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## Appendix

Abstracts &amp; Titles, No. 66~70

BULLETIN  
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## NOTICE

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## **Stiffness Matrix for Thinwalled Curved Bridges**

Noboru WATANABE, Tomonori KANO, Yuji FUJII

### **Abstract**

The stiffness matrix method of structural analysis has been used extensively and accepted as a potent analytical tool. The method can be applied to any type of structure for which the stiffness coefficients can be derived.

It is the writers' purpose to present the derivation of thinwalled curved beam stiffness coefficients. Using the solutions of homogeneous differential equations governing the static problem for thinwalled curved beam considering bending-torsion, the stiffness matrix is derived. As the procedure, the way that established by numerous authors for structures composed from solid beams is used. Obtained results are completely agreement with results calculated by force method and are exact.

This stiffness matrix is applicable to curved beam of arbitrary arc length and arbitrary orientation. In the field of civil engineering, architecture, naval architecture and aeronautics, it might be applied to structures assembled from thinwalled members with open cross section.

## **Computational Methods for Optimal Control by Branch and Bound Methods**

Yoshihisa ISURUGI, Shoichi KOYAMA, Ryoichi MIURA

### **Abstract**

In this paper, computational methods for the solution of optimal control are presented using Branch-and-Bound methods.

The problem treated here is the means by which to calculate optimal control of linear time-continuous and time-discrete systems with constrained state and control variables under the quadratic performance measure.

In order to determine the lower bounds of the performance index, Dynamic Programming recursive formula was used for the time-discrete systems. This is due to the fact that the lower bounds of optimal control with unconstrained state and control variables could be considered lower than those of the optimal control with constrained variables. And for the time-continuous systems, the Brockett's inequality was used.

Our methods are useful and effective when the number of dimensions of the control space is smaller than that of the state space.

## Electromagnetic Reflectivity of Nonuniform Moving Plasma Slab

Teruwo KAZAMA and Ichiro FUKAI

### Abstract

Moving nonuniform plasma slabs, can be divide dinto the following two types, (1) a moving plasma slab which has nonuiform velocity on the moving velocity profile, and (2) a slab which has a nonuniform plasma density on the plasma density profile. Also, it can do it next two states of the plasma medium, (1) isotropic, (2) anisotropic. In this aper, the reflection coefficient of a plane monochromatic electromagnetic wave incident on an idealized laminar plane stratified plasma stream with a arbitrary incident angle was determined. This was accomplished by applying the principle of invariant imbedding to derive a differential equation which is of the Riccati type. This was solved approximately for the case of a plasma stream with the above described combinations with special consideration to a slab which has a parabolic velocity and a plasma density profile of the form respectively.

## On the Realization of a Hybrid Tree Graph

Masakazu SENGOKU

### Abstract

A hybrid tree on a linear graph is a generalized concept of a tree and a cotree. A hybrid tree graph is a linear graph which represents the relations among the elements of the set of hybrid trees.

In this paper, some properties of a hybrid tree graph of a connected linear graph  $G$  are investigated. And an algorithm for finding a cut set matrix of the graph which realizes the given subgraph (the local subgraph) of a hybrid tree graph is presented. An interesting property of a hybrid tree graph  $HT_g$  of  $G$ , that is,  $HT_g$  is balanced, is used for classification of edges in  $G$ . These results show that only a local subgraph of the hybrid tree graph  $HT_g$  and the sign of edges of a tree on the subgraph are the sufficient knowledge for the realization of the set of hybrid trees.

## **On the Construction of the Microwave Hologram in Real Time**

Keinosuke NAGAI, Yoshinao AOKI, and Michio SUZUKI

### **Abstract**

In this paper the construction of an experimental apparatus for recording microwave holograms in real time by an antenna array is reported.

A one-dimensional array with 20 receiver elements of electromagnetic horns was constructed. The output signals from each antenna element are amplified and they are applied to the input of CRT through a switching circuit, which selects the hologram signals from each antenna element to synchronize the beam deflection of the CRT with the position of antennas. An experiment to construct a one-dimensional hologram of a simple object was conducted using this apparatus. A discussion was made concerning the numerical reconstruction of images with the sampled data by this antenna array.

## **A FORTRAN Program for Japanese-English Translation**

Masatoshi ONO, Akira SAKAI, Nobuo MORI  
Mitsuru SUDO, Koji TOCHINAI, Yoshimasa NAKAMARU

### **Abstract**

This paper deals with a computer program for Japanese-English translation.

By our method, some improvements were added to the common immediate constituent method and semantical informations are contained in a word dictionary. A method which finds a harmonious relation between the subject and the verb was also developed in such way that the conjugation of the verb can be correctly decided.

In our experimental program, we used 397 English words, 443 Japanese equivalents and 176 grammatical patterns, with which we have obtained good results as shown in the appendix. The program is written in FORTRAN and consists of 2031 statements.

## Semi-empirical Expressions for Photon and Photo-neutron Production from Targets Bombarded with Electrons

Masakuni NARITA, Yasutomo OZAWA

### Abstract

The photon production efficiency of a thick target, namely, bremsstrahlung is obtained as a function of incident energy  $E_0$  and atomic number  $Z$ , that is

$$C = 1 - \frac{800}{E_0 Z} \ln \left( 1 + \frac{ZE_0}{800} \right)$$

Using an approximated photon spectrum, a semi-empirical expression for neutron yields per unit length from targets bombarded with an electron can be expressed as

$$Y(E_0, Z) = n\sigma_r \frac{E_0 Z}{E_0 Z + 800} \left( \ln \frac{E_0}{E_t} - \frac{E_0 - E_t}{E_0} \right)$$

where  $n$  is the atomic density,  $\sigma_r$  is the giant resonance integral and  $E_t$  is the threshold energy of  $(\gamma, n)$  reaction. The present estimated yields agree fairly well with experimental values at several tens of MeV for both  $E_0$ - and  $Z$ -dependence.

## Low Energy neutron Time-of-flight Experiments

Kazuhiko INOUE, Norio OTOMO, Hirokatu IWASA and Yosiaki KIYANAGI.

### Abstract

Low energy neutron time-of-flight experiments using the pulsed neutron source of the Hokkaido university 45-MeV electron LINAC were carried out. This paper describes the 5 meter neutron time-of-flight facility. Cold neutron spectra from the very cold ice at 18°K and the condensed ethane at 22°K were measured as an application of this facility.

## Reduktion von Nitril mit Hydrazinhydrat in Gegenwart von Chromiverbindung

Eiji SATO, Toshiro CHIBA, Yoshiyuki TAKADA

### Zusammenfassung

Ueber die Reduktion von Nitril mit Hydrazinhydrat in Gegenwart von Chromiverbindung wurde die Untersuchung vorgenommen.

Nachdem Erwärmen von Chromoacetat mit Hydrazinhydrat wurde Zusatz von Nitril und die weitere Erwärmung durchgeführt. Mit überschüssigem Hydrazinhydrat wurde  $\beta$ -Phenyl-äthylamin aus Benzylcyanid mit Ausbeute von 28% der Theorie erhalten, und aus  $\beta$ -Cyan-

pyridin wurde  $\beta$ -Pyridylmethylamin mit Ausbeute von 18% der Theorie erhalten. Aus Benzonitril und n-Valeronitril wurden dagegen keine entsprechenden primären Amine erhalten.

Neben den primären Aminen wurde das Derivat von 4-Aminotriazol erhalten.

Aus Benzonitril ergaben sich die Derivate von Tetrazin und von 1-sowie 2-Dihydrötetrazin neben dem Derivat von 4-Aminotriazol.

### **Die synthetische Herstellung von $\epsilon$ -Caprolactam nach der Reaktion des $\epsilon$ -Caprolactons mit wässriger Ammoniaklösung**

Kazuo TAN, Kenji TAKAHASHI, Yoichi ISHIBASHI  
Toshio MATSUDA, Yoshiyuki TAKADA

#### **Zusammenfassung**

Die Katalysatoren für die Herstellung von  $\epsilon$ -Caprolactam nach der Reaktion des  $\epsilon$ -Caprolactons mit wässriger Ammoniaklösung wurde untersucht. Dabei zeigte sich, daß Halogenammonium und andere Ammoniumsalze von der starken Säure, wie Sulfaminsäure, Schwefelsäure,  $\beta$ -Naphthalinsulfonsäure, Ueberchlorsäure usw. die hoch katalytische Wirkung haben.

Bei der Reaktion von  $\epsilon$ -Caprolacton mit wässriger Ammoniaklösung unter höherer Temperatur ergab sich die höhere Ausbeute.

Beim Ammoniumchlorid-Katalysator ergab sich die höchste Ausbeute, wenn das Molverhältnis von Ammoniumchlorid gegenüber  $\epsilon$ -Caprolacton 0.75 war. Das Ammoniumsalz von Schwefelsäure, Sulfaminsäure,  $\beta$ -Naphthalinsulfonsäure oder Ueberchlorsäure hat bei seiner wenigen Gegenwart von Ammoniumsalz gegenüber  $\epsilon$ -Caprolacton wie 0.0025  $\epsilon$ -Caprolactam erhalten wurde mit 20-25% Ausbeute der Theorie.

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## **Bed Forms and Resistance to Flow in Erodible-Bed Channels (I)**

### **—Hydraulic Relations for Flow over Sand Waves—**

Tsutomu KISHI and Mikio KUROKI

#### **Abstract**

The friction law for flow in erodible-bed channels remains imperfect due to the strong inter-dependency between the flow conditions and channel geometry. It follows that hydraulic relations for flow, over sand waves are more complex than for flow on a fixed bed. The authors, in the present paper, have succeeded in clarifying the properties of resistance to flow by classifying a large number of experimental data according to the bed forms. To this end, the authors first studied and formulated the flow conditions for various bed forms.

In order to analyze the resistance properties of channel beds the authors investigated the relationships between the normalized bed shear stress and the normalized grain shear stress for various bed forms and have arrived at an universal functional relationship in which Engelund's theory is included as a special case. The fact that a dune bed and a transition bed should be subdivided in two types, respectively, by their varying hydraulic relations was also found.

Manning's mean velocity formula seems unlikely to be applied favorably to the erodible-bed channels, in contrast with the fixed-bed channels. The new expressions for the mean velocity of flow over the respective bed forms were presented.

## **On the Similarities of Turbulent Boundary Layers Developed from a Roughness Element**

Sei-ichi IIDA, Yoshiyuki SHIGETOMI, Yasujiro KOBASHI

#### **Abstract**

It is a well known fact that the velocity profile of a fully developed turbulent boundary layer is expressed by a linear combination of two universal laws. One is the law of the wall and the other is the law of the wake, which is characterized by a universal function.

After an experimental survey of the turbulent boundary layer in the transient regime, we found that there exists a similarity rule in the wake function before it reaches its final universality. From the degree of the discrepancy between the universal wake function and that of the measured velocity profile at a certain section, we can determine to what extent the boundary layer of that section has become fully developed.

This similarity rule also enables us to estimate the position where the fully developed turbulent boundary layer commences.

## SEM Observation of Brittle Fracture Surface of steel

Itsuo TAKAHASHI, Takuya SAITO, Toru NOGUCHI, Kingo NAGAOKA

### Abstract

The features of brittle fracture were investigated by means of scanning electron fractography.

Notched tensile specimens of mild steel with ferritic-pearlitic structure were fractured at liquid nitrogen temperatures. The grain size of the specimens were  $100\ \mu$  and  $200\ \mu$ . The entire fracture surface ( $5 \times 5$  mm) was observed and covered by pictures with SEM.

Tracing of river patterns on ferrite and pearlite facets clearly revealed the origin and the route of propagation in brittle fracture. Brittle cracks seemed to commence within the ferrite grains or at the boundary of the ferrite-pearlite grain, at a depth of a few grains below the notch root. With a notch radii of 1 mm, the origin was at a depth of 0.3 and 0.5 mm below the notch root, and with notch radii of 0.25 mm, the origin was at a depth of 0.15 and 0.2 mm below.

Brittle cracks propagating to the entire fracture surface along many different routes, breadthwise and depthwise were traced.

Macroscopic "tear lines" were at times formed between two different routes.

## D. C. Analysis of Transmission Line Containing Tunnel Diode

Norinobu YOSHIDA, Ichiro FUKAI, Jun-ichi FUKUOKA

### Abstract

A tunnel diode connected to a distributed line is useful for a high speed pulses circuit. The estimation of voltage level is important in pulse circuit design before analysis of transient response. But the nonlinearity of the tunnel diode, containing negative conductance, renders the solving of a D. C. network equation very difficult. A study of this problem revealed that the introduction of the concept of quasi static state and state variables, to the mathematical method, the method of Newton-Raphson, is highly effective leading to a physically reasonable solution of such a nonlinear equation. Thus from this point of view, by the use of only D. C. conditions, we can develop a general algorithm for computing the D. C. level of the tunnel diode involved in a distributed circuit. With a digital computer we can simulate time domain characteristics of a self-oscillating circuit consisting of a tunnel diode and a distributed no-loss, nondispersive line.

## **An Algorithm for Ranking All Extreme Points**

Azuma OOUCHI and Ikuo KAJI

### **Abstract**

An algorithm for searching and leveling all extreme points of a convex polyhedron corresponding to a linear programming problem in a decreasing order of the linear objective function is described.

## **The Realization of Knuth's Formal Differentiation Algorithm**

Akira TAKEUCHI Tadashi YAMAGUCHI Ikuo KAJI

### **Abstract**

This paper demonstrates the application of Knuth's algorithm using list processing for formal differentiation. The algorithm of formal differentiation is composed of the next three main steps.

In step one, the mathematical expression is analyzed and translated into a right threaded tree.

Step two consists of an actual application of derivative rules and generates the derivative tree from the right threaded tree. We applied Knuth's algorithm to this step.

In the last step, the tree obtained in the first step is translated into a mathematical expression.

To realize these algorithms, we have used the PL/I language which provides a list and string-processing facility.

## **Two-Dimensional Fast Fourier Transform with Data of Arbitrary Sampling Number (1)**

—Its Algorithm—

Yoshinao AOKI

### **Abstract**

An algorithm of a two-dimensional fast Fourier transform is discussed. The algorithm is applicable for the calculation of a two-dimensional discrete Fourier transform with data of different sampling numbers with respect to each dimension. The algorithm is derived by factoring the Fourier transform matrix when the sampling numbers can be factored. Even

when the sampling numbers are primes, the algorithm is valid, resulting in an algorithm applicable to any numbers of sampled data. To estimate the time required in the transform operation, the number of multiplications is discussed by running a comparison between the fast Fourier transform algorithm and a conventional one.

## On the Input Impedance of Folded Slot Antenna

Kaigiro NAKAOKA, Kiyohiko ITOH, Tadashi MATSUMOTO

### Abstract

It is known that a shallow-cavity-backed slot antenna is convenient as one of the parts of an energy density antenna. Design theory of shallow-cavity-backed slot antenna has been established by one of the authors. The theory of a slot antenna is also well known. As indicated in these theories the input impedance of a slot antenna which is fed into at the center is very high, the matching between a 50 ohm coaxial cable and a slot antenna is not easy in general. Thus a folded slot antenna is proposed as a means of solving this difficulty.

However, very little is known about this folded slot antenna. Therefore, this report deals with the experimental results on a folded slot antenna on a conducting plane and on a dielectric-filled shallow-backed-cavity. Further we have derived an approximate equation to calculate the input impedance of this folded slot antenna by using the theory of folded dipole antenna, and have compared the experimental results with the calculated.

These results are available for designing a folded slot antenna.

## Hybrid $k$ Trees, Hybrid $\bar{k}$ Trees and Their Some Properties (I)

Masakazu SENGOKU, Teiichi KUROBE, Yoshihiko OGAWA, Tadashi MATSUMOTO

### Abstract

Topological formulas of the computation of network functions are expressed in terms of a set of trees, cotrees,  $k$  trees, co- $k$  trees,  $k$  cotrees and co- $k$  cotrees in the corresponding graph.

In this paper, "hybrid  $k$  trees" and "hybrid  $\bar{k}$  trees" in a graph which are the generalized concepts of " $k$  trees and co- $k$  trees" and " $k$  cotrees and co- $k$  cotrees," respectively are defined. And relationships among hybrid trees, hybrid 2 trees, hybrid  $\bar{2}$  trees, circuits, cutsets, paths and sub-cutsets in a graph are presented.

These results (using hybrid  $k$  trees and hybrid  $\bar{k}$  trees) may be considered as a generalization and an extension of work using subgraphs such as trees, cotrees,  $k$  trees and co- $k$  trees etc.

## **Programming of Network Analysis by Graph Theoretical Technique**

Yoneki TAHARA, Takanori HOSHIBA, Masakazu SENGOKU  
Yoshihiko OGAWA, Teiichi KUROBE

### **Abstract**

Recently, a state-variable technique is frequently applied to network analysis (DC, transient, and frequency characteristics) with the aid of a digital computer.

We have established programs for obtaining transient and frequency characteristics of a network which contains both passive elements and transistors. In these programs, the graph theoretical method proposed by W. Mayeda, S. Seshu and M. B. Reed which differs from the above was used.

This report is devoted exclusively to programming carried out to find all trees in a network by an efficient method without duplications and to determine the sign of common trees appearing in the voltage graph and also in the current graph of a network.

## **Real-Time Correlational Signal-Processing by Optical Heterodyne Detection Technique Using Twin Ultrasonic Light Modulators**

Yoshihiro OHTSUKA, Yoshiaki NAKANO

### **Abstract**

A collinear optical heterodyne detection-system, consisting of closely successive ultrasonic light modulators (ULM) and an optical mask with a reference signal, has been studied for the purpose of real-time correlational signal processing. The first order in the dual diffraction spectrum of light, produced by the twin ULM's, can provide both a signal light wave and a reference one for photomixing. The signal light wave arises from only the first ULM, while the reference light beam arises from the second ULM alone. For a system with the twin ULM's but without the mask, two-varying signals which modulate the signal as well as the reference light beams can be processed in a form of real-time convolution obtainable from the envelope of the beating signal. If the optical mask is added to this systems and a time-varying signal is fed to only the second ULM, a real-time correlational processing can be carried out between those two signals. Those theoretical predictions are verified experimentally. When the two ultrasonic waves, modulated with a rectangular pulse, are arranged to propagate in the opposite direction in the twin ULM's, an optical signal of the frequency 10.6 MHz, which is exactly the sum of two sound frequencies, is simply generated.

## Change of Water Temperature Variation in a Flow through a Tunnel (1)

—Change of Daily Variation of Water Temperature,—

Isao YAKUWA

### Abstract

The author made an attempt to solve an equation of the water temperature variation in a flow through a tunnel and estimated the changes of mean temperature, amplitude and phase of daily variation in flows of various velocity.

It was found that the mean temperature approaches the invariable temperature of a stratum in the surrounding rock, and the amplitude decreases and the phase increases as the water flows downward. This tendency is evident especially in a low velocity flow.

## On The High Temperature Syntheses of FeS-Based Sulfides in Fe-Cr-S and Fe-Cu-S Systems

Keizo NISHIDA and Toshio NARITA

### Abstract

In order to obtain basic data required for the study of sulfidation of metals and alloys, sulfides in an Fe-Cr-S system as well as an Fe-Cu-S system were synthesized under various conditions and their lattice parameters as well as their solid solubilities were determined.

The results obtained show that in the Fe-Cr-S system a spinel type crystal such as  $\text{FeCr}_2\text{S}_4$  was formed under  $P(\text{S}_2)=1$  and  $10^{-3}$  atm. Other numerous types of Cr-sulfides were produced under various temperatures and in different compositions, while, in the FeS-CrS system no spinel crystal was formed, but two-phase mixtures of FeS and CrS were noted.

The solid solubility of CuS is found to be greater than that of  $\text{Cu}_2\text{S}$  in the Fe-monosulfide.

In consideration of the dissolution states and their mechanisms of these sulfides into FeS it was suggested that the solid solubilities and dissolved states have an intimate connection with the ionic state and the lattice defect formation in FeS crystals.

## Effects of Addition of Potassium Chlorate on Thermal Decomposition of Oxalates

Tadao ISHII, Ryusaburo FURUICHI  
Toshihiro KAWASAKI, Kunitsugu KAMADA

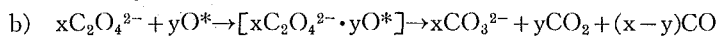
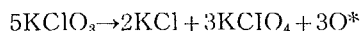
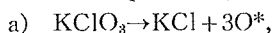
### Abstract

The effects of adding  $\text{KClO}_3$  (0~30 mol %) on the thermal decomposition of alkali and alkaline earth oxalates,  $\text{MC}_2\text{O}_4$  ( $\text{M}=\text{Na}, \text{K}, \text{Mg}$  and  $\text{Ca}$ ), have been studied by using gas-flow DTA, X-ray powder diffraction and infrared disk techniques.

$\text{KClO}_3$  additive was introduced by evaporating aqueous  $\text{KClO}_3$  solutions containing solid  $\text{Na}_2\text{C}_2\text{O}_4$ ,  $\text{MgC}_2\text{O}_4$  and  $\text{CaC}_2\text{O}_4$ , and by mechanical mixing of the powders for  $\text{K}_2\text{C}_2\text{O}_4$ . Gas-flow DTA apparatus consists of two quartz tubes (id.=9 mm) placed vertically in a furnace, in which gas flows through the reference and sample powders during tests.

The characteristic feature of the decomposition of all  $\text{MC}_2\text{O}_4$  with  $\text{KClO}_3$  was that a singular large exothermic peak,  $\text{P}_M$ , appeared at around  $350^\circ\text{C}$  on DTA curve. And, at peak  $\text{P}_M$ , the decomposition of  $\text{KClO}_3$  and  $\text{MC}_2\text{O}_4$  was promoted.

It was suggested that the effects of the additive may be related to the oxidation properties of active oxygen generated by the decomposition of  $\text{KClO}_3$ . On the basis of the hypothesis that the first stage in the thermal decomposition of all oxalates is the rupture of C-C bond in the oxalate ion, the following reaction mechanisms were suggested to be  $\text{MeC}_2\text{O}_4 \cdot \text{KClO}_3$  systems at the peak  $\text{P}_M$ ;



where  $\text{O}^*$  and  $[x\text{C}_2\text{O}_4^{2-} \cdot y\text{O}^*]$  is active oxygen and intermediate M, respectively.

## The Effect of Preparation Temperatures of $\alpha\text{-Fe}_2\text{O}_3$ on the Formation of $\text{ZnFe}_2\text{O}_4$ Ferrite

Ryusaburo FURUICHI, Tadao ISHII and Mitsuhiro MAKINO

### Abstract

The Effect of preparation temperatures of  $\alpha\text{-Fe}_2\text{O}_3$  on the formation of  $\text{ZnFe}_2\text{O}_4$  ferrite was investigated by means of chemical analysis, x-ray and differential scanning calorimetric measurements.  $\alpha\text{-Fe}_2\text{O}_3$  was obtained by calcination in air of precipitated magnetite at temperatures ranging from  $500^\circ\text{C}$  to  $900^\circ\text{C}$  for 3 hr. The rate of  $\text{ZnFe}_2\text{O}_4$  formation obeyed Jander's equation, namely,  $kt = \{1 - (1 - \alpha)^{1/3}\}^2$  (where  $k$  is the rate constant and  $\alpha$  is the fractional conversion). The values of  $k$  and  $\alpha$  for a fixed reaction time at  $700^\circ\text{C}$  were observed to show a steeper decrease at preparation temperatures between  $600^\circ\text{C}$  and  $700^\circ\text{C}$  than that below and above this temperature range. Above  $800^\circ\text{C}$ ,  $\alpha$  was almost independent of the preparation temperature.

## Preparation of Dimethyl Ketene from Isobutyric Acid by Pyrolysis

Yuichi KITAGAWA, Yoshiyuki TAKATA, Kingo KATAOKA

### Abstract

The authors investigated basic experiments used in the preparation of dimethyl ketene from isobutyric acid by means of pyrolysis.

A quartz tube of 20 mm in diameter and 1 m in length was used as the reaction vessel. This was heated in an electric furnace at a desired temperature.

To produce dimethyl ketene, isobutyric acid was released into the quartz tube in the presence of introduction of nitrogen gas. As a result the generated gas was absorbed by aniline, and dimethyl ketene was converted into isobutyroanilide. The yield of dimethyl ketene was determined indirectly by gas-liquid chromatography.

In the absence of catalyst to obtain a yield of dimethyl ketene from isobutyric acid is quite difficult. By an addition of triethyl phosphate catalyst, the decomposition rate of isobutyric acid increased as much as 30% at 650°C and decomposed isobutyric acid produced dimethyl ketene in a 29% yield. When amine was added with triethyl phosphate, the decomposition rate of isobutyric acid and the yield of dimethyl ketene rose to 30% and 44% respectively.

## Reduktion der Carbonylverbindungen mit dem Gemisch von Alkaliformiat und tertiärem Aminhydrochlorid

Masashizu TABATA, Yusuke MORITA,  
Shiniti KAWAMURA, Yoshiyuki TAKATA

### Zusammenfassung

Wir fanden, daß Carbonylverbindungen beim Erhitzen mit dem Gemisch von Alkaliformiat, tertiärem Aminhydrochlorid und Dimethylsulfoxid als Lösungsmittel unter Rückfluss in Alkohol reduzieren.

Als Benzaldehyd entstand Benzylalkohol mit guter Ausbeute. Acetophenon wurde zu  $\alpha$ -Phenyläthanol reduziert.

Benzylalkohol wurde mit 97% Ausbeute gewonnen, wenn das Gemisch von 0.02 Mol Benzaldehyd, 0.06 Mol Alkaliformiat, 0.03 Mol Triäthylaminhydrochlorid und 20g Dimethylsulfoxid 3 Stunden auf 170°C erhitzt wurde. Aus Acetophenon wurde  $\alpha$ -Phenyläthanol mit 42% Ausbeute gewonnen, wenn Acetophenon, Kaliumformiat, Trimethylaminhydrochlorid und Dimethylsulfoxid 15 Stunden auf 190°C erhitzt wurde.



**Catalytic Properties of Synthetic Zeolites A Type (I)**  
**Isomerization of 1,2-Butylene Oxide over Various Cation Exchanged Forms**

Kazuo AOMURA, Masahiro NITTA, Shigemi MATSUMOTO

**Abstract**

The catalytic activities and selectivities for the isomerization of 1,2-butylene oxide in the presence of zeolites A exchanged with each of Li, Na, Mg, Ca, Sr, Ag, Zn and Cd ions were investigated in a flow system at 453~513 K.

The products were butyraldehyde, methyl ethyl ketone, trans-, cis-crotyl alcohol and n-butyl alcohol, and the selectivity of those formation reactions was constant for all types of cation exchanged zeolites.

The reaction rate decreased as the concentration of butylene oxide in the feed increased and the activation energy of this reaction was 132.1 kJ/mol.

The catalytic activities were found to vary in the order of Zn-5A > Cd-5A > Mg-5A > Ag-5A > Ca-5A > Li-5A, Sr-5A > 4A, K-5A ≈ 0, and to correlate with electronegativities of exchanged cations and acid amounts at the strength of  $H_0 \leq +4.8$ , respectively.

From the results mentioned above, it appears that the active sites of zeolite A exchanged with these cations are the Brønsted acid which are the structural hydroxyl group polarized by cation and the rate determining step of the isomerization reaction is the formation process of carbonium ion produced by a cleavage of carbon-oxygen bond of butylene oxide absorbed on the zeolite surface.

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## On the Analysis of Structures Consisting of Curved Beams and Ring Plates

Noriyoshi NIRASAWA

### Abstract

Curved bridges have become increasingly common in modern high way systems as a result of smooth traffic flow requirements. Hence, it is desirable to have a refined and more accurate method of analysis than the present elementary beam theory. This paper is one attempt to provide a more accurate analysis.

One of the most common curved girders consists of curved beams and ring plates as shown in Fig. 1. These curved beams and ring plates are combined together along combination lines, leading to the fact that the forces and displacements of the two constituent elements are continuous. From this condition the forces acting along combination lines can be solved.

In this paper, the equations defining the displacements of the curved beam with arbitrary cross sections under arbitrary loads and moments are developed. These expressions are presented from eq. (21) to eq. (26).

A numerical example illustrating the application of the method is shown. Some interesting results with respect to the effect of radius of a curvature were obtained, Fig. 9, 10.

## On the Three Dimensional Stress Analysis of a Short Right Prism

Isamu OKUMURA

### Abstract

This paper presents a three dimensional stress analysis of a short right prism by the series method. The solution of the governing equations of three dimensional stress problems was expressed in a generalized H. Neuber's solution<sup>1)</sup> to which was added the third term  $2 \operatorname{rot} \mathcal{V}$  and which is equivalent to J. Boussinesq's solution.

The boundary conditions of the short right prism are free from external forces on the side surfaces of the prism and the uniformly distributed partial rectangular compressive load is accepted on the upper surface. The displacements of the lower surface of the prism are constrained, that is,  $u=0$ ,  $v=0$  and  $w=0$ .

The boundary conditions of this type are frequently found in the foundation structures of civil engineering.

Numerical calculations were done for the case of a cube under a square load distributed in symmetry.

The stress distributions were calculated for several ratios of the cross-sectional breadth

of the prism to the loaded breadth from 6.0 to 10/9. These results are shown in Fig. 3~Fig. 8.

The numerical results presented here were obtained using 18 terms in the Fourier series. The simultaneous linear equations of high order in many unknown constants produced in such cases were solved successfully by the iterative method using an accelerator.

The convergence of normal stress is satisfactory in the interior of the prism. Particularly, the convergence of the normal stress  $\sigma_z$  along the central axis of the prism is very rapid and satisfactory results are obtained by using only 8 terms in the Fourier series.

### **Stresses of a Curved Girder analyzed by the Folded Plate Theory**

Jin YOSHIMURA    Noriyoshi NIRASAWA

#### **Abstract**

At the present, curved bridges are generally analyzed using the elementary curved beam theory. The most important assumption underlying this theory is that the cross sections are not distorted transversely. Such an analysis may be inaccurate in some cases. The folded plate analysis, however, allows for cross-sectional distortions, hence the structural behavior can be interpreted more accurately.

In most cases, curved bridges can be considered as assemblies of curved plate, each of which is in general a segment of a conical frustum, Fig. 1. In this paper, a curved girder consisting of circular ring plates and cylindrical shells was treated as folded plate structure.

A numerical example is shown. The deflections, longitudinal stresses, bending moments of the curved girder were analyzed for six different acting points of a concentrated load. And a comparison is made with the stresses of a straight girder.

### **Analytical Research for Buckling of the Circular Curved Corner in Rigid Frame Structure**

Noboru WATANABE    Makoto KAWAKAMI    Kouji SAKAI

#### **Abstract**

Web plate buckling of a circular curved corner in a rigid frame structure is discussed in this paper.

In the calculation of critical values of moment, normal force and shearing force applied on the middle plane of a thin web plate of the corner, at which point the flat form of equilibrium becomes unstable and the plate begins to buckle, the Ritz's energy method is used.

The objectives of this paper are: (1) To present an analytical theory in which the effects of a curved flange are taken; (2) to present the behavior of the critical values on which the effects of curved flange width, curved flange thickness, web plate height and web plate curvature; and (3) to present the effects of a stiffener in a radial direction.

### **Structural Behavior of Horizontally Curved Grillage Bridges with Thin Walled Open Cross-Section**

Noboru WATANABE Tomonori KANO Yuji FUJII

#### **Abstract**

The basic theory for structural analysis of horizontally curved plate girders was developed by the authors, using the stiffness matrix method which includes the warping rigidity.

This paper describes the structural behavior of grillage bridges with horizontally curved main girders and straight cross beams.

The objectives of this paper are:

(1) to present the effects of increased cross beam rigidity upon bending moment and bi-moment at the curved main girders; and (2) to present the effects of the number of cross beams upon bending moment and bi-moment at the curved main girders.

### **Flexural Properties and Section Determination of Prestressed Reinforced Concrete Beams**

Hideo YOKOMICHI Yoshio KAKUTA Nobuyuki TAKADA

#### **Abstract**

The term "Prestressed Reinforced Concrete (PRC)" as used by the authors may be defined as reinforced concrete into which limited prestressing forces are introduced in order to improve its limit-state properties under working loads. In the present study the flexural characteristics of PRC beams are investigated and the method of section determination of the beams is proposed. The important points of this paper are as follows.

The stresses and deflection of PRC beams can be calculated by the elastic theory in so-called State 1 or State 11, as seen in Fig. 1-3.

The plastic theories for prestressed concrete beams developed by Fujita are also applicable to PRC beams for the prediction of cracking and ultimate moments. Tab. 3 shows the comparison of the observed values of ultimate moment in PRC test beams with the calculated ones.

The formulas for the calculation of maximum crack widths in reinforced concrete

beams, proposed by the authors, are also valid for PRC beams, as may be seen in Tab. 1.

Theoretical decompression in PRC beams is found to be effective as a limit of closing of crack widths under static loads as well as repeated loads. Tab. 2 shows the maximum residual crack widths observed in the static tests of PRC beams. Fig. 4-8 shows the cracking behavior of PRC beams subjected to high repeated loads.

The calculation of the safety factor of PRC beams against fatigue failure can be made in the same manner as that of RC beams, by using the values of stresses of reinforcing bars calculated in so-called State II. Fig. 9 shows the comparison of Wöhler's curve for fatigue failure of reinforcing bars in PRC beams with that in RC beams. Fig. 11-13 show the effectiveness of prestressing in improving the serviceability limit states of PRC beams such as decompression, cracking, crack widths and fatigue strength.

The methods of the section determination of PRC beams under the requirement of safety against various limit states, are proposed. The effective depth of the section is determined by eq. (5). The total area of reinforcing and prestressing bars is to be determined by eq. (10). The ratio of the area of prestressing bars to that of reinforcing bars is to be determined by eq. (13) from the requirement for decompression limit state, by eq. (13) or (17) from cracking requirement, or by eq. (19) from the requirement for maximum crack widths or safety against fatigue failure of reinforcing bars. In the case of considering safety against fatigue failure of prestressing bars, the areas of steels and initial tensioning stresses of prestressing bars are to be determined by eq. (10), (19) and (12).

## Stress Redistribution in Concrete Composite Beams due to Delayed Deformation of Concrete

Yoshio KAKUTA    Hisashi NARA

### Abstract

To fill the requirement for the shortening construction time the use of composite types of concrete members is increasing. However in the composite members stress redistribution occurs due to the restriction of delayed deformation of concrete by steel and also due to the reciprocal restriction of deformations of two different concretes.

In this paper an exact solution of delayed stresses in reinforced concrete composite beams is given. The solution for a simply supported beam with composite section, as shown in Fig. 1, is obtained by numerical integration of eq. (20), in which the effect of change of Young's moduli of concretes with time is also considered. Some numerical examples are shown in Fig. 6 to 8, from which it is found that the neglecting of the effect of steels or the effect of change of Young's modulus of concretes, commonly used for the simplicity, is not necessarily valid. In continuous beams a solution is obtained from eq. (20) by adding the effect of changes of the magnitude of indeterminate moments, given in eq. (29), caused by incompatible delayed deflections.

## **Torsional stress Analysis for a Continuous Box Girder Bridge With a Variable Cross Section and its Numerical Examples**

Noboru SAEKI and Yoshio FUJITA

### **Abstract**

Torsion-bending theory in consideration of deformation due to secondary shearing stress is proposed by the authors and torsional stress on a continuous beam with variable cross sections is analyzed by the theory. Results of model beam test on a box-beam having a length of 50 cm, a width of 4 cm and a height of 3 cm, are compared with values calculated by Bornscheuer's, Grasse's and the author's theory, and it was ascertained that the proposed theory in the present paper has a higher degree of accuracy as compared with the others.

Influence lines of primary torsional moment, secondary torsional moment, warping moment, and torsional stress are calculated by this theory and compared with Bredt's and Bornscheuer's, thus it was clarified that the torsional stress on continuous concrete beams takes an intermediate value between Bredt's and Bornscheuer's.

## **Analysis and Calculation of Load Distribution of Two-Box Girders**

Noboru SAEKI Yoshio FUJITA

### **Abstract**

In this paper the load distribution of the two-box girders is discussed and compared with the results in Bieger's report. In Bieger's paper the distributing force and moment are analyzed by using Fourier's series. But in this paper it is assumed that the moment of distribution to each beam is negligible or it is assumed that two-box beams are connected with a longitudinal hinge, therefore only the shearing force acts and thus can be represented by one differential equation.

Load distributions of simple beam, fixed beam and cantilever are analyzed by the equation and denoted by a variable  $C_p$  and a parameter  $C_t$ . The results are shown in the figures and by the proposed analysis it was found that the value was somewhat smaller than Bieger's.

Load distributions of the beam with variable cross section are analyzed by difference equations and those of simple, beam, fixed beam and cantilever are discussed. It was clarified that the load distribution varies from certain values up to 0.5 by the situation of line load, influences of thickness of the floor slab and that intervals of two beams are sensitive and the difference between beams with a variable cross section and a equiva-



lent cross section is small but an assumed cross section ( $I_t = \infty, I_x$ ) is large with regard to load distribution.

### The Reciprocity between Bed Configuration and Turbulence in Alluvial Streams

Tsutomu KISHI\* Akio MORI Mikio KUROKI

#### Abstract

Fluctuations of flow velocity and bed elevation were observed at a time in an alluvial stream, and the reciprocity between the bed configuration and turbulence was studied statistically.

The following is an outline of the results obtained from the analysis:

The fluctuation of flow velocity is composed of the variation of mean velocity and the turbulence due to a turbulent boundary layer.

A model was proposed to express the fluctuation of velocity.

In the author's experimental work, a phase of mean velocity was observed to change in accordance with the bed configurations, whereas, according to the theory proposed by Hayashi<sup>1)</sup>, the phase of mean velocity coincides with that of the bed configuration of the dunes.

Due to the analysis of the coherency between the fluctuation of velocity and the bed elevation, a higher correlation was observed at a lower frequency which corresponds to the mean velocity in the dunes and the transition, but was not observed in the ripples.

### The Mechanism of Suspended Sediment Transport in an Open Channel

Tadaoki ITAKURA Tsutomu KISHI

#### Abstract

The velocity distribution in an open channel water flow with suspended sediment was investigated by experiments. It is known that the velocity distribution with suspended sediment differs from so-called Karman-Prandtl velocity defect relation. The difference consists of two components; one in which the Von Karman universal constant is smaller than  $\kappa=0.4$ , and the other where the velocity is higher than the clear water flow for the 10% depth near the bottom.

All measurements were performed in a hydraulically smooth channel for various concentrations of sand. Several theoretical and experimental relationships were examined in the experiments. Shimura's theory was found to give the best correlation with the authors' experiments.

The measurements of turbulence was carried out in an open channel water flow with suspended sand particles using a hot-film anemometer. Characteristics of the structure of turbulence were investigated to obtain some basic data in an attempt to generalize the theories of suspended sediment transport.

### **The Mechanics of Wave Transformation Inside a Surf Zone**

Hiroshi SAEKI Mikio SASAKI

#### **Abstract**

Numerous reports on periodic wave transformation inside surf zones have already been published by various researchers such as Nakamura et al, Horikawa et al, Toyoshima et al and Sawaragi et al.

On solitary waves, Kishi et al, Street et al and Saeki et al have published substantial reports.

This paper deals with the mechanics of wave transformation inside a surf zone. The authors measured the wave height, mean water level and wave celerity at a high degree of accuracy, and have divided the waves inside a surf zone into three regions namely the breaking region, the stable region and shore line region.

### **Considerations on the Formation of the Lake Saroma Inlet**

Akira OZAKI

#### **Abstract**

Lake Saroma on the North Eastern coast of Hokkaido is connected with the Okhotsk sea by a deep and short channel which was first opened in 1929 by the cutting and dredging of the narrowest part of a long sand bar, separating the lake from the sea. The width of the bar, at the site, was 120 m before the present inlet was formed.

However, the width of the same site has widened to 460 meters on the righthand bank, and 200 meters on the lefthand bank. Especially on the righthand bank, the growth of sandspits, which change their shape with each season of the year, are remarkable. In this paper the auther has attempted to explain the causal factors involved in such changes considering the prevailing meteorological and oceanographical conditions.

## Two-dimensional Jet Analysis Using Reichardt's Momentum Transfer Law

— In the Case of Holding Pressure Term —

Kazuyoshi HASEGAWA    Isao YAMAOKA

### Abstract

A detailed knowledge of the velocity distribution of a jet within a finite region is essential to many practical problems of jet diffusion.

However, it is difficult to treat such problems analytically because the fluid within such a jet as restrained by a finite boundary will undergo complicated interactions of lateral diffusion, forced deceleration and surrounding circulation due to limits of the zone, where the pressure distribution is non-static.

This paper describes the analytical solution of a jet in the infinite region where the pressure distribution is non-static, and by using the momentum transfer law of Reichardt instead of a hypothesis of shearing stress.

The solution presented herein is not so different as expected from the solution under conditions of static pressure distribution where an infinite region is assumed.

In order to obtain a solution under an actual finite region, it is necessary that the equation of the jet boundary layer within a finite region must contain the knowledge that the diffusion process is not similar in dynamics near the boundary and moreover that the pressure is non-static.

This paper refers to these considerations.

## An Experimental Study of Snowmelt

Mutsuhiro FUJITA

### Abstract

The phenomenon of snowmelt may occur at the bottom of a snowpack by heat conducted from the ground and on the surface of a snowpack by radiant heat from the sun, latent heat of vaporization released by condensation of water vapour, and heat conducted from the environment in contact with snow such as air and rainfall.

This paper describes some results of field observations and considerations for both types of snowmelt studied in the drainage of Kanayama dam (470 km<sup>2</sup>) and at the campus of Hokkaido University for three years.

For the former snowmelt:

1) The runoff from snowmelt at the bottom of a snowpack occupies a third part of the low streamflow as shown in Fig. 2-7 during the winter season in the drainage of Kanayama dam.

2) This runoff decreases during the winter season and in about 0.3 mm/day on the date of the lowest streamflow.

For the latter snowmelt:

1) The snowmelt on the surface of a snowpack starts at 9 to 10 a.m. and ends at 5 to 6 p.m.. In the night, the temperature near the surface of a snowpack falls below zero by radiation and by conductivity to its environment.

2) The part of snowmelt due to net radiation observed in snowpack occupies 80% or more of the total snowmelt (Fig. 3-3, 3-4).

3) Following experimental equations were obtained:

$$W = (0.28 + 0.012 V) T \quad (\text{Kanayama dam})$$

$$W = (0.35 + 0.0025 V) T \quad (\text{Campus of H.U.})$$

where  $W$ : hourly snowmelt on the surface of snowpack (mm/hr)

$V$ : average wind speed during an hour at 1 meter above the snowpack surface (m/sec)

$T$ : average air temperature during an hour at 1.5 meter above the snowpack surface ( $^{\circ}\text{C}$ ).

## A Study on the Geometry of Meandering River Channels

Isao YAMAOKA Kazuyoshi HASEGAWA

### Abstract

Generally the course of alluvial river channels meanders, and a quantitative expression on geometry of meandering river channels is required in order to analyse the relation of free meander geometry to stream discharge and behavior of sediment.

The geometry of meandering streams must be studied from both sides of the plan form and bed variation. We have attempted to express the former as a series of  $\Delta\phi$ , the angle by which the stream course direction is changed at each point of stream line separated by a regular unit length  $\Delta S$  and their spectral analysis with meander wave lengths has presented us with a dominant meander wave length  $\tilde{L}$  and so on. Then, the relations of  $\tilde{L}$  to the river discharge (mean annual discharge  $Q_m$ ) and to the bank-full stream width  $B$  were studied.

From our field data of nine rivers in Hokkaido, the following empirical equations were obtained:

$$\tilde{L} = 300 Q_m^{0.46}, \quad \tilde{L} = 7 \sim 15 B$$

The exponent 0.46 is the same as that of Carlston's equation. Next, the relation between plan form and river bed variations was studied.

Moreover, that of the propagating velocity of alternating bars  $U_a$  to the length of bars  $L_a$  was studied. Our data observed on two maps of the same alternating bars of the Ishikari river in 1955 and in 1960 were found to correspond to the following theoretical

equation with some experimental data.

$$\frac{U_d}{U_*} \left( \tau_*^{2/3} I^{3/5} f \right) = A \left( \frac{L_d}{d} \right)^{-1}$$

### Regional Characteristics of Precipitation by Three Dimensional Representation of Structure Vector

Kiyoshi HOSHI

#### Abstract

Current water-resource development requires highest standard engineering procedures for the evaluation, prediction, and control of water resources in line with the rapid population growth and economic development in several regions. The water-resource systems involve substantially large-scale water supply on a region-by-region basis to meet the increasing demand for water. Therefore, an adequate description of regional differences of hydrologic events over a wide area is required for this purpose.

This paper describes the characteristics of space variation of precipitation by synthetic consideration of the statistical quantity in an attempt to measure the degree of independent effects of precipitation patterns in individual regions. The structure of dependence of precipitation events among the observatory stations is approached by multivariate analysis where the structure vector consisting of correlation coefficients between the composite variate and precipitation at the stations facilitates the evaluation of regional differences of precipitation pattern over a large area. The methodology was tested using available records of 27 years at 10 stations in Hokkaido.

### An Analysis of Distribution Networks for Leakage Prevention

Tetsuo TAKAKUWA

#### Abstract

The method for analyzing the distribution of flow and pressure in a water distribution system is well established and has been in use for a long time. However, this method is of little use in preventing leakage because of the difficulty of separating leakage from demand.

In order to save water lost by leakage, it is necessary to reduce excessive pressure as well as making repairs of water mains and services.

It is the purpose of this paper to develop a method for determining leakage in

distribution systems and to demonstrate the application of this method to leakage prevention.

As a result of analyzing a system of pipe network specimen, it was shown that both the nodal residual pressures and the total retes of leakage change almost linearly with the source head.

## Studies on Geotechnical Properties of Volcanic Soil in Central Hokkaido

Shigeru KITAGO Masaru TAKAIWA Mitsuhiko KAMIYA

### Abstract

Since the serious damages were sustained by private residences and public properties constructed on loose fill of volcanic soils in the 1968 Tokachioki Earth Quake in Kiyota Residential Area near Sapporo, attention has been focussed on the geotechnical properties of soils of volcanic origin in Hokkaido, and several contributions have been made by several research institutes. The reason for this delay in commencement of geotechnical research on volcanic soils as compared with that in Kyushu, where the soils are locally called Shirasu and have the same geological origin as that of Hokkaido, is that while Kyushu suffers frequent attacks of typhoons and severe rainfalls, which loosen the Shirasu soils rendering their slopes unstable, in Hokkaido the exposure to typhoons are much less frequent and the intensity of rain is much lower. The damages in Kiyota Residential Area mentioned above, is not attributed to rain water, but rather to poor geotechnical properties of loose fill of volcanic soils. The attentions of researchers on volcanic soils, therefore, have been focussed on their deformation, strength and compaction characteristics.

In this paper, some results of our experiments carried out for the last three years are presented on geotechnical properties of volcanic soils originated from the Shikotsu. There are two major types of volcanic soils, ie. fall type deposit and flow type deposit. The outstanding structural characteristics of individual particles of volcanic soil are that the particle is extremely angular and porous, and that its angular corners are easy to be crushed. Most of their characteristic behavior in compaction, deformation and resistance to shear can be attributed to this structural and surface properties of the particle. The existence of numerous pores within a particle which can not be replaced by water, results in a much lower value of specific gravity of volcanic soil as far as the present standard method of testing is concerned. Crushed particles at a higher confining pressure in strength test render its internal friction angle smaller and, in contrast to this, the angular surface of the particle increases its values at lower confining pressure. Each experimental detail is presented on these geotechnical behaviors by tests on index properties, compaction and strength.

## Experimental Studies on Geotechnical Properties of Sand-Clay Mixtures

Shigeru KITAGO Teruyuki SUZUKI

### Abstract

Geotechnical properties of sand and clay differ considerably, and the treatment of these soils of pure quality in design of earth structures has already been established. For the simplicity of design procedure, however, it is common practice in most cases to classify existing natural soils even with varying components of cohesion or friction as either pure sand or pure clay. This disregarded component of cohesion or friction have been taken as extra safety margin, but it remains unknown in what case a soil with a slight cohesion behaves almost like pure sand, or whether another soil with a slight friction can duely be treated as pure clay. It is, therefore, of great importance to have some kind of standard or criterion for this simplification. Data are not yet sufficiently accumulated for establishing this type of standard.

There is, of course, an intermediate case in which soils are treated as having properties in between sand and clay, and this indicates that there exists soils which have characteristics of both sand and clay. Little is known, however, as to what an intermediate soil is. In other words, the percentage of the extra fraction of clay in sandy soil or that of sand in clayey soil, which can not be disregarded, is not yet investigated at least for design purposes. Thus, it is also necessary to clarify the properties of this intermediate soil.

In this paper, experimental results and their discussion are presented to show some effects of the clay content of sand and clay mixture on its geotechnical properties such as compressibility in triaxial consolidation, pore water pressure and strain behavior in undrained triaxial compression, strength parameter in effective stress and influence of stress history. Efforts were concentrated in making consolidated undrained triaxial compression tests with pore water pressure measurement for a remolded, saturated mixture of sand and clay with varying contents of the clay fraction.

The primary conclusion from the present research work is that laboratory mixed soils of sand and clay can be classified into three groups, depending on its clay content, from the standpoint of geotechnical properties mentioned above. Soils belonging to the first group, behave like pure sand, and as another extremity, soils of the second group exhibit properties of pure clay. The intermediate case includes a soil of clay fraction of 20 to 40% for the present soils tested, and geotechnical properties of a soil in this category seem to lie in between sand and clay.

## The Influence of Stress History on the Shear Strength Characteristics of Cohesive Soils

Toshiyuki MITACHI    Shigeru KITAGO

### Abstract

Practical problems involving the shear strength of saturated cohesive soils are usually solved by measuring the strength of "undisturbed" samples in the laboratory. In general, the shear strength of cohesive soils is greatly influenced by the stress to which they have been subjected before shear. Therefore, it is necessary to test soils under exactly the same conditions as exist in situ.

Even if perfectly "undisturbed" samples could be obtained and used in a test, they would inevitably be subjected to a change in stress condition on removal from the ground, and the strength obtained might be more or less affected by this change.

The purpose of the present study is to investigate the relationship between the "in situ" undrained strength of saturated normally consolidated clays, and that of reconsolidated "perfect sample", by simulating the stress conditions of both in situ and in the laboratory.

Three series of test were conducted on four saturated remolded clays. One of them is to simulate the shear failure of soil mass in situ under undrained conditions (CAU test). The second one is to represent routine isotropically consolidated undrained tests on laboratory made perfect samples (CAPU test). The last one is to obtain Hvorslev strength parameters,  $c_e$  and  $\phi_e$  (CAPRU test).

Experimental results indicate that

1) the relationship between water content and average effective principal stress at the end of consolidation is almost identical for the two series of CAU and CAPU, 2) the effective angle of shearing resistance  $\phi'$  from the results of CAPU test is smaller than that from CAU test by  $3\sim 4^\circ$ , and 3) undrained shear strength  $S_u$  from CAPU is greater than that from CAU by about 40% for equal vertical consolidation stress  $\sigma'_{1c}$ , whereas, comparing  $S_u$  data with respect to the equal average consolidation stress  $\sigma'_{me}$ , CAPU test gives about 20% smaller values.

A comparatively simple method is proposed for estimating the in situ strength of normally consolidated clays in terms of Hvorslev strength parameters,  $c_e$  and  $\phi_e$ . Application of this method to the test data for the present experiments, in accordance with the procedures proposed in this paper, indicate that there is good agreement with the strength "in situ".



## Effect of Stress History on Deformation Characteristics of Dry Sand Subjected to Cyclic Loading

Shosuke TOKI   Shigeru KITAGŌ   Teruyuki SUZUKI

### Abstract

The importance of investigating the dynamic properties of earth materials for geotechnical design of foundation and earth structures, subjected to vibratory or impulsive forces, has increasingly been recognized. Since the new branch of soil mechanics, i.e., soil dynamics, was brought about into our field in the early 1930's, more than four decades have elapsed. During these years, a large number of theoretical, experimental, and field studies have been carried out in many countries, and outstanding contributions have been made in recent years.

Reliable and comprehensive knowledges on soil properties under dynamic stress conditions are increasingly in demand not only because of academic interest, but also because large electronic computer assemblies have been coming into use for design purposes.

In the present paper an investigation on the influence of the magnitude of dynamic stress and the number of stress applications on deformation behavior of dry sand is reported. The repeating load is applied to test specimen in such a way as to simulate the stress condition on the horizontal surface in subgrade during earthquake.

It is shown that the deformation of test specimen subjected to repeating load, in advance to subsequent cyclic loading, decreases considerably, compared to specimens with the same initial void ratio, but not subjected to dynamic stress in advance. This is considered to be primarily due to the decrease of the volumetric component of axial strain. This obviously indicates that the effect of stress history on deformation behavior under dynamic stress conditions is dominant in the volumetric component of axial strain and is little in its shear component.

It is also shown that in a type of test in which test specimen is subjected to a different total number of cyclic loading, for instance, 500, 5,000 and 10,000, rate of increase of the volumetric component of axial strain depends on the number of dynamic stress applications, and the dynamic shear modulus of deformation increases with increasing number of stress applications.

These deformation characteristics of dry sand subjected to cyclic loading in advance, can not be attributed to the decrease of void ratio, because the amount of void ratio decrease by these stress application is too small to give rise to corresponding change in axial strain or shear modulus. In order to clarify these inconsistencies, changes in soil structure or particle orientation and also changes in surface conditions of sand particles must be taken into consideration.

This can be demonstrated by the test results, which show irregular relationships between shear modulus, void ratio, and confining pressure in a static compression test on test specimens subjected to repeating load in advance, and this irregularity disappears if the values of shear modulus are replotted against the terminal state of shear strain at

which time the specimen is conjectured to assume a particular type of particle orientation.

It can be concluded from above mentioned findings that in addition to the important roles of initial void ratio or relative density in the mechanical properties of sand, particle orientation and its surface condition play also significant parts in deformation, especially in volumetric deformation behavior.

Consequently, further investigations on the effects of soil structure should be made with special reference to stress or strain history, void ratio change, and grain disintegration.

### Basic Research on Creep behaviour of Asphalt Pavements

Akihiro MORIYOSHI Tsuyoshi KAMIJIMA Masaru TAKAHASHI

#### Abstract

This paper describes the test results on the creep behaviour of bituminous mixtures. The purpose of this investigation is to clarify the creep property of a mixture in use in hydraulic structures such as a facing or a lining of soil structures and as the deformation of a highway pavement brought about by a constant load over a long duration. Two types of mixtures were chosen, namely an asphalt concrete type mixture for hydraulic use and British type rolled asphalt for highway pavement.

The creep behaviour of a long loading duration ( $10^0 \sim 10^3$  sec) for asphalt concrete, and the creep behaviour of rolled asphalt for shorter duration ( $10^0 \sim 10^1$  sec) was studied.

The tests were carried out by means of beam flexure and the load was applied at the center of the beam and the tests were performed at various temperature and stress. The deflection and time relationship was measured under each creep stress and the creep compliance of the mixture was calculated.

The principle of time-temperature superposition was applied for the analysis of creep compliance and master curves of creep compliance were obtained for both types of mixture. The relationship between creep compliance and reduced time varied over a wide loading duration;  $10^{-2} \sim 10^0$  sec for the highway mixtures and  $10^0 \sim 10^5$  sec for the hydraulic mixtures.

The effect of binder property on creep behaviour of mixture was also investigated. The increase of binder content also controls the creep behaviour. High filler content shows a decrease of creep compliance.

As a result of this study the creep behaviour of both types of mixture was clarified to be a function of the loading condition, temperature, type of mixture, type of binder, mixture composition and the creep compliance obtained on the various creep stress as showed a good agreement.

## Mechanical Properties of Catalytic Semi-Blown Asphalt and its Mixture

Teruo SUGAWARA Akio NAKAJIMA Atsushi KASAHARA

### Abstract

This paper describes the test results concerning the mechanical properties of catalytic semi-blown asphalts and their paving mixtures.

Many attempts have been made for the improvement of bituminous paving mixtures. Along this line the usage of catalytic semi-blown asphalt has been regarded as one of the most effective methods for the improvement of resistance to deformation and the low temperature characteristics of bituminous mixtures.

In this investigation, the physical properties of asphalts were examined by means of penetration, softening point, Fraass breaking point and the others, while the penetration index as an index of the rheological property of asphalt was calculated. Considerable effort was made on the viscosity characteristics over a wide range of temperature from 5° to 200°C and shear rates. A rotating coaxial cylinder viscometer and a parallel plate micro-viscometer were utilized and the viscosity was measured as a function of temperature and shear rate. As a result, a rheology diagram, the viscosity temperature relation, dependency of viscosity on shear rate and degree of complex flow were obtained for 5 types of asphalt.

In the present study on bituminous mixtures, a simulated wheel tracking test was carried out to evaluate the resistance to deformation. A considerable improvement of the high temperature properties of mixtures were obtained by the usage of catalytic semi-blown asphalt.

In a beam flexure test, mode of fracture, strain at rupture versus temperature and flexural strength versus temperature were observed. The peak point of flexural strength versus temperature was designated "brittle point" by the author. On the lower temperature side from "brittle point", the mixture showed a brittle fracture, and on the higher temperature from the peak, it showed a ductile fracture. This brittle point moves so the lower or higher temperature side depending on a variety of variables. As a result, most of the mixtures showed an equal brittle point except for one asphalt, regardless of the variation of the penetration or consistency.

One of the objectives of the present work was to obtain the detailed effects of the binder property. In this study, the softening point was adopted as the standard temperature and discussions were based on the assumption that the penetration of asphalt can be neglected when the difference in temperature from the softening point is adopted as a parameter. Based on the above, no penetration difference except for the rheological index, P.I., is to be considered. From the test results, the strength vs. temperature, strain at rupture vs. temperature curves with high P.I. catalytic semi-blown asphalt is further from the softening point than low P.I. straight asphalt, and it is situated on the low temperature side. This fact indicates, provided that stability or resistance to deformation at high temperature is constant, the brittle point of a binder with high P.I. tends to

deviate to the low temperature side and then the visco-elastic zone extends to where the brittle zone becomes narrower. From the results of this investigation, while it may be said that catalytic semi-blown asphalts with high P.I. have a wide favorable region, the characteristics of the maximum value of P.I. should also be studied from a viewpoint of other properties such as workability, stress relaxation property, adhesion to aggregate, thermal properties etcetera.

Finally, a performance study on an actual highway was carried out, and the maximum value of 1.7 of P.I. for 100/120 grade asphalt was obtained.

## **A Study on Areal Concentration of Population and Regional Income**

Hirozo OGAWA and Etsuo YAMAMURA

### **Abstract**

Theoretical concentration analyses were made, namely a time series analysis and a distribution analysis of areal concentration were conducted. The results were compared with the actual data of prefectural population and income.

According to the time series analysis of areal concentration of a prefectural population, a rapid areal concentration of population is apparent with an especially remarkable expansion of the commuting area of Tokyo and Osaka.

With respect to the prefectural income related to areal concentration, the correlations between the rates of changes of prefectural population and total engaged persons indicate high values and it was concluded that the main factor of areal concentration of population is the total engaged persons.

According to the time series analysis and weight vector and structure vector of areal concentration of prefectural income, it seems that the areal concentration of production incomes of secondary and tertiary industries increases gradually with the lapse of time and the main factor of the rate of changes of production income depend on these industries.

## On the Data Precision of Home-Interview Person-Trip Survey

Koichi YAMAGATA

### Abstract

Hitherto, the data precision of home-interview person-trip survey has been calculated under the assumption that trip sample collected by home-interview survey is random. But, this sample should be understood to be a cluster sampling rather than the simple random sampling, when data-collecting procedure is considered. The author has attempted to determine the effect of innercluster co-relation of trips within person or household by a method in which secondary samples are re-sampled from actual survey data and in which thereof are analysed statistically.

The results are summarized as follows. The data precision of homeinterview survey, namely, the relative standard error of estimator does not fit the theoretical values which are calculated under the assumption of trip randomness in the sample. In many cases, the standard error of estimator in the actual survey data shows higher values than the theoretical values. The former is expressed as the product of the latter standard error multiplied by a certain constant. These constants corresponding to each charactor of trips are calibrated in this research. Moreover, the effect of the sampling unit is considered, and household sampling and person sampling are compared.

## A Study on the search of the optimum traffic signal offset pattern

Terutoshi KAKU    Noriyuki KISHI    Yuzo MASUYA

### Abstract

An attempt was made to determine an optimal traffic signal offset pattern. Various aspects of the Transit method were applied successfully.

In this paper, a traffic model in which allowance is made for the flow interaction between successive road sections, for the dispersion of platoons and traffic flow conditions by traffic signals. The assessment standard for the optimal traffic signal offset pattern is the Performance Index (P.I.) namely the balance between total delay and the number of stops.

Repeated calculations are used in the optimization procedure by which P.I. is minimized.

The simulation was carried out on a selected network which includes 12 traffic signal intersections in Sapporo city. This model has the advantage of being applicable not only to the grid network but also to other network types including networks which have no right turn or one-way operations. P.I., the assesment standard, is believed to be appropriate for unsaturated traffic flow conditions.

## A Study on the Optimum Size of a City

Hirozo OGAWA and Hideo IGARASHI

### Abstract

The overconcentration of population centered around metropolis areas and the outflow from small local cities and villages over recent years have been upsetting the balance of the living environment for man, causing various social problems. These are, destruction of the ecological balance, air pollution, health impairment, alienation of human relationships, increase of traffic accidents, and others.

This study, in analyzing the factors that influence a city, especially from the point of view of the population concentration, intends to discuss the optimum size, and environment of a city.

In forming the optimum size, the concept of urbanization index is applied. This index indicates comprehensively the degrees of the urban growth and development, and consists mainly of the functions and the environments of a city.

In this study, the method of the principal axis factor analysis is applied to the functions and the environments of 46 cities which are the local government seats of in Japan up to 1968, and as a result, it has become obvious that the following three factors are dominant in order to apply the urbanization index.

Primary factor : agglomeration index  
Secondary factor : facility density index  
Third factor : industrial structure index

In the second place, 37 variables to be mentioned later, are classified into two groups with the method of the factor analysis: one group with 24 positive composite variables, and the other with 13 negative. The former indicates the agglomeration index, whereas the latter expresses the space index. Thus, assuming that the optimum urban environment may be defined as the junction point on which the above two groups of the composite variables come to meet at a well balanced co-existence, it may be deduced that the optimal size is 400,000 in population, and 1,600 persons/km<sup>2</sup> in population density; the density is the mean of the resident district with the biggest density and the fringe urban areas.

It goes without saying that the appropriate urban environment cannot be obtained by such quantities as size and density of population, and itself evident that the qualities and placements of urban facilities or the social structure are the decisive elements.

Therefore, this study is a mere tentative suggestion for the better understanding of the optimal size of a city.

## Some research on traffic volume and velocity in winter

Terutoshi KAKU Yuzo MASUYA Yuki ONODERA

### Abstract

In winter, there are many special traffic characteristics, which affect public, social and industrial activities, in snowy cold regions such as Hokkaido.

Although various public agencies and researchers seek knowledge of such traffic characteristics in winter, there are only a limited amount of work available on the characteristics except for those reported by authors in this paper.

This research attempts to clarify some influencing traffic characteristics in winter.

The contents of this paper are as follows :

- (1) difference of traffic volume between summer and winter in urban, suburban and rural areas.
- (2) time variation of traffic volume and percentage of commercial vehicles in rural areas compared with those of summer and winter.
- (3) annual trend of traffic volume in rural areas.
- (4) running velocity at grade intersections in urban areas compared with summer and winter.
- (5) acceleration and deceleration in urban areas compared with summer and winter.
- (6) calculated green loss time of traffic signals in urban areas.
- (7) running velocity at grade intersections using traffic concentration rate.

The results of this research are as follows :

- (1) percentage of traffic volume in winter is 70 percent as compared with that in summer in Sapporo city and also rural areas.
- (2) passage velocity at grade intersections in winter is from 20 to 30 percent less than that in summer, similarly, start acceleration is from 20 to 30 percent less than that in summer.
- (3) running velocity between at-grade intersections in winter is 15 percent less than that in summer.
- (4) green loss time in winter is from 15 to 30 percent less than that in summer, if the velocity in winter is maintained at the same level as that in summer.

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## A Simulation Technique of Runoff at Multistations

Kiyoshi HOSHI and Isao YAMAOKA

### Abstract

This paper presents a mathematical model for generating hydrologic data when the structure of a hydrologic time series is characterized by the Markov process; the system inputs are the lag-zero and lag-one cross correlations. The procedure to estimate parameters is based on criterion in which vectors are mutually orthogonal. The adoption of an orthogonality facilitates the evaluation of regional differences of hydrologic characteristics over a large area where hydrologic events are far from homogeneous, and independent effects of the derived parameters are presented which improve on the shortcomings of the regression technique.

The system proposed herein ultimately leads to the solution of the eigenvalues and corresponding eigenvectors of a real symmetric matrix. Therefore, the computation procedure is simple and useful in practical hydrologic engineering.

The inverse transformation of a model equation produces properly correlated synthetic sequences of hydrologic data over any specified time length for any number of stations.

The model equation was applied for generating sequences of monthly runoff in the Ishikari River basin, Hokkaido, Japan. The results indicate that the statistical properties of the simulated data are in good agreement with those of the observed records and that the proposed technique would be useful for planning of water-resource systems in the simulation process.

The numerical analysis of this study was carried on the FACOM 230-60 system at the computing center of Hokkaido University.

## A Study on Turbulent Wakes of Circular Cylinders in a Uniform Shear Flow

Hisataka TAMURA Masaru KIYA Mikio ARIE

### Abstract

Described in this paper are the mean flow properties in turbulent wakes of circular cylinders mounted in a uniform shear flow. The mean velocity profiles in the far-wake are theoretically determined by means of an asymptotic analysis which treats the shear as a small perturbation on a uniform stream. Experimental measurements are also performed to examine the results obtained by the present theoretical analysis.

It was found from these investigations that the theoretical velocity profiles agree fairly well with the measurements at sections downstream of more than approximately 20 times of the diameter of the circular cylinder. The investigation also showed that the spreading of the wake is much larger on the low-velocity side than on the high-velocity side.

## Various Methods of Snow Melting with Heated Water

Ken-ichi ITO, Kiyotaka YAMANE and Shoichi FUKAZAWA

### Abstract

On various types of snow melting methods with heated water, model tests on a small scale are presented. It is found as a result of model tests that the existing melting machines with water pools are lacking in internal melting speed. A method of increasing the internal melting speed is required to increase the overall melting rate. The melting with running water is not quite effective. Water sprinkling or showering is superior in the internal flow through a snow block, and yet insufficient because of big heat loss.

Most advantageous method is the combination of the showering and the soaking. Soaking partly a lump of snow in the melting water reduces the heat loss and furthers the snow block breaking loose.

This new method has been applied to an experimental melting machine of the capacity of 4 ton/h of a practical scale. At the conditions of the soak rate of about 15-30% and of the showering quantity ten times the melting rate, the maximum melting rate is obtained both in model and practical experiments.

## Experimental Study on EGD Electrical Power Generation

Toshiaki YANO Kenichi ITO and Shoichi FUKAZAWA

### Abstract

An electrogasdynamic (EGD) generator produces electricity by using a moving gas to transport charged particles from a low potential region to a high potential region. An EGD generator consists of a corona ion source, a conversion channel and a charge collector.

In this paper, we have dealt with the design problems of an EGD generator and have experimentally investigated the corona discharge characteristics, the effect of channel length and the charge collector geometry which affect the performance of the EGD electrical power generation process.

The experimental results are as follows. A large number of ions which have been transported into the channel can be obtained by the high velocity of working gas. Thus the electrical power output is proportional to the gas velocity. It is necessary to increase the voltage supplied to the ion source to match the increase of the gas velocity. As to the effect of the channel length, the maximum power output is given by the optimum channel length. In order to increase the output current, it was found to be more effective to seed the working gas with liquid and solid powder particles.

## Transient Solution of Erlang's Model by Numerical Inversion of the Laplace Transform

Masanao NIKAIDO Ikuo KAJI

### Abstract

In the analysis of the queuing phenomenon, the Laplace transform is a powerful tool, but in many cases its analytical inversion is difficult. Hence applications such as obtaining a time dependent solution by the Laplace transform seems to be lacking in the literature.

However, if such a numerical inversion can be obtained, an accurate transient solution may be obtained.

This paper introduces a numerical inversion technique of the Laplace transform, which involves Bellman's Method and describes its limitation by applying it to Erlang's model which has a known accurate solution.

Judging from the results of the numerical experiment, this technique is very useful in a sufficiently wide range of parameters.

## Stability Analysis of a Columnar Pinch Using the Long-Wave Limit in the Case of a Uniformalized Parameter $\alpha_i=0$

Toshihisa HONMA Masafumi KITO Ikuo KAJI

### Abstract

The dispersion relations of a case in which all currents are carried on the plasma surface and a case in which all the axial currents are uniformly distributed across the plasma have been treated separately. Thus, it is not sufficient to merely run a comparison of the growth rates of instabilities and the complete stability conditions in both cases.

In this paper, in order to compare both cases, both dispersion relations are unified using the uniformalized parameter  $\alpha_i$ . Furthermore, the above dispersion relation in the case of  $\alpha_i=0$  is solved using the long-wave limit. Thus, the growth rates and the complete stability conditions are analytically obtained.

The results obtained in this manner show a better agreement qualitatively and quantitatively with the numerical solutions for a short-wave. Thus, the applicability of usage of long-wave limit is recognized.

## A Method of Generation of Hybrid Trees

Yasutaka OGAWA, Masakazu SENGOKU, Tadashi MATSUMOTO

### Abstract

It is known that network functions can be evaluated by finding all trees, cotrees or hybrid trees in a corresponding graph. Many methods are known for generating trees or cotrees.

However, no effective methods for computers have been given for hybrid trees.

In this paper, a method of generating all hybrid trees is proposed. This method consists of two processes, one of which is to reduce the given graph by repetition of open-circuiting of parallel edges and short-circuiting of edges, and the other is to expand the reduced graph to the original graph by using 1-vertex cut-sets.

These two processes can be readily carried out by computer.

Further, this method has some advantageous points when running a comparison with that of generating of trees or cotrees.

## Hybrid $k$ Trees, Hybrid $\bar{k}$ Trees and Their Some Properties (II)

Masakazu SENGOKU    Teiichi KUROBE  
Yoshihiko OGAWA    Tadashi MATSUMOTO

### Abstract

In our previous paper: "Hybrid  $k$  Trees, Hybrid  $\bar{k}$  Trees and Their some Properties (I)" hybrid  $k$  trees and hybrid  $\bar{k}$  trees in a graph were defined and the relationships among hybrid trees, hybrid 2 trees, hybrid  $\bar{2}$  trees, circuits, paths and sub-cutsets were presented. In this paper, the above results are extended to a discussion using hybrid  $k$  trees and hybrid  $\bar{k}$  trees. Further, the relationships between hybrid  $k$  trees and hybrid  $\bar{k}$  trees are presented.

These results may be considered as a generalization and an extension of work using subgraphs such as trees, cotrees,  $k$  trees and co- $k$  trees etc.

## **On the Bandwidth of Shallow-Cavity-Backed Slot Antenna**

Kaigiro NAKAOKA, Kiyohiko ITOH, Tadashi MATSUMOTO

### **Abstract**

In this paper we describe the bandwidth of shallow-cavity-backed slot antenna on the basis of experimental results. It is known that a shallow-cavity-backed slot antenna is convenient as one of the components of an energy density antenna.

With regard to the shallow-cavity-backed slot antenna which has a hollow inside, a detailed investigation has already been made theoretically and experimentally by the present authors. And the characteristics of an antenna filled with a dielectric medium have been clarified experimentally.

Input impedance and directivity are required for the design of an antenna and it is noted that the bandwidth is an important factor. Here, some experiments on the bandwidth of the shallow-cavity-backed slot antenna were made, and we have found some means to broaden the bandwidth of this slot antenna. As a result it was clarified that the relative bandwidth could be broadened to about 7.0 per cent.

We are of the opinion that our experimental results may be applied extensively in the future, in the designing of a shallow-cavity-backed slot antenna.

## **On the Propagation Constants of Leaky and Surface Waves of an Axially Slotted Waveguide Partially Filled with Certain Dielectric Media and Ferrite**

Kiyohiko ITOH Kazuo OHKI Osamu MIYAGISHI Tadashi MATSUMOTO

### **Abstract**

When a surface wave is launched in an axially slotted waveguide whose cavity is partially filled with some dielectric media and ferrite, we can use this waveguide as a transmission line. However, this slotted waveguide can not be used as a transmission line below a certain frequency at which point the surface wave is converted into leaky wave. In this frequency range where the leaky wave is launched on the slot, we can use this slotted waveguide as a traveling leaky wave antenna whose radiation peak is steerable by means of varying the frequency and/or dc magnetic field.

This report deals with the method of obtaining propagation constants of leaky and surface waves of the above-mentioned slotted waveguide by using the transverse resonance method. Various numerical examples in figures are also given.

## **A High Speed C-MOS Push Pull Memory**

Makoto TAKECHI, Teiichi KUROBE, Yoshihiko OCAWA

### **Abstract**

When a memory cell is composed of C-MOS transistors, a flip-flop circuit is usually employed. As the flip-flop circuit has a positive feedback loop, it slows down the change from one state to another. Two ways have been used to aim at high performance namely the push-pull system and the feedback system. We have made improvements on the push-pull memory, which is free from the influences of the positive feedback loop. This new memory circuit performance was verified by experiments. Thus a memory cell with a high speed and low power dissipation was produced under appropriate operating conditions.

## **Image Reconstruction from a Sound-Wave Hologram by Computer**

Yoshinao AOKI,\* Youichi SUZUKI

### **Abstract**

An experiment to reconstruct images from a sound-wave hologram using computer was conducted. A sound-wave hologram was constructed using a sound-wave of 15 KHz, with an electronic reference which simulates the coherent background wave. A photograph of a sound-wave hologram was divided into  $128 \times 128$  cells and each cell was considered as one sampled point. According to the emulsion brightness of the photograph, each sampled cell was digitized into five levels. Reconstruction by computer was done by calculating the Frensel transform of the digitized hologram using the fast Fourier transform algorithm. Multiple-printing technique was used to display the reconstructed images, resulting in images with six gray levels. The numerical image reconstruction from a binary hologram with two digitized values was also discussed.

## Two-Dimensional Fast Fourier Transform with Data of Arbitrary Sampling Number (2)

—Its Programming—

Yoshinao AOKI

### Abstract

A computer program of a two-dimensional fast Fourier transform is discussed. The program is written according to the algorithm applicable for calculating the two-dimensional discrete Fourier transform with data of arbitrary sampling numbers with respect to each dimension. The execution time is examined for various data of different sampling numbers and the results were discussed with reference to the theory. The Fourier spectra distributions of two-dimensional rectangular functions are calculated as examples for processing the two-dimensional data of arbitrary sampling numbers, resulting in showing the validity of the program as a two-dimensional fast Fourier transform program.

## Contrast of Images on X-Ray Topographs of Dislocations in Ice Single Crystals

Mitsugu OGURO

### Abstract

Contrast of dislocation images on X-ray diffraction topographs were investigated in ice single crystals. Bimodal images obtained in topographs taken by diffracting planes of higher indices (Fig. 3) were interpreted by symmetrical dispositions of equal inclination contours of  $\delta\theta$ , which is the effective misorientation around a dislocation in ice (Fig. 5). The width of the images at different parts on curved dislocations for different diffracting planes (Fig. 2 and Fig. 3) were compared with theoretical values of the width  $L$  calculated by equation (5) in which  $n=1$  was assumed. Good agreement between the observed and calculated values (Table II) proved the validity of the assumption  $n=1$  which indicates that the lattice misorientation effective to form dislocation images on the topographs is approximately equal to the width of the rocking curve of the diffracted X-ray.

Limited accuracy of the present experiments which is caused by wider opening of slits for short exposure time failed to exhibit clear bimodal images for the case of  $(10\bar{1}0)$  and  $(2\bar{1}\bar{1}0)$ , diffracting planes (Fig. 2 and Fig. 3), although it is clearly discernible in the  $(0002)$  diffracting plane (Fig. 1). Discrepancies between the observed and calculated values of the image width can be attributed also to the limited accuracy. It is anticipated that the variation in image width will be used as a qualitative indicator of impurity segregation along dislocation when the accuracy of measurements is improved.

## Slow Neutron Scattering by One-dimensional Rotor and Mathieu Function

Kazuhiko INOUE

### Abstract

While neutron scattering is a powerful tool for studying the internal rotations of molecules, it is necessary to perform considerable theoretical and numerical calculations. The expression of incoherent neutron scattering cross section from a hydrogen atom in one-dimensional rigid rotor was obtained. To compute this scattering cross section the Mathieu eigenvalues and eigenfunctions are necessary, and the latter appears in a form of matrix element of the exponential function  $\exp(im\theta)$ . Appropriate procedures for calculating these quantities are also given.

## A Study of Internal Rotations in Ammoniumiodide by Neutron Scattering

Kazuhiko INOUE

### Abstract

Neutron elastic scattering form factors in phases I and III of  $\text{NH}_4\text{I}$  were calculated assuming one-dimensional rotation of the ion around an N-H-X axis. A comparison of theory and experiment showed that; (1) the model of one-dimensional rotor can account for the form factor observed in phase III, and (2) however both this model and the model of fully free rotation cannot account for the form factor observed in phase I. The latter result is consistent with the conclusion obtained from an infrared study of phase I.

## Change of Water Temperature Variation in a Flow through a Tunnel (II)

— The Influence of Turbulent Motion on the Daily  
Variation of Water Temperature —

Isao YAKUWA and Morimasa OHTANI

### Abstract

The influence of turbulence on the daily variation of water temperature of a flow through a tunnel is discussed in this paper by solving an equation of the water temperature variation. According to the results of numerical estimation with given thermal and hydrological elements it was expected that the influence was not effective on the flow through a tunnel at the power-



station at Kamikawa, and the expectation was confirmed by records of the daily variation of water temperature.

A useful equation to estimate the water temperature variation of the flow through a tunnel was also given on the basis of the results of observation at Kamikawa.

## Studies on Suspension Bed Reactor with Narrow Spacing (II)

— Mass Transfer of Cylindrical Suspension Bed —

Masahisa FUJIKAWA, Seiya ANO and Masao KUGO

### Abstract

A suspension bed is a method expected to be of higher efficiency for the gas-solid contact than that of the fluidized bed. In this suspension bed the gas velocity has values of 0.6–1.0 of  $u/u_c$  which is considerably higher than that in regular fluidization.

The present experiments were carried out with drying of a constant rate period for silica gel particles to measure the mass-transfer coefficient which would depend on the gas velocity, the diameter of particles as well as the cylinder and the weight of suspended particles. An experimental equation for the coefficient was obtained as follows:

$$Sh_p = 3.0 \times 10^4 Re_p^{1.5} Ga^{0.5} (Mu/\mu)^{-1.25}$$

It was noted that the larger the diameter of the cylinder, the least effective the contact efficiency becomes owing to the decrease of the well effect of particles which might otherwise promote efficiency.

## Mass Transfer from restricted-Area Source

— Transfer Enhancement due to Solute Diffusion in  
Parallel Direction to Interface —

Toshiharu SHIBATA Masao SHUKUYA Masao KUGO

### Abstract

A transport phenomenon of mass which wells out from restricted-area sources to extended-area solvents was discussed theoretically and experimentally.

As a result of theoretical formulation and its numerical analysis, the following correlation may be used for a diffusional mass transfer with restricted-area sources.

$$W(t) \doteq 0.313 \pi^2 c^* a R \sqrt{Dt} \quad (a \ll R)$$

As mixed solvents, benzene-hexane, benzene-ethanol and hexane-ethanol and as solid solutes, benzoic and salicylic acids which were sealed into fine glass tubes, were used.

As a result, all systems showed approximately a three fold or larger transfer amount than that calculated by Higbie's pure one directional diffusion. It was also shown that the ethanol system may have some diffusional resistance in the source because of its high solubility, and the benzene system showed some interesting phenomena.

## Pressure Sintering of Beryllium Oxide

Kohei KODAIRA

### Abstract

The fabrication of products with theoretical density was achieved by high pressure sintering in a temperature range of 1000 to 1400°C and at 20 kbars. The material produced at optimum condition transmitted light over 60% in the visible range. The rate of densification was observed to be rapid under the above conditions and the fully dense products were obtained within a few minutes. The densification due to high pressure sintering is explained by the following mechanisms. The fragmentation and rearrangement of particles take place as an operative mechanism in the initial stage of application of pressure. On heating, plastic flow becomes dominant.

## Influences of Water vapor on Formation of $MgAl_2O_4$

Shiro SHIMADA, Ryusaburo FURUICHI, Tadao ISHII

### Abstract

MgO samples were preserved in vacuum, air and in a desiccator containing silica gel at room temperature, and were used for reaction with  $\alpha-Al_2O_3$  at 1000°C for 2 hr in air. MgO samples were prepared by calcining  $Mg(OH)_2$  in a temperature range of 400–900°C. It was found that the higher reactivity of MgO preserved in vacuum and air resulted from the influences of  $H_2O$  vapor contained in air in the course of the reaction and adsorbed  $H_2O$  on to the MgO particles during the preservation, respectively.

Then, the mixed powders of MgO with  $\alpha-Al_2O_3$  were isothermally heated at a temperature range of 1190–1360°C in dry and wet  $N_2$ -atmospheres. MgO samples were prepared by calcining MgO obtained from  $Mg(OH)_2$ , at 1300°C in air. The results showed that the kinetic data for two atmospheres obeyed the diffusion-controlled Jander's equation up to a fractional conversion of 70%. The activation energy was estimated to be  $E=68$  Kcal/mol for the reaction. The promoting effects of  $H_2O$  vapor on the formation of  $MgAl_2O_4$  were discussed.

## Modification of Manganese Dioxide Catalyst Owing to the Change in Gas Composition

Masayoshi KOBAYASHI and Haruo KOBAYASHI

### Abstract

Modification of the electrolytic manganese dioxide surface during oxidation of carbon monoxide was studied experimentally by perturbing the reaction steady state with a stepwise change in the concentration of carbon monoxide. The transient behavior of the oxidation activity corresponded exactly to that of the amount of surface oxygen species having a higher oxidation power,  $O_s^{h*}$ , and moreover the apparent first order rate constant predicted by the steady state kinetics varied in proportion to the amount of  $O_s^{h*}$ . It was shown that the modification of catalyst surface owing to the change in gas composition affected the oxidation activity through the change of the amount of  $O_s^{h*}$  which was catalytically active for oxidation of carbon monoxide.

## Discontinuous Change of the Surface of Natural Manganese Dioxide Catalyst

Masayoshi KOBAYASHI, Masakatsu HATANO  
and Haruo KOBAYASHI

### Abstract

The oxidation kinetics of carbon monoxide on natural manganese dioxide of  $\beta$ -type crystal structure was studied in a temperature range of 140 to 155°C. The oxidation rates are proportional to the partial pressure of carbon monoxide, however they change discontinuously at partial pressures of carbon monoxide above 0.08 atm regardless of the concentration of oxygen and the temperature. Kinetic analysis of the rate data obtained below and above this critical partial pressure of carbon monoxide gave the same activation energy, 16.5 kcal/mole and also the same heat of adsorption of oxygen, 22 kcal/mole. It is concluded from these results that the change of reaction rates can be attributed solely to the change of the number of active sites on the surface of manganese dioxide.

## The Study of Hydrocracking of Thiophene over Supported Metal Catalysts

Masatoshi SUGIOKA and Kazuo AOMURA

### Abstract

Hydrocracking of thiophene over supported metal catalysts was investigated in order to clarify the nature of the effective active sites on the catalyst surface for this reaction.

The catalysts having the highest activity for this reaction were metal catalysts, which are capable of adsorbing hydrogen, supported on the acidic carriers such as silica·alumina and  $\gamma$ -alumina. Especially, Ni-silica·alumina and Mo- $\gamma$ -alumina catalysts showed higher activity when an optimum amount of metal was supported on acidic carriers.

On the other hand, the catalytic activity of Ni-silica·alumina catalyst for both of the thiophene hydrocracking and cumene cracking decreased when the acid sites on the catalyst surface were poisoned by treatment with KOH solution.

From these results, it was concluded that one of the active sites of the metal catalysts supported on the acidic carriers for the thiophene hydrocracking is the acid sites of the catalyst surface.

## Selective Hydrogenation of $\alpha$ - $\beta$ -Unsaturated Aldehyde to Unsaturated Alcohol (II)

— Selective Hydrogenation of Crotonaldehyde to Crotyl Alcohol over Copper-Cadmium Catalyst —

Masatoshi SUGIOKA and Kazuo AOMURA

### Abstract

Selective hydrogenation of crotonaldehyde to produce crotyl alcohol over a copper-cadmium catalyst was studied with special reference to the active species of the catalyst and the nature of the catalyst surface.

Identical activity per unit surface area of the copper-cadmium catalyst was obtained by different preparation methods of the catalysts for hydrogenation of crotonaldehyde. Thus, it was considered that the activity and selectivity of the copper-cadmium catalyst for the hydrogenation of crotonaldehyde arise when the catalyst is reduced by a hydrogen stream.

On the other hand, the activity and selectivity of the catalyst for the hydrogenation of crotonaldehyde showed its maximum value when the catalyst was reduced at a temperature close to the melting point of cadmium. Furthermore, the copper-cadmium catalyst for the hydrogenation of crotonaldehyde was not poisoned by thiophene. This phenomena differs from the case of copper catalyst as described in the previous paper.

From these results, it was suggested that the surface of the copper-cadmium catalyst is almost covered by cadmium which diffuses to the catalyst surface when the catalyst is reduced by a hydrogen stream. Consequently, the cause of selective formation of crotyl alcohol in the hydrogenation of crotonaldehyde on the copper-cadmium catalyst could be described as follows; the CHO group is predominantly hydrogenated as compared with the C=C group in the crotonaldehyde molecule, since the adsorption of hydrogen on the catalyst surface is increasingly weakened by cadmium.

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## A Experimental study on a Diesel Exhaust Odor

Tadashi MURAYAMA Tōichi HAYAKAWA

### Abstract

Recently, diesel exhaust odor has become a problematic point with special regards to air pollution.

The mechanism of formation of hydrocarbons and aldehydes which are regarded as the cause of odor remain unclarified with special regards to engine operating condition.

In the present experiment, the various contributing factors were investigated and we have established the direct relations between the engine operating conditions and emitted aldehydes.

As a result, it was clarified that the formation of exhaust aldehydes and unburned hydrocarbons are especially influenced by the excess air factor, the injection timing and the temperature of the cooling water.

## Dynamic Analysis of Cutting Tools by the Finite Element Method

Toshihiko AKIYAMA Hiroshi KONNO  
Tateshi KISHINAMI Katsumasa SAITO

### Abstract

It is known that the phenomena of chatter vibration in metal cutting process gives unfavorable influences on the accuracy of required geometries and the finished surface of workpieces and the life of cutting tools. Various investigations have been made on the chatter vibration especially self-excited chatter of machine tools.

In this paper, an investigation on the dynamic behavior of cutting tools was made in an attempt to clarify the influences of the tool clearance angle on the chatter vibration in the metal cutting process and the effects of the overhang length of the cutting tool on the vibrational behaviors of the tool post by using the finite element method.

The main results obtained are as follows.

(1) The natural frequency of chatter frequency of the cutting tool increases with the increase of tool clearance angle.

(2) By increasing the overhang length of the cutting tool, the natural frequency of vibration of the tool post increases somewhat, but higher natural vibration frequencies decrease inversely.

## Study on Surface-finishing with an Elastic Wheel (IV)

— The Structure and Mechanical Properties of PVA-foam —

Satoru IGARASHI    Katsumasa SAITO

### Abstract

In order to determine the mechanism of surface-finishing of soft metals with a PVA-wheel (a kind of elastic wheel), the authors analyzed the behavior of one single active grain at the surface of the wheel in grinding of soft metals.

To extend this study, it is necessary to clarify the structure and mechanical properties of the PVA-foam which is a bond of the PVA-wheel.

The PVA-foam is quite different in the character from the usual vitrified bond and has quite different mechanical properties from the usual one.

The PVA-foams containing no grains were prepared in the same process as to make the PVA-wheel and studied as following.

(1) The size and shape of pores in the cross section of the PVA-foams were observed by an optical microscope.

(2) Young's modulus and creep characteristics of the foams were investigated by compression tests.

(3) The effects of compression in the foaming process for regulating the foam structure on the above mentioned structure and mechanical properties were discussed.

## Electromagnetic Reflectivity of Stratified Moving Plasma

Teruwo KAZAMA    Ichiro FUKAI

### Abstract

The reflection and transmission of electromagnetic waves obliquely incident on an idealized laminar plane consisting of stratified homogenous plasma slab, moving in parallel with the boundary of at a parabolic velocity together with the density profile are investigated theoretically. This was accomplished by applying the principle of invariant imbedding of propagation of electromagnetic waves through a given plasma medium. The electric vector of the incident wave is assumed to be polarized in the plane of incidence (parallel polarization). Solutions were facilitated by the introduction of propagation matrices. Analytical and numerical results are presented.

## Experimental Study of Cold Neutron Gain Using an Electron LINAC

Kazuhiko INOUE    Norio OTOMO    Hirokatu IWASA

### Abstract

Neutron time-of-flight experiments using an electron LINAC were performed to obtain data for the optimum design of pulsed cold neutron source assembly. Cold neutron gain factors for several cold moderators were measured at various temperatures. This investigation showed that very cold solid methane is a favourable moderator material for the pulsed cold neutron source.

## Anharmonic Damping of Surface Elastic Waves

Tetsuro SAKUMA    Tsuneyoshi NAKAYAMA

### Abstract

The frequency and temperature dependence of the attenuation rate of Rayleigh waves by cubic anharmonic terms in elastic energy is investigated by means of the quantum-mechanical perturbation theory. The damping mechanism considered in this paper is the interaction between the Rayleigh wave and the two bulk thermal phonons. Within a limit where the energy of thermal phonons is much larger than that of Rayleigh waves, it is found that the attenuation rate of the Rayleigh waves is proportional to  $T^4$  but independent of the frequency.

## Transformations on Trees

Yoshio MOMOUCHI

### Abstract

We consider inclusion relations among finite state top-down tree transducers, finite state bottom-up tree transducers and extended finite state bottom-up tree transducers. Also studied are tree walking automata and tree walking transducers in relation to tree automata and finite state bottom-up tree transducers. A syntax-directed translation scheme and transformational grammar are discussed briefly in connection with the tree transducers.



## Oxygen Adsorption on Coals in the Temperature Range of 25–55°C

Ryusaburo FURUICHI   Haruo KOBAYASHI   Go OKAMOTO

### Abstract

The rates of oxygen adsorption on Sumiyoshi, Taiheiyō, and Ōyubari coals were measured at 25–55°C and at 15.0–44.4 cmHg by using a constant pressure apparatus. The rate was found to obey Elovich's equation,  $dq/dt = k_a \exp(-\alpha q/RT)$ , for the initial stage of adsorption and the parabolic law,  $q = k_{at}^{0.5} + q_0$ , for the later stage, where  $q$  is the amount of adsorbed oxygen (mℓ N.T.P./g),  $k_a$  and  $k_{at}$  are the rate constants, and  $q_0$  and  $\alpha$  are constants. On the basis of the measured changes in these rate parameters with adsorption temperature and oxygen pressure, the adsorption process was interpreted to consist of three successive stages; (1) the equilibrium of physical adsorption on the outer surface of coal particle, which is characterized by the Freundlich's type adsorption ( $P_0^{0.84}$ ), (2) chemisorption at the rate expressed by Elovich's law of the oxygen physisorbed on the surface, and (3) the diffusion of oxygen into the coal after completion of the chemisorption, with an activation energy of 6.5–6.9 kcal/mol. The decrease in rate for coals of higher ranks was assumed to result from the decrease in surface area and the number of adsorption sites due to the polymerization of the coal structure as the rank increases.

## Acylation of Amino Groups with Acid Chloride in Polar Aprotic Solvents

Kazumi TADAIDE   Kazuo TAN  
Kazuaki YOKOTA   Yoshiyuki TAKADA

### Abstract

The acylation of amino groups with benzoyl chloride was attempted in polar aprotic solvents namely, N-methylpyrrolidone, dimethylformamide and dimethylacetamide. Aniline, o-toluidine and cyclohexylamine produced N-benzoyl derivatives by reaction with benzoyl chloride in N-methylpyrrolidone and dimethylacetamide in high yields. Particularly, with excess benzoyl chloride the N-benzoyl derivatives were obtained in yields 95% higher than that of theoretical values. In dimethylformamide, the yield was significantly less than in N-methylpyrrolidone.

p-Acetylamino benzenesulfonamide produced N<sup>1</sup>-benzoyl-N<sup>4</sup>-acetylsulfanilamide by reaction with excess benzoyl chloride in N-methylpyrrolidone in good yields. The yield was lowered considerably in dimethylformamide and dimethylacetamide. The lowering was more significant in dimethylformamide than in dimethylacetamide.

Anthranilic acid produced N-benzoylanthranilic acid in N-methylpyrrolidone and dimethylacetamide in high yields. Whereas the benzoylation of glycine was difficult because

of its poor solubility among the solvents above described. The benzylation of benzamide was also difficult.

## Synthese von Aminopivalinsäure aus Pivalinsäure und Polykondensation von Aminopivalinsäure

Eiji SATO    Toshiro CHIBA    Yoshiyuki TAKATA

### Zusammenfassung

Wir erhielten die Aminopivalinsäure über Chlorpivalinsäure aus Pivalinsäure durch Chlorierung und folgende Aminierung und untersuchten die Herstellung von Polyamid durch Polykondensation der Aminopivalinsäure.

Unter Anwendung von Benzoylperoxid als Katalysator wurde die Chlorpivalinsäure durch Umsetzung von Pivalinsäure mit Sulfurylchlorid hergestellt. Durch Erwärmen von Chlorpivalinsäure mit wässrigem Ammoniak 18 Stunden auf 100°C wurde die Aminopivalinsäure mit der Ausbeute von 60% der Theorie erhalten. Durch Umkrystallisieren aus wasserhaltigem Dimethylformamid wurde Aminopivalinsäure aus Nebenprodukt, Ammoniumchlorid getrennt. Als Nebenprodukt wurden Oxypivalinsäure und Oxypivalinsäureamid erkannt.

Die Polykondensation der Aminopivalinsäure zu Polyamid von höherem Molekulargewicht war ziemlich schwer. Aminopivalinsäure wurde in *m*-Cresol als Lösungsmittel gelöst und 40 Stunden auf 250°C unter vermindertem Druck erhitzt. In Aceton wurde das entstandene Produkt gegossen und das abgeschiedene Polyamid wurde mit Aceton gewaschen.

Das entstandene Polyamid: Fp. 250°C,  $[\eta]=0.20$  (in *m*-Cresol).

### Isomerization of $\epsilon$ -Caprolactone

Kazuo TAN                      Kenji TAKAHASHI  
Toshio MATSUDA                Yoshiyuki TAKATA

### Abstract

Isomerization of  $\epsilon$ -caprolactone in a solution of ammonium halide was studied in connection with the synthesis of  $\epsilon$ -caprolactam from  $\epsilon$ -caprolactone.  $\epsilon$ -Caprolactone in aqueous solution of ammonium chloride was heated at 300°C in an autoclave to give  $\gamma$ -caprolactone and a small amount of  $\delta$ -caprolactone. The total yields: 40% of theory. The same reaction in diluted hydrochloric acid gave similar results.

It was shown that the isomerization of  $\epsilon$ -caprolactone to  $\gamma$ -caprolactone and  $\delta$ -caprolactone took place in the acidic aqueous solution at high temperatures.