Abstracts

1 3-D FEM Simulation Analyses of Forced Vibration Tests during both Horizontal and Vertical Excitations of PWR-type Reactor Building

by Michihiro Ohori, Masataka Kaneko, Yuzuru Yasui
Manabu Endo, Yoshiaki Komatsu and Toshio Kuno

Many studies have been done on horizontal responses of reactor buildings using results of forced vibration tests, but no thorough one has been done on vertical responses. This paper reports forced vibration tests and simulation analyses on both horizontal and vertical excitations of a Pressurized Water Reactor (PWR) type 4-loop reactor building (1,180 MWe): the Genkai Nuclear Power Station Unit 3 of the Kyushu Electric Power Co., Inc. Vibration characteristics were obtained, such as natural frequency, modal shape, and modal damping factor of the building. A three-dimensional (3-D) FEM model was used to simulate test results in detail. Simulation results showed good agreement with test results with respect to vertical as well as horizontal responses. This study confirms that 3-D FEM modeling accurately expresses the vibration characteristics of the reactor building.

2 Analysis of Unsymmetrical Pressure Acting on Circular Retaining Wall

by Takashi Hanya, Masato Ito, Junji Sakimoto and Kunioki Hirama

Circular retaining walls are sometimes excessively stressed due to unsymmetrical pressure. There has recently been increasing construction of large-diameter thin-section walls in bad ground conditions, making it important to estimate unsymmetrical pressure in their design.A three-dimensional FEM analysis has been carried out to estimate the influence of unsymmetrical pressure caused by ground conditions and indefinite factors relating to construction methods on wall displacements and stresses, in order to check the structural stability of circular retaining walls. Analysis has also been carried out using a three-dimensional shell-spring frame model normally used in design of circular retaining walls. As a result, a practical design method has been developed using the relation between unsymmetrical pressure and earth pressure at rest.

3 Lateral Resistance of Piles Near a Cliff (Part 2) —— Estimation of Lateral Resistance of Pile ——

by Fumio Chatani, Takashi Nishiyama and Yusuke Miyazaki

Part 1 has reported model load test results for a pile near a cliff. Part 2 analyzes the test results of Part 1 by FEM and confirms that the behavior of a pile near a cliff can be simulated by deriving an appropriate stress/strain relationship for the soil. A series of FEM simulation analyses was performed for steel pipe piles near a cliff. Parameters adopted were distance of pile from cliff, cliff height, soil rigidity, etc. As a result, a practical estimation method is suggested for lateral resistance of piles near cliffs.

4 Study on Low-heat, Ultra-high-strength Concrete for Diaphragm Walls —— Concrete Workability and Strength Distribution in Construction of Actual Wall Panels ——

By Norihiko Miura, Shigeru Aoki, Yasumichi Kousiro,
Hidenori Kawamura, Shigeyuki Sogo and Isao Aihara

Mix designs of low-heat, ultra-high-strength concrete have been tested in experimentally constructed diaphragm walls to verify its applicability to large-scale underground structures. The following results were obtained: 1) Ultra-high-strength concrete can be produced even in a ready-mixed-concrete plant by using high-belite-content cement and a w/c ratio reduced to the range of 22%, and it shows good workability when placed by the tremie method. 2) The mean rising velocity of trench concrete placed by the tremie method can be determined from its flow-out time through a funnel, which is closely related to its viscosity. 3) Strength tests on cores taken from constructed walls showed that more than 110N/mm^2 of specified could be achieved in actual diaphragm wall structures. 4) The strength gain in the depth direction of the diaphragm wall seems to occur under combined conditions of high curing temperature and high pressure under self weight. In this experimental construction, higher structural strength was obtained than under normal curing.

5 Development of Prestressed Concrete Members with Rectangular Carbon Fiber Tendons

by Motoyuki Okano and Hajime Ohuchi

A continuing study on carbon fiber tendons is in progress to improve corrosion resistance of prestressed concrete structures. Rectangular carbon fiber tendons are especially effective because of their strong bond and their ability to be wound in a small diameter.This paper describes fundamental tests on rectangular carbon fiber tendons and bending tests on pre-tensioning prestressed concrete beams.The results of these tests (tensile strength, relaxation, and bond strength) demonstrate that these tendons can be applied as prestressed concrete tendons, and those of the bending tests demonstrate that they make full strength of the tensile tests in concrete beams,and the ultimate load can be calculated by existing methods.

6 A Study on Strengthening with Carbon Fiber of Existing Reinforced Concrete Structures (Part 3) —— Experiments on Shear Strengthening of Beams ——

by Yuichi Sato, Hideo Katsumata and Yoshiro Kobatake

The seismic retrofitting technique using CFRP (Carbon Fiber Reinforced Plastic) sheets has been applied to concrete structures such as chimneys, bridge piers and building columns, and it is hoped to extend it to building beams. Members are shear strengthened by wrapping in CFRP sheets to provide a confining effect. Beams, however, are usually connected to slabs, making wrapping impossible. CFRP sheets are expected to peel if they are bonded in a U-shape under the slab, so they need to be anchored to the beam. An experiment was conducted using various anchoring methods to develop a shear strengthening technique for beams and a method of estimating strengthening effectiveness. Test results have shown that sufficient strength can not be achieved unless the CFRP sheets are mechanically anchored with steel plates and bolts. Although the most effective method is wrapping in CFRP sheets, U-shaped wrapping combined with lateral steel plates and resin-bonded bolts also provides sufficient strength. This paper introduces a method of estimating the shear strength of retrofitted beams, and suggests some modification to the equation proposed by the Architectural Institute of Japan (AIJ).

7 Development of Permanent Form, "ORI-FORM" (Part 3) —— Development of Structural Part of Beam, "ORI-FORM III" ——

by Mitsuo Koyanagi, Sunao Nakane, Kenzo Yoshioka and Yuzuru Kobayashi

Precast panels have been developed as permanent forms for use as part of the structural frame. The structural

ability of composite beams incorporating these forms was confirmed by bending-shear tests. The material ability of panels was also confirmed from tests on bending strength, compressive strength and bond strength between panel and concrete.The ultimate strength of composite beams based on shear destructive pattern was 1.2 to 1.4 times that of ordinary RC beams, and based on bending destructive pattern it was equal. Design guidelines for RC beams based on the ultimate strength concept can also be applied to composite beams.

8 Development of a Material Control System in Industrialized RC Construction

by Kazunari Fukuda, Takashi Shiokawa, Koji Hamada and Tatsuya Wakisaka

A Material Control System has been developed for efficient construction management, and has been applied to a certain construction site. This system was found to have the following three merits:1) It uses a CAD system, which is effective in construction management, erection planning and transportation planning.2) It effectively monitors site work progress effecting formwork planning and transportation planning.3) It enables accurate construction management by enabling automatic recording of data for all materials by handheld computer.This paper outlines the system and describes a practical application.

9 Development of All-weather Construction Facility for Civil Work —— Movable and Soundproof System for Improving Labor Conditions and Preserving Site Environment ——

by Tetsumi Higasayama, Masayoshi Tsuboi, Kiyoshige Nishibayashi and Shigeru Hirano

All-weather construction methods have not been developed for civil works as they have for building work, because a civil construction site is so much larger and more mobile, making it difficult to cover an entire site with a roof. Civil construction involves a lot of earthworks, so it is greatly influenced by the weather. There have recently been increasing cases where work has been restricted by noise, dust and dirty site effluents.The authors have developed an All-weather Construction Method for civil works, which increases the working rate and improves labor conditions. It also protects the site environment from construction noise and dust, and improves the view. After many feasibility studies, two systems have been utilized in practice. One is a movable facility for road works, and the other is a soundproof facility for sinking large-section shafts.

10 Underfloor Air Distribution System for Reduced Energy Consumption (Part 1) —— Model for Predicting Room Air Temperature Profiles ——

by Hisashi Fujita and Kanji Sakai

Room air temperature stratification inherent in underfloor air distribution systems can be utilized to reduce energy consumption. The objective of this research is to develop a model for easily predicting room air temperature profiles in relation to the air flow rate and temperature of supply air, as well as the heat load on the room. Measurements were made in a full-scale test room under various conditions of floor-mounted outlet types, supply air flow rates and heat loads. A model for simulating room air flow patterns is proposed on the basis of the measurement results. It consists of two vertical areas (occupied area and jet area) and three horizontal zones (entrainment zone, diffusive mixing zone and piston flow zone). Further analysis of the measurement results by applying the model clarifies some relationships regarding air flow and heat. The model with these relationships reproduces the measured profiles with practical accuracy. It is shown by comparison with the uniform room air temperature case, that the underfloor air distribution system consumes less energy and allows a lower temperature rise with an increase in heat load.

11 An Airflow Simulation Technique using the Overset-type Composite Grid Coordinate System

by Yoshihide Suwa

Airflow simulation systems have recently been applied to several kinds of problems, and the results have been utilized in design of building structures and control of wind environments around buildings. However, it has sometimes been difficult to apply these techniques in particular cases. Most of them are based on formulations which use single-structured grid coordinate systems, and their applicability is limited when the flow fields have complicated configurations.In this research, we developed a new airflow simulation technique which enables application to complicated flow field problems. With this technique, flow fields are modeled by dividing them into local grid systems, and fundamental equations are solved using the overset type composite grid calculation technique. Complicated flow fields can thus be easily handled, and it also becomes possible to change locations and angles of obstacles in the flow field. This technique performs powerfully in parametric studies on problems which could not be simulated with conventional techniques. This paper describes an application example on a draft airflow problem through an opening with a complicated configuration.

12 Development of a Long-term Thermal Energy Storage System (Part 2) —— Energy Conservation and Economic Efficiency of Aquifer Thermal Energy Storage ——

by Kenji Mikoda, Kanji Sakai and Hisashi Fujita

Aquifer Thermal Energy Storage (ATES) is categorized as a seasonal storage method,so it is an important technique in predicting the effect of thermal energy storage,including the influence of underground water flow. In particular, to determine whether the ATES system is better than the conventional air conditioning system, it is necessary to estimate its consumption of secondary energy such as electrical energy. A numerical simulation program has been developed to analyze the ATES. Several case studies were carried out for the warmed area of a medium-sized office, and the heat energy conservation and electrical energy consumption were calculated to determine an economically optimum system.

13 Method for Predicting an Urban Thermal Environment (Part 2) —— Support for Zonal Development Plan with Numerical Models ——

by Hiroyuki Akagawa, Hidetaka Komiya and Yasuyuki Miyagawa

The effects of vegetation and building layout in the summertime thermal environment have been evaluated with numerical models for an imaginary development a few square kilometers in area. Firstly, heat fluxes from various ground cover materials such as asphalt, concrete, etc., were calculated with a vertically one-dimensional heat-balance model for a typical summer day. This model took into account the static stability of the atmosphere in the boundary layer. Heat fluxes from trees, which were evaluated at both the crown and the ground surface, and from the walls and rooftops of buildings, are also evaluated. Sensible heat fluxes into the atmosphere thus obtained were then used as boundary conditions in three-dimensional simulation of the air heat flow in the development area. The simulation shows that the air temperature during daytime in summer depends significantly on the amount of vegetation in open space between buildings. It is shown that spatial coverage by trees of 30% of open space is sufficient to lower the air temperature in the area, leading to significant improvement of thermal conditions. It is also shown that trees are much more effective in moderating the thermal conditions at the level of pedestrians than low vegetation such as grass. The method developed here can be applied to design of optimal land-use in zonal developments.

14 Prediction of Temperature and Wind Influence on Propagating Noise in Open Air

by Masayoshi Tsuboi and Shigeru Hirano

It is common knowledge that propagated noise level can fluctuate by more than 10dB(A) under varying temperature and wind conditions. A software has been developed for predicting such fluctuations, using an EWS (Engineering Work Station).

This software is based on the sound-rays tracing method with Snell's low of refraction for moving media.The calculation result shows that noise level is large when the temperature gradient is inverse or where the lee side is near the ground surface. Comparison with measured data in the literature shows good correspondence at frequencies of more than 1kHz.Results show first that fluctuations are large when the sound source is near the ground surface,and second that, when wind speed is 2.0m/s, propagated noise level is large near the ground surface. The temperature and velocity gradients near the ground surface are large, so sound refraction is also large.

15 Estimation and Prediction of Coastal Environment Effects —— Wave Transformation, Nearshore Currents and Coastal Processes ——

by Yasuo Fujisawa, Ivan Botev, Masayasu Ito and Takahisa Maeda

The Japanese coast and coastal structures including new construction within the frame of coastal development projects suffer the disastrous consequences of erosion caused by waves, nearshore currents, tidal currents and tsunami. Wave dynamics in the coastal zone have been analyzed with disaster prevention in mind, focusing on the transformation of waves advancing from deep to shallow water and their interaction with existing coastal structures. This analysis also plays a very important role in reliably predicting nearshore currents and changes in beach topography, which in turn dictate improved layout of the structures in the coastal zone and their safe design. This paper reports part of the work carried out using a recently developed system for predicting coastal evolution. The results include data on wave transformation, nearshore currents and coastal processes.

16 Study on Suppression of Oxygen-Deficient Water Formation and Elimination of Odor in Semi-Enclosed Port Water

by Shuji Miyaoka, Mamoru Ishigaki and Hirokazu Tsuji

A renewal project is being carried out in a port which has an unpleasant odor in summer. This port is semi-enclosed by a breakwater. In summer it is thermally stratified. In the lower layer in which there is little water exchange with the upper layer, dissolved oxygen is consumed by decomposition of organic matter in the sediment and the water. Thus oxygen-deficient water is formed. As a result, odorous substances such as hydrogen sulfide are produced in the lower layer.

Alternative remedial methods seemed to be 1) covering the sediment with sand, 2) promoting water circulation and 3) filling up the lower layer with soil. In laboratory experiments, it was found that odor produced from the sediment was effectively eliminated by these methods. Remediation effects of the water environment were estimated by means of numerical experiments with a box-type model. It seemed that applying 1) and 2) together, or 3) by itself was effective.

17 Electro-chemical Remediation of Contaminated Soil (Part 1) —— Mobility of Heavy Metals in Small Model Test ——

by Hiroshi Kubo and Takeshi Kawachi

When redeveloping old factory sites, it is occasionally necessary to clean up ground contaminated with heavy metals. The electro-chemical method is one method, but there are few practical examples of its use, and its effectiveness, application limitations, and design method have therefore not been clearly established. In this study, the mobility of heavy metals in soil was first tested by a small modeling experiment. The following three phenomena were observed when a DC current was input to electrodes in the soil mass: 1) The cations in the soil migrate to the cathode and the anions to the anode by electro-phoresis, 2) The cathode side soil changes to alkaline and the anode side soil to acid by electrolysis, 3) The soil pore water migrates to the cathode by electro-osmosis. This method is based mainly on migration of harmful ionic substances by electro-phoresis.Cu^{2+} and Pb^{2+} are stopped by changing to hydroxide in the alkaline region when they migrate to the cathode side. CrO_4^{2-} migrates to the anode without stopping and is thus effectively removed.

18 Study on Bioremediation of Oil-contaminated Soil (Part 2) —— Interim Report of Field Demonstlation Experiment in Kuwait ——

by Hiroyuki Chino, Hirokazu Tsuji, Yoji Ishikawa and Mizuyo Yotsumoto

A lake of oil was formed in the State of Kuwait by effluence of crude oil caused by destruction of oil wells in the final stages of the Gulf War, creating a huge quantity of contaminated soil.A field experiment using bioremediation was started on 1ha of oil-contaminated land in the Burgan oil field to the south of Kuwait city, in an attempt to clean up the contaminated soil.Nutrient, compost and wood chips were added, and three different technologies (landfarming, windrow composting and static bioventing) were adopted with two different soil oil contents. The soil moisture content was managed in the range of 8 ~ 10% , and the area was chemically and micobiologically monitored once a month.The landfarming method resulted in the fastest degradation of oil.After six months,80% of aliphatic components and 40 ~ 50% of aromatic components were degraded.This method required three times more water than the other methods.On the other hand,80% of aliphatic components and 35~50% of aromatic components were degraded after 12 months in the case of the windrow composting and the static bioventing methods.

19 Study on Fire Properties of Building Materials (Part 1) —— Investigation by Cone Calorimeter Method ——

by Koichiro Takahashi, Nagao Hori and Takeshi Kawachi

This study investigates fire properties of building products such as wallpapers and sealing compounds by the cone calorimeter method.The cone calorimeter method is based on the oxygen consumption principle and is standardized in ISO 5660. This method is also investigated as an alternative to the "Surface Test" now used in the Ministry of Construction's general technology development projects.Results have clarified the time to ignition and the heat release rate of thin materials like wallpapers are affected by the base material, and that silicone rubber system sealing compounds have superrior fire protection properties i.e., long time to ignition and low heat release rate, but high smoke production.