Imperfection Sensitivity of Ultimate Strength of Elasto-plastic Squareplates under Compression
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International Journal of Non-Linear Mechanics, 42, pp. 529 -541 (2007)
The mechanism of imperfection sensitivity of elasto–plastic plates under compression is complex as they undergo elastic and/or plastic buckling, dependent on their width–thickness ratio. For elastic buckling, the Koiter power law is an established means to describe the imperfection sensitivity. Yet, for plastic buckling, there is no such an established way to describe it. In this paper, the quadratic power law is advanced to describe imperfection-insensitive plastic buckling behavior. The Koiter power law is extended by implementing the quadratic law so as to describe the elastic and plastic buckling in a synthetic manner. The finite-displacement, elasto–plastic analysis was conducted on simply-supported square plates under compression by varying the plate thickness and the initial deflection of a sinusoidal form. In association with an increase of the plate slenderness parameter (decrease of plate thickness), the predominant buckling is shown to change from (1) plastic buckling to (2) unstable elasto–plastic buckling and to (3) elastic stable bifurcation followed by a maximum point of load. In accordance with the change of the mechanism of buckling, the power law is changed pertinently to describe the complex imperfection sensitivity of the compression plates in a synthetic manner. The extended imperfection sensitivity law is thus advanced as a simple and strong tool to describe the ultimate buckling strength of elasto–plastic plates.

Performance of thin-walled steel structures by longitudinally and transeversely profiled steel plates
Takuji KUMANO （Kawatetsu Bridge and Steel Structure）, Kunitomo SUGIURA （Kyoto University）, Takashi YAMAGUCHI, Eiichi WATANABE (RPI) and Yasuo SUZUKI (Utsunomiya University)
IABSE Reports, Volume.93, IABSE Symposium, Weimar, Germany (CD-ROM) (2007)
Longitudinally profiled steel plates can be applied to steel bridges and make it possible to reduce the construction cost including fabrication cost and material cost. Proposed herein is the longitudinally and transversely profiled steel plates; namely, steel plates with varied thickness in two orthogonal directions. Structural performace superior in strength and ductility will be expected by using such plates to a flange plate as well as a web plate of girders and columns. Parametric study on such a steel plate with several boundary and loading conditions is carried out by means of the elasto-plastic finite displacement analysis. In case of a simply supported steel plate subjected to uniaxial compression, it is concluded that the plate whose thickness along the supported edge is larger can have higher strength and ductility.

Experimental Study on Fiber Stress-strain Relationship of Concrete-filled Steel Members Subjected to Bending and Torsion Simultaneously
Yongri AN, Masahide MATSUMURA and Toshiyuki KITADA
Steel Construction Engineering, JSSC, Vol. 14, No. 54, pp. 69-81 (2007) (in Japanese)
It is important to formulate the stress-strain relationship of the encased concrete of concrete-filled steel members with rectangular cross section subjected to bending and torsion simultaneously by considering confined effect due to the outer steel plates in order to simulate the elasto-plastic and finite displacement behavior up to and in the vicinity of the ultimate state of these members. Then, formulated in this paper is the stress-strain relationship of the encased concrete of these members by extending the existing theory of concrete-filled steel members subjected to pure torsion. Also carried out is a loading test on the ultimate strength of concrete-filled steel box members subjected to bending and/or torsion to verify the proposed formulation of the stress-strain relationship of the encased concrete.

Concrete Filling Effect of Arch Ribs of Steel Arch Bridge with Upper Deck
Yongri AN, Masahide MATSUMURA and Toshiyuki KITADA
Proceedings of the Japan Concrete Institute, Vol. 29, No. 3, pp. 13-18 (2007) (in Japanese)
Concrete filling effects into arch ribs of steel arch bridge with upper deck, which is modeled as a framed structure, are investigated through the elasto-plastic and finite displacement analysis in this paper. 3 analytical cases, that is, i) concrete is filled into the full length of the arch ribs, ii) concrete is partially filled into the arch ribs, and iii)concrete is not filled, are prepared for the analysis. Especially in the analysis, the stress-strain relationship of the encased concrete for concrete-filled steel members with rectangular cross section, which can consider the confined effect due to the outer steel plates, is adopted. Analytical results verify the efficiency of the concrete filling effects on the load carrying capacity and the flexural rigidity of the arch bridge.

Development of a Live Load Simulation System Using Monte Carlo Methods and Finite Element Analyses

Masato KANO (JIP Techno Science Corp.), Takashi YAMAGUCHI and Toshiyuki KITADA
Proceedings of 7th German -Japanese Bridge Symposium, Osaka (CD-ROM) (2007)
Recently, performance-based design method is drawing much attention with the trend of the internationalization of the technological standards and requirements in Japan. A live load simulation system for finite element models with Monte Carlo method has been developed as an improved version of EPASS/USSP. In this system, with the influence lines calculated and saved into the storage and the vehicle loads generated by Monte Carlo method based on the actual observed data, the statistical distribution of the stress resultants or the stresses of the composed members in the bridge structures could be evaluated in order to specify the reliability index, for example. In this paper, the outline of the live load simulation system, especially the method to calculate the influence lines in finite element models and the Monte Carlo method to generate vehicle loads are described in detail and several numerical and practical examples are analyzed to verify the efficiency of the system.

Experimental Study on Mechanical Behaviour of High Strength Bolted Tensile Joints with Sealant
Yasuo SUZUKI (Utsunomiya University), Takahiro SHIMIZU (Utsunomiya City), Akinori NAKAJIMA (Utsunomiya University) and Takashi YAMAGUCHI
Proceedings of 7th German -Japanese Bridge Symposium, Osaka (CD-ROM) (2007)
The split tee joint is one of the rational methods for connecting steel structural members because of their good characteristics, such as high rigidity, high fatigue durability, easiness of erection without using special facilities and so on. In the split tee joints, the prying force occurs due to the deformation of the tee flange plates, and the prying force reduces the strength of the joint. Therefore, it is very important for this type of joints to suppress the prying force. Generally, using thick or stiffened tee flange plates is one of the most effective methods to prevent the prying force. However these are not necessarily rational methods, because the steel weight and the welding line increase. Accordingly, in this study, in order to make it possible to reduce the prying force of split tee joints easily, we propose to apply the sealant named as filler plate for the split tee joints consists of soft rubber and steel rings. The mechanical behavior of split tee joints with sealant is investigated experimentally. And the influence of the sealant and shapes of the tee flange plates on strength and deformation of such joints are mainly discussed.

Fundamental Study on Evaluation of Bending Strength of Steel and Reinforced Concrete Girder Bridges Based on Reliability Theory by Using Lives Load Simulation and FE Analysis
Takashi YAMAGUCHI, Toshiyuki KITADA and Namiko KOHARA
Proceedings of 7th German -Japanese Bridge Symposium, Osaka (CD-ROM) (2007)
In recent years, many composite and mixed structures consisting of different material members have been designed and constructed because of their structural rationality and economical aspect. In case of the design of such structures, it is important to make the failure probability of each member equal as much as possible. In this study, the safeties of a typical steel plate girder bridge and a RC girder bridge are evaluated by using the reliability theory. The load effect for the live load is determined by Monte-Carlo simulation using the actual vehicle distribution data. The resistances are determined based on the load carrying capacities of both bridges obtained by the elasto-plastic finite element analysis considering stochastic properties of material strengths. Finally, the safeties based on the failure probabilities of them are discussed using the reliability indexes.

Several Considerations on Bolted Joints Expecting Bearing and Friction Resistance
Yukiko MITSUGI (New Structural Engineering, Ltd.), Takashi YAMAGUCHI, Takeshi SAKAI (Tomoe Corp.), Michio FUKUYA (JFE Engineering Ltd.) and Nobuyuki ISHII (Yamanashi University)
Proceedings of 7th German -Japanese Bridge Symposium, Osaka (CD-ROM) (2007)
In this paper, the design method of the bolted joints expecting bearing and friction resistance is studied based on the literature survey and design calculation. The bolted joints in this study have some clearance between a bolt and a hole due to constructability. The mechanism of resistance and the limit states are classified considering its stability and ultimate behavior. And a design method is proposed focusing on its energy absorbing capacity by slip and yield.

Study on Effect of Internal Struts to Prevent Overall Bucking of Stiffened Plated Panels and to Enhance Ductility of Thin-Walled Box Columns
Masahide MATSUMURA, Toshiyuki KITADA and Yoshihiko TAKADA (Hanshin Expressway Management Technology Center)
Proceedings of 7th German -Japanese Bridge Symposium, Osaka (CD-ROM) (2007)
Bracing members are widely used in a rigid framed structure in building structures to increase the ductility performance and to avoid the serious damage of them. The overall buckling of stiffened plate panel causes a

severe damage to the thin-walled steel columns. Proposed in this paper is a strengthening technique to prevent the overall buckling of the stiffened plates of steel columns with box cross section by adding internal struts inside the box cross section. The strengthening effect of the internal struts for the stiffened plated column member is verified through analytical and experimental approaches.

Recent Applications of Eddy Current Test to the Maintenance Inspection of Steel Bridges

Luiza H. ICHINOSE (Japan Industrial Testing Corp.), Yuzuru KOHNO (Japan Industrial Testing Corp.) and Toshiyuki KITADA

Proceedings of 7th German -Japanese Bridge Symposium, Osaka (CD-ROM) (2007)

Bridge structures, being vital elements of roads and railways, are important assets in the infrastructure network. To manage this invaluable asset and maintain the enormous number of existing bridges working under satisfactory conditions, an efficient bridge management is indispensable. In recently years, non-destructive testing (NDT) has emerged as one of the alternatives to improve the effectiveness and accuracy in bridge inspection and is being increasingly applied in this field. In the present paper, applications of eddy current test to the detection of crack in welds of steel bridges structures are presented. Improvements to reduce the problems of lift-off at welding toes have proved to be successful in these applications.

Study on Effect of Internal Struts Preventing Overall Buckling of Stiffened Plated Panels on Ductility of Thin-walled Box Columns

Masahide MATSUMURA, Toshiyuki KITADA, Yoshihiko TAKADA (Hanshin Expressway Management Technology Center) and Hidenao HAYASHI (Kurimoto Ltd.)

JSCE Journal of Earthquake Eng., Vol. 29, pp. 680-689 (2007) (In Japanese)

Bracing members are widely used in rigid framed structures in steel buildings to increase the ductility performance and to avoid the serious damage of them. The overall buckling of stiffened plates arises a severe damage to the thin-walled steel columns. Proposed in this paper is a strengthening technique to prevent the overall buckling of the stiffened plates of steel columns with box cross section by adding internal struts into the box cross section. The strengthening effect of the internal struts for the stiffened plated column member is verified through analytical and experimental approaches.

Fundamental Study on Seismic Response of Steel Bridge Piers through Dynamic Analysis and Shaking Table Test using Small-size Specimens

Masahide MATSUMURA, Yasuyuki NAKANISHI, Toshiyuki KITADA and Takashi YAMAGUCHI

Proceedings of the 9th Korea-Japan Joint Symposium on Steel Bridges, Incheon, Korea, pp.569-577 (2007)

In the dynamic responses analysis of a steel bridge pier, simplified and idealized analytical models are employed on the basis of some assumptions onto material properties such as stress-strain relationship of steel, damping properties and so on. While in the shaking table test these assumptions are automatically included into the test results.Then investigated in this paper is dynamic response of a cantilever type single column with a squash loading through a comparison between the shaking table test using a small-size specimen with 50x50 mm of rectangular cross section and the dynamic response analysis of the specimen. Seismic load is subjected to the specimen in one direction both in the experimental and analytical approaches. It is concluded that both the analytical and experimental results indicate a good agreement when an accurate analytical model, which details the cross-sectional profile of the specimen and the material properties, is adopted.

Fundamental Study on Crack Propagation of Steel Plate Subject to High Cyclic Load

Takanori KOMATSU, Toshiyuki KITADA and Takashi YAMAGUCHI

Proceedings of the 9th Korea-Japan Joint Symposium on Steel Bridges, Incheon, Korea, pp. 275-280 (2007)

In this study, fatigue experiments with 3 types of specimens (non-welding type, full-penetration welding type and full-penetration type welding with some defect) were conducted. The relations between fatigue crack propagation rate and stress intensity factor range were focused in the experiment. Based on the experimental results, the influence of both the load amplitude and the defect of the welding to fatigue crack propagation is discussed.

Applicability of Seismic Retrofitting Technique by Setting EPS Segment into Existing Steel Bridge Pier

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Proceedings of the 40th Research Session, Japan Civil Engineering Consultants Association, Kinki branch, 2007 (in Japanese)

Steel column members with Embedded Plastic Segment (EPS) has been developed and proposed as a new seismic

retrofitting technique for existing steel bridge piers to enhance the ductility with less increment in the ultimate strength of the columns. In this paper, the effect of the seismic retrofitting technique is investigated by comparing with a concrete filled column member and a constitutive model of EPS with the proper length is proposed for the elasto-plastic analysis in the design. Also presented is an application example of the seismic retrofitting technique into an actual existing steel bridge pier required to be retrofitted.

Experimental Study On Strengthening Effect Of Steel Girder By CFRP Plate of High Elastic Modulus
Masahide MATSUMURA and Toshiyuki KITADA
Proceedings of the 7th Symposium on Research and Application of Hybrid Structures, JECE, pp. 55-1-55-4 (2007) (in Japanese)
The use of CFRP sheet and plate of tensile strength can be an effective strengthening method for a superannuated existing steel I girder in terms of improving its load carrying capacity. Experimentally investigated in this study is strengthening effect of steel girder of I-shape by CFRP plate of high elastic modulus through a bending test. Strengthening effect derived from the differences in elastic modulus with CFRP Plate is verified by compared with an strengthening effect in the case strengthened by CFRP plate of high tensile strength.

Analytical Study on Damage Identification of Bridge by Dynamic Vehicle Response
Kei KITAGAKI, Takashi YAMAGUCHI, Toshiyuki KITADA, Kunitomo SUGIURA (Kyoto University) and Masato KANO (JIP Techno Science Corp.)
Journal of Constructional Steel, JSSC, Vol. 15, pp. 585-590 (2007) (in Japanese)
In this paper, dealt with is a damage identification of a bridge through the variation of the dynamic response characteristics of a vehicle passing over the bridge. It is considered that the change of the vibration characteristics is caused by the damage such as the depression of a shoe, and the crack of slabs, girders and so on. Focused on the change of the vertical acceleration response of the vehicle and the vibration characteristics of the damaged bridges caused by the extent of such damage, the bridge and the vehicle are analyzed by using a vehicle-bridge system considering the slab surface roughness. It is concluded that the damage of the shoe and the slab can be detected by this propose method.

Experimental Study on Base Stiffened Structures with High Fatigue Resistance for Additional Columns on Bridges
Tomohiko ISHIBASHI (Nasu Denki-Tekko Co., Ltd.), Takashi YAMAGUCHI, Toshiyuki KITADA, Kanji NAKAMOTO, Kazuyuki HENMI (Nasu Denki-Tekko Co., Ltd.)
Journal of Constructional Steel, JSSC, Vol. 15, pp. 351-356 (2007) (in Japanese)
This paper deals with the fatigue problem of the conventional connection and its improved ones for base stiffened column structures on bridges. Triangular rib plates are often used for connecting the pipe column and its base flange plate in order to smooth the stress flow in the base stiffened structure. However, high stress concentration is observed at the welded portion of the top of the triangular rib plate. The weld defect has been sometimes involved in this portion due to difficulty of welding. In this research, proposed are 2 new types of improved connection called flare type and increased thickness type, which have no rib plate. It has been found through fatigue tests that the both types can improve the fatigue life as compared with the conventional type.

Application of Eddy Current Test on Fatigue Crack Inspection of Steel Bridge
Luiza H. ICHINOSE (Japan Industrial Testing Corp.), Yuzuru KOHNO (Japan Industrial Testing Corp.), Toshiyuki KITADA and Masahide MATSUMURA
Memoirs of the Faculty of Engineering, Osaka City University, Vol.48, pp. 57-62 (2007)
Bridge structures, being vital elements of roads and railways, are important assets in the infrastructure network. To manage these invaluable assets and maintain the enormous number of existing bridges working under satisfactory conditions, an efficient ridge management is indispensable. However, establishment of the most effective and sophisticated bridge management systems are dependant on field data. In recently years, non-destructive testing (NDT) has emerged as one of the alternatives to improve the effectiveness and accuracy in bridge inspection and is being increasingly applied in this field. In the present paper, applications of eddy current test to the detection of crack in welds of steel bridges structures are presented. Improvements to reduce the problems of lift-off at welding toes have proved to be successful in these applications.