher

OHTA Yoko, Ph.D.

Ph. D., 2023, Kobe University

Participatory Planning and Consensus Building

Participation by citizens and stakeholders in decision making processes is becoming more important in urban, regional, and environmental planning. The decision making process, where multiple individuals or organizations are involved, can be called a **participatory decision making process**. In the field of urban, regional and environmental planning, it is difficult to find alternatives that improve the conditions of the majority without making any others worse off. Consequently, a proposal for changing the status quo often causes a conflict. To govern such a conflict, individuals or organizations that have concerns about the policy need to communicate, understand each other, and find a solution. The participatory decision making process can be interpreted as a means for governing a conflict. To support a participatory decision making process, we proposed **a model that describes a policy conflict** as the communication base, which is shared by participants involved in the participatory decision making process. We are also using **text mining methodologies** to understand participants' concerns.

Opinions aggregation in workshop discussion

About Researcher

SAKAKIBARA Hiroyuki, Ph.D.

Ph.D., 2001, Kyoto University

WEB ≫ http://www.civil.yamaguchi-u.ac.jp/?page_id=1628&lang=en

Attitude and Behavior Modification to Achieve Sustainable Transportation

In modern society, motorization leads to economic growth and improves the convenience of daily life. However, excessive car use also causes various social, environmental and psychological problems. These problems are prominent issues, especially in small-mid size provincial city. For example, highly-motorized cities have a reduced need for public transport services and result in mobility gaps. With our research, it is suggested that excessive motorization causes a decline in subjective well-being and emotional place attachment toward residential place. In addition to improving infrastructure, we need to promote change concerning people's attitude and behavior in order to solve these problems and achieve **sustainable transportation**.

With these perspectives, our research explores the following: 1) How to modify people's attitude and behavior towards more sustainable behavior (**Mobility Management**), 2) How to get people more committed to engaging in public activities, 3) What is sustainable and "good" travel behavior. Regarding measures against mobility gaps in local cities, we examined the effect of car-sharing services and public transport services owned by neighborhood communities.

Effective discussion in communities is essential to achieving sustainable transport

About Researcher

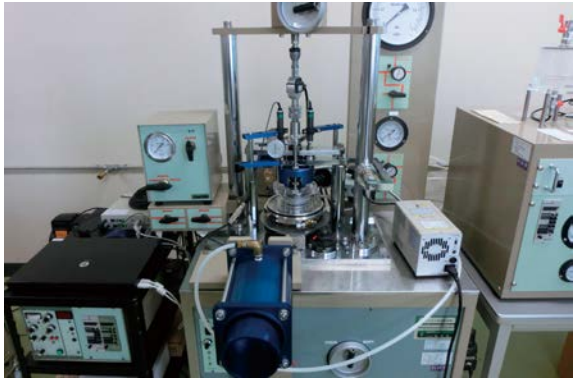
SUZUKI Haruna, Dr.Eng.

Dr.Eng., 2009, Tokyo Institute of Technology

WEB ≫ http://www.plan.civil.yamaguchi-u.ac.jp/suzukieng.html

Static and Dynamic Mechanical Properties of Naturally Cemented Soil and Risk Assessment of Earthquake-Induced Landslides

Mitigation of natural disasters is becoming an increasingly important and urgent matter in today's world. Landslides that occur during a torrential rain or earthquake are a particularly serious problem in hilly and mountainous regions like Japan. It is therefore necessary to predict and control the behavior of landslides to prevent the loss of human lives and property. We are also engaged in the following research projects through experimental and numerical approaches. According to the case histories of previous earthquakes, innumerable landslides have occurred along discontinuous planes in natural slopes composed of mudstone, sandstone, and other such rock. It is therefore very important to evaluate seismic slope stability using the shear strength of soils subjected to substantial accumulated deformation as a result of cyclic shearing. The static and dynamic mechanical properties of the soils, however, have not yet been investigated. Accordingly, cyclic ring shear tests we developed are being carried out by setting different conditions using weakly cemented soils. The current research focuses on clarifying the effects of loading conditions on the mechanical behavior of the boundary surfaces between non-cemented and cemented soils. Further, the numerical solution for estimating residual deformation caused by an earthquake is tentatively being developed by application of Newmark's method as modified by us. The outcome of the research will prove useful for proposing a reasonable anti-earthquake design method.



The "Cyclic ring shear test apparatus" we developed. It has the smallest specimen among similar test apparatuses (inner dia. 42mm, outer dia. 70mm, height 20mm). Shear and normal forces, skin frictional force, shear and normal displacements, pore water pressure are severally monitored. It provides the macro zoom capture system for observation of soil particles around slip surfaces.

About Researcher

SUZUKI Motoyuki, Dr.Eng.

Dr.Eng., 1998, Shinshu University

WEB ≫ http://web.cc.yamaguchi-u.ac.jp/~taishin/

Structural Dynamics and Performance Monitoring of Bridge Structures

Bridges are an important lifeline that supports our safe and secure lives. We aim to develop a bridge that is resistant to earthquakes by analyzing how bridges shake during an earthquake, based on numerical simulations. The figure shows a three-dimensional model (**digital twin**) created for use in the simulations. We create **digital twins** and conduct research using simulations in order to evaluate the **earthquake** resistance of bridges, develop new seismic devices, and perform **health-monitoring** to evaluate bridge performance.

In order to create a bridge that is resistant to earthquakes, it must be made resistant not only to external forces, but also to earthquake effects that could damage it by flexibly deforming it. It is important to reduce these effects, for example by installing seismic isolation bearings, damping devices, etc. We are conducting research to create bridges that are resistant to natural disasters using new technologies such as simulation, monitoring, and digital twins.

Three-dimensional model of a bridge structure (digital twin) created for conducting simulations of bridge earthquakes

About Researcher

WATANABE Gakuho, Dr.Eng.

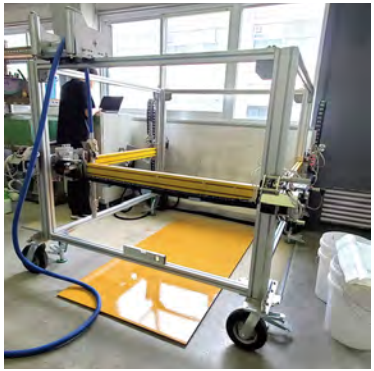
Dr.Eng., 2005, Tokyo Institute of Technology

Development of Printing Materials for the Social Implementation of 3D Printing for Construction

In Japan, the working-age population is declining due to a shrinking population and an aging society with a decreasing number of children. In addition, the construction sector tends to have longer working hours than other industries, and there is a need to review working hours.

In response to these problems, construction sites are required to **automate construction** and **shorten construction periods** by using digital technology. **3D printing for construction** uses mortar or concrete as ink and, like conventional 3D printers, automates construction because the printer automatically prints in three dimensions using a 3D model. In addition, while conventional concrete construction requires formwork, 3D printing for construction can omit formworks because the material is self-supporting, thereby shortening construction periods. On the other hand, there are issues such as the high costs of materials and difficulty of reinforcing with steel materials as in the case of conventional concrete structures.

In this study, we are developing low-cost materials that do not require steel reinforcement.



A 3D printer used for construction. The nozzle moves around the area enclosed by the frame to eject the mortar that will be used as ink.

About Researcher

YAMADA Yuji, Dr.Eng.

Dr. Eng., 2017, Tokushima University

WEB ≫ http://www.civil.yamaguchi-u.ac.jp/EN/

Coastal Erosion Caused by Massive Peat Failure and Formation of New Peat in Tidal Flat Ecosystems

Massive **coastal erosion** is occurring on Bengkalis Island in the the Strait of Malacca in **Sumatra**, Indonesia. Before the 1950s, mangrove forests grew in the coastal areas. These forests have gradually disappeared since the 1960s, and inland **peat** swamp forests have begun to erode. From 1988 to 2013, 741 hectares of peatland on the island was lost. The erosion rate on the coast has almost doubled in the last 5 years. An annual total of 2.6 Mm^3 of peat and 1.2 Mm^3 of clay has eroded into the ocean. Annual particulate organic carbon loss from the Bengkalis Island is at a peak 0.13 Tg. On the other hand, new peat is being formed in tidal flats on the other side of the island, which presents the possibility of establishing new ecosystems. Yamaguchi University is collaborating with Politeknik Bengkalis, Riau University to clarify the mechanisms of the peat failure and estimate the amount of carbon loss to the ocean.

Inland peat swamp forests are now exposed to the sea and are in danger of being eroded (Bengkalis Island, Indonesia, 2014)

About Researcher

YAMAMOTO Koichi, Ph.D.

Ph.D., 2002, Hokkaido University

WEB ≫ https://www.facebook.com/yamolabo

Water Resources Risk Assessment on Climate Change

Fresh water is fundamental for human life and makes up about slightly 0.01% of all water on Earth. About precious water resources which is critical for human activities, One standard used to understand water resources in the future is to know whether climate change will cause precipitation to increase or decrease. The rise in the Earth's temperature, which is caused entirely by global warming, has recently been remarkable, and cases of extreme weather, including heavy rain, drought, floods, and water shortages, have become more frequent.
This study aims to understand **hydrological cycles on earth** from various aspects and develop methods of future **water resources risk assessment** on **climate change** in order to contribute to disaster prevention and mitigation against heavy rain, drought, floods, and water shortages caused by extreme weather.

The lake, ecosystem, and artificial structures at Tokiwa Park. Fresh water used by human make up less than 0.01% of all water on Earth.

About Researcher

YOSHIDA Natsuki, Dr. Eng.

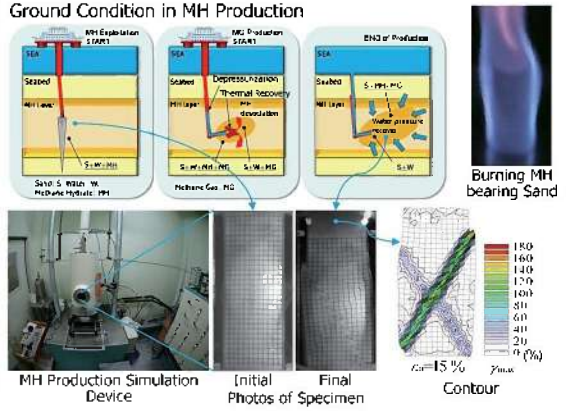
Dr.Eng.(Civil Engineering) 2018,
The University of Tokyo

WEB ≫ https://researchmap.jp/natsukiyoshida
http://www.civil.yamaguchi-u.ac.jp/research/researcher/

Exploitation of Deep Seabed Resources and Geotechnical Engineering

In the deep seabed, **methane hydrate** is stable under conditions of high pressure and low temperature. It exists in a cemented state between sand particles of sandy sediments beneath the deep ocean floor. Several production methods have been proposed for extraction of the gas from hydrates, namely heating, depressurization, and inhibitor injection methods. However, there are still many uncertainties regarding the production process, especially with respect to subsurface deformation caused by dissociation. In order to solve many of these uncertain problems, our research group has performed a number of experimental and analytical studies. We have developed **special experimental devices** for methane hydrate testing, as well as a **constitutive model** and a **simulation method based on a chemo-thermo-mechanically coupled analysis** to predict ground deformation due to dissociation.

Representative articles: 1) Hyodo, M., Yoneda, J., Yoshimoto, N., and Nakata, Y.: Mechanical and Dissociation Properties of Methane Hydrate-Bearing Sand in Deep Seabed, Soils and Foundations, Vol.53, No.2, pp.299-314, 2013. 2) Yoneda, J., Hyodo, M., Yoshimoto, N., Nakata, Y., and Kato, A.: Development of High-pressure Low-temperature Plane Strain Testing Apparatus for Methane Hydrate-bearing Sand, Soils and Foundations, Vol.53, No.5, pp.774-783, 2013.



Ground condition in MH production, burning MH bearing sand, MH production simulation device, photos of specimen, contour

About Researcher

YOSHIMOTO Norimasa, Ph.D.

Ph.D., 2007, Yamaguchi University

WEB » http://geotech.civil.yamaguchi-u.ac.jp/

Advanced Composite Materials for Strengthening Concrete Structures

My primary research interest includes the maintenance and strengthening systems for infrastructure such as bridges and tunnels. In particular, the targets of my research are aged / deteriorated / damaged concrete structures. The current projects of my research group are outlined below:

1) Applicability of **advanced composite materials** for strengthening.

The research project aims at examining the durability of concrete members strengthened with fiber reinforced polymers (FRP). A near-surface mounted (NSM) FRP strengthening system has been developed for steel-reinforced concrete (RC) slabs of highway bridges. The current project is developing a novel NSM-FRP strengthening system for damaged tunnel lining concrete.

2) **Post-tensioning system** with an internal anchorage for strengthening concrete.

The research project aims to develop a reliable internal strengthening technique applicable for a broad range of concrete structures. The internal strengthening system can improve the load-carrying capacity and crack-resistance of concrete members. To mitigate the possibility of steel corrosion, the applicability of CFRP cable as an alternative steel tendon is examined.

3) **Non-destructive testing (NDT)** technique for the invisible deterioration of concrete.

The research project aims at detecting unfilled ducts in post-tensioning prestressed concrete by analyzing ultrasonic reflection waves. In addition, to detect the deterioration of FRP-covered concrete, the project develops a novel NDT using electrical impedance variations and phase transitions.

Moving-wheel load test for a cantilever RC slab strengthened with CFRP rods

About Researcher

YOSHITAKE Isamu, Dr.Eng.

Dr.Eng., 2000, Yamaguchi University

WEB ⁄ http://www.concrete.civil.yamaguchi-u.ac.jp/english.html
http://www.concrete.civil.yamaguchi-u.ac.jp/yoshitake-e.html