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Department of Civil Engineering
Osaka City University
3-3-138, Sugimoto
Sumiyoshi-Ku, Osaka, 558-8585
JAPAN

Experimental Study on Seismic Retrofitting Method by Filling Concrete with Empty Gap into Existing Bridge Piers

Masahide Matsumura, Toshiyuki Kitada, Yoshinobu Sawanobori (Hanshin Expressway Public Corporation) and Yoshirou Nakahara

Journal of Structural Engineering, Vol.47A, JSCE, pp.35-44, March 2001 (in Japanese)

Suggested in this paper is a new seismic retrofitting method for existing steel bridge piers, which improves current retrofitting methods drastically in a practical and economical point of view. It is intended in the method that plastic deformation occurs intensively and substantially in a narrow region with steel cross section in a bridge pier. And the validity of the method is investigated through an experimental study by using 5 specimens subjected to gradually increased cyclic bending moment and constant axial force. It is concluded that sufficient ductility can be obtained with a little increment of the ultimate strength of existing steel bridge piers if the bridge piers are strengthened by this retrofitting method.

Mechanical Behavior on High Strength Bolted Tensile Joints of Box Cross Sections Subjected to Tension and Bending

Takashi YAMAGUCHI, Yasuo SUZUKI, Toshiyuki KITADA, Kunitomo SUGIURA (Kyoto University) and Hisayuki AKIYAMA (Komai Tekko Inc.)

Journal of Structural Engineering, Vol.47A, JSCE, pp.103-112, March 2001 (in Japanese)

Most of the past studies on high strength bolted tensile joints have dealt with parts of connections, such as split tee joints subjected to only tension, due to simplicity. However, in order to apply these joints to bridge structures, the mechanical behavior of overall connections under actual loading states must be made clear. In this study, therefore, paying attentions to the mechanical behavior of joints subjected to combined loads, that is, both bending and tension simultaneously, the loading tests for the connections using this type of joints for box cross sections are carried out. Based on the experimental results, the mechanical behavior considering geometrical configurations, especially, bolt arrangements and its applicability to the connections of bridge structural members are discussed in detail.

On Elasto-Plastic and Finite Displacement Analysis for Calculating Load Carrying Capacity of Steel Bridge Structures

Katsuhiro TANAKA (Japan Information Processing Service Co., Ltd.) and Toshiyuki KITADA

Journal of Structural Engineering, Vol.47A, JSCE, pp.125-136, March 2001 (in Japanese)

Dealt with in this paper are strategies concerning numerical analysis and issues on generating analytical models, such as the shape of initial imperfections, pre-stressing forces of cables, and loading methods of combined applied loads for calculating the load carrying capacity of' steel bridge structures through elasto-plastic and finite displacement analysis. Arc-length method, current stiffness parameter, partial approximate updated Lagrangian description (AULD), and a method for deciding the severest shape of initial deflection are described as representative strategies. The efficiency of the strategies are demonstrated through the numerical analyses of a practical cable-stayed bridge model by EPASS, which is a computer program for elasto-plastic and finite displacement analyses of steel framed bridges structures.

Relationships between Safety Factors of Structural Members and Overall Load Carrying Capacity of Steel Cable-Stayed Bridges

Jiro NOGUCHI (Sogo Engineering Inc.) , Toshiyuki KITADA and Manabu HIKIGUCHI
Journal of Structural Engineering, Vol.47A, JSCE, pp.137-146, March 2001 (in Japanese)

Dealt with in this paper are relationships between the safety factors of cables, pylons and main girders, and the overall load carrying capacity of steel cable-stayed bridges. A parametric study through elasto-plastic and finite displacement analysis is carried out using three types of cable-stayed bridge models designed according to the Japanese Specifications for Highway Bridges and neglecting the buckling phenomenon of the structural members. The main conclusions are as follows : ①The stress-strain relationship of cables should be idealized as not a bi-linear model but tri-linear model. ②The current safety factor of cables (2.5) can be reduced to about 2.0 from a buckling point of view. ③Variation of the safety factors of pylons and main girders does not affect substantially to the load carrying capacity of overall cable-stayed bridges. Finally, future research needs are also discussed.

High Strength Bolted Tensile Joints for Bridge Structures in Japan,

Takashi YAMAGUCHI and Toshiyuki KITADA
Japanese – German Bridge Colloquium, Munich, pp.154-169, April 2001

In Japan, rational bridge structures in both technological and economical aspects are desired recently. High performances of bolted tensile joints, such as high stiffness, high strength, and easiness of construction are evaluated under such social conditions, so that these joints have began to be used gradually in bridges. In this paper, the state of the arts, concept of the design procedure and latest topics on tensile joints in Japan are described in brief.

On Safety Factor of Cables in Steel Cable-Stayed Bridges

Jiro NOGUCHI (Sogo Engineering Inc.), Toshiyuki KITADA and Manabu HIKIGUCHI
Proceedings of IABSE Conference on Cable-Stayed Bridges, Seoul, KOREA, pp.138-147, June 2001

Dealt with in this paper is proper value of the safety factor of steel cables in steel cable-stayed bridges through the elasto-plastic and finite displacement analysis of this type of three bridge models designed on trial according to the Japanese Specifications for Highway Bridges (JSHB). The number of cable layers in these models is 1, 3 and 19, and their main span length is 100m, 150m and 700m, respectively. It can be concluded by the analysis that the load carrying capacity of cable-stayed bridges is mainly decided by the strength of cables. It is also important to formulate as exactly as possible the stress-strain relationship of cables in the analysis for design in order to simulate the accurate behavior of cable-stayed bridges up to the ultimate limit state.

Feasibility Design on Cable-Stayed Bridges with H-Shaped Main Girders

Jiro NOGUCHI (Sogo Engineering Inc.), Toshiyuki KITADA, Masahiko YOSHIDA (Pasco Corp.), Ryoji TSUKAMOTO (Kokusai Kogyo Co., Ltd.), Seiji ENDO (Sumitomo Heavy Industries Ltd.), Hiroshi SHINMYO (Hansin Consultants Co., Ltd.)
Proceedings of IABSE Conference on Cable-Stayed Bridges, Seoul, KOREA, pp.122-131, June

2001

This paper deals with the feasibility of cable-stayed bridges having H-shaped composite main girders with prestressed concrete slabs or steel-concrete composite slabs from an economical point of view. This type of two cable-stayed bridges with main span length of 165 m and 84 m are designed on trial according to the Japanese Specifications for Highway Bridges. The load carrying capacity and behavior up to the ultimate limit state of the bridges is investigated through the elasto-plastic and finite displacement analysis of the bridge model with the longer main span of 165 m. The economical aspect of this type of cable-stayed bridges is discussed in comparison with the other type of bridges, for example steel box girder bridges and prestressed concrete box girder bridges.

Checking Method for Load Carrying Capacity of Nielsen-Lohse Bridges and Cable-Stayed Bridges through Elasto-Plastic and Finite Displacement Analysis
Katsuhiro TANAKA (Japan Information Processing Service Co., Ltd.) and Toshiyuki KITADA
Steel Construction Engineering, Vol.8, No.30, JSSC, pp. 39-49, June 2001 (in Japanese)

Dealt with in this paper is a method for deciding the proper shape of initial deformation for elasto-plastic and finite displacement analysis of rigid framed steel bridge structures through using a Nielsen-Lohse bridge model as an example. In the method, an elasto-plastic buckling mode in the vicinity of the ultimate limit state, which can be approximately obtained without executing eigenvalue analysis, is adopted as the proper initial deformation shape. Proposed in this paper also is a method for finding out structural members of which strength affects predominantly the load carrying capacity of a steel bridge structure by comparing with the results of elasto-plastic and finite displacement analysis of two models. One is the model idealized with elasto-plastic finite elements, and the other one is the model in which only the structural members under consideration are idealized with elasto-plastic finite elements and the other members are idealized with elastic finite elements. Effectiveness of the method is verified by using two numerical models of cable-stayed bridges.

Relationship between Magnitude of Applied Seismic Acceleration and Extent of Damage to Steel Thin-Walled Bridge Piers due to Local Buckling
Jun OKADA and Toshiyuki KITADA
Journal of Applied Mechanics, Vol. 4, JSCE, pp. 445-452, August 2001 (in Japanese)

In this study, elasto-plastic and dynamic response analysis is carried out to investigate the influence of applied seismic acceleration and the flexural rigidity of longitudinal stiffeners onto damage to steel bridge piers having single thin-walled box columns and the relationships between the extent of the damage and the limit states, such as serviceability limit, repairable limit and ultimate limit of the bridge piers. Firstly, a method for estimating the proper flexural rigidity of longitudinal stiffeners is dealt with. Secondly, a parametric analysis is carried out by varying types of the seismic acceleration waves and the flexural rigidity of longitudinal stiffeners in order to investigate the definition of the limit states.

Development of a Practical System for Detecting Portal Marker Columns and Lighting Poles with Damage on Highway Bridges

Hideo ISHA, Toshiyuki KITADA, Takashi YAMAGUCHI, Kiyoshi MIYAWAKI (Hanshin Expressway Public Corporation) , Yukitoshi OTOGURO (Hanshin Expressway Public Corporation) and Jota TOKI (Hanshin Expressway Public Corporation)
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.31-42, August 2001

A practical system for detecting portal marker columns and lighting poles with damage without stopping traffic flow and for evaluating their safety is developed. For obtaining fundamental data on the development, the vibration characteristics of two standard portal marker columns with rigid frame type and F-type, and a standard lighting pole were measured. The following points on the development are found out through the measurement. (1) Vibration measurement from places on highway bridges is not allowed for the reason of disturbing the traffic flow. (2) Measurement by digital video camera from locations underneath highway bridges is most acceptable and convenient. (3) The natural period of first vibration mode can be easily and exactly measured by an ordinary digital video camera. (4) It is very useful if the natural period of second vibration mode can be measured by a higher efficient digital video camera and high technology of an image data analysis. Described in this paper is the outline of the vibration measurement and the vibration analysis for evaluating the results of the measurement.

Feasibility Study of a New Type Bridge with Single Narrow Box Girder and Diagonal Struts

Hiroki TAKENO, Takashi YAMAGUCHI, Toshiyuki KITADA and Atsunori KAWABATA (NKK Inc.)
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.155-161, August 2001

Recently, in Japan, steel bridges with a few I shaped main girders are frequently constructed for the reduction of total life cost including cost for fabrication, construction and maintenance. This type of bridges is going to be a standard type for straight girder bridges with their span length less than 70m outside urban areas. However, it may be difficult to apply this type of bridges to curved bridges because of insufficient torsional rigidity. Authors have suggested a new type bridge, which can be applicable to curved bridges, because the bridge consists of a single narrow box girder with sufficient torsional rigidity and many diagonal struts supporting the RC slab. The features of this type bridge are as follows: 1) one box girder without stiffeners is economical, 2) diagonal struts for supporting the slab can improve the torsional rigidity of the bridge. In this study, a finite displacement analysis using a computer program EPASS for elasto-plastic and finite displacement analysis of steel framed structures is executed in order to discuss the feasibility of the new type bridge as curved bridges. The load carrying capacity of this type bridge and the effectiveness of the arrangement of the struts upon the bridge performance are discussed through the numerical results. It can be found as a result that this type of bridges has enough load carrying capacity and that crossing arrangement (truss type) of struts is effective than that of parallel arrangement of struts from the viewpoint of torsional rigidity. Moreover, it can be concluded that the sufficient pitch of struts is about 5m.

Torsional Buckling and Ultimate Strength of Horizontally Curved I-Girders for Bridges

Toshiro YAMANO (Bridge & Computer Engineering Co.,Ltd.), Toshiyuki KITADA, Hiroshi

NAKAI (Fukui University of Technology) aud Jun Tai JEON (Inha Technical Junior College)
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.183-190, August 2001

This paper deals with the lateral torsional buckling and the ultimate strength of horizontally curved I-girders used in steel bridges. First of all, the analytical model of a three-span beam consisting of the central supported span and the cantilever side spans is proposed to simulate accurately the hehavior up to the ultimate state of horizontally curved I-girder panels between sway bracings or floor beams. Then, investigated are the lateral torsional buckling behavior and the characteristics of the buckling modes due to the variation of the central angle, flange width and boundary conditions of horizontally curved I-girders through elasto-plastic and finite displacement analysis using the analytical model.

Ultimate Strength and Required Flexural Rigidity of Transverse Stiffeners in Plate Girders under Shear

Yasuhiro KURITA (Kawada lndustries Inc.), Toshiyuki KITADA and Yoshihide TAKADA (Kawada lndustries Inc.)
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.225-231, August 2001

Investigated in this paper is appropriateness of the minimum required flexural rigidity of transverse stiffeners in the webs of plate girders to be designed according to the Japanese Specifications for Highway Bridges. First of all a formula for calculating the elastic buckling stress of a simply supported web plate panel with a transverse stiffener subjected to pure shearing force is derived through energy method. Then, the minimum required flexural rigidity of the transverse stiffener is formulated by using the formula and by equating the elastic buckling stress of the overall stiffened web plate panel to that of the sub plate panels separated by the stiffener. The appropriateness of the minimum required flexural rigidity of transverse stiffeners is investigated by calculating the ultimate strength of a web plate model stiffened by a transverse stiffener of which flexural rigidity is changed on the basis of the minimum required flexural rigidity through a computer program USSP developed for the elasto-plastic and finite displacement analysis of steel plated structures. Using the numerical results, the minimum required flexural rigidity of the transverse stiffener that ensures the ultimate strength of the stiffened wed equal to that of the sub panels is discussed. It is concluded that the minimum required flexural rigidity corresponding to the ultimate strength is larger and smaller in the regions of larger and smaller width-thickness ratio respectively, compared with the minimum required flexural rigidity on the elastic buckling strength by the formula derived by the energy method.

Mechanical Behavior of High Strength Bolted Tensile Joints for Steel Box Members Subjected to Tension and Bending

Yasuo SUZUKI, Takashi YAMAGUCHI, Toshiyuki KITADA and Hisayuki AKIYAMA
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.233-243, August 2001

Most of the past studies on high strength bolted tensile joints have dealt with parts of connections, such as split tee joints subjected to only tension, due to simplicity. However, in order to apply these joints to actual bridge structures, the mechanical behavior of overall

connections of this type of joints must be made clear under actual loading states. In this study, therefore, the loading tests for connections using this type of joints for box cross sections are carried out, paying attentions to the mechanical behavior of the connections subjected to combined cross sectional forces, i.e. both bending and tension simultaneously. Based on the experimental results, the mechanical behavior is discussed in detail considering bolt arrangements and its applicability to the connections of bridge structural members.

Study on Buckling Stability of Steel Cable-Stayed Bridges and Effective Buckling Length of Pylons

Jiro NOGUCHI (Sogo Engineering Inc.), Toshiyuki KITADA and Manabu HIKIGUCHI
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.245-254, August 2001

This paper deals with characteristics of the buckling stability of steel cable-stayed bridges subjected to dead and live loads and the design method of the pylons and girders of the cable-stayed bridges. Generally, in the design, the pylons and girders are checked against their buckling instability by using the method of effective buckling length. The effective buckling length is usually decided by elastic-buckling analysis without considering elasto-plastic behavior of the bridges. In this paper, therefore, the overall behavior and the ultimate strength of the cable-stayed bridge models are investigated through the elasto-plastic and finite displacement analyses with considering the plasticity of cable material. A method for deciding the effective buckling lengths of pylons in perpendicular to the cable plane is proposed. The suitability of the proposed method is checked through the elasto-plastic and finite displacement analysis using the program EPASS (Elasto-Plastic Analysis of Steel Structures).

Elasto-Plastic and Finite Displacement Analysis of Steel Framed Bridge Structures Considering Interaction of Local And Overall Buckling

Mitsuru HATTORI, Toshiyuki KITADA, and Yasumitsu MORISHITA (Takada Kikou Co., Ltd.)
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.277-287, August 2001

A method for using elasto-plastic and finite displacement analysis is investigated in this study for simulating the interactive behavior between the local buckling of plate panels between longitudinal stiffeners and component stiffened plate panels, and the overall buckling of a column member with thin-walled stiffened box cross section. Comparison of the numerical results by the analysis with loading test results using 4 specimens is carried out. And a method using buckling indices developed newly in this study is proposed for detecting the occurrence of the local plate buckling of the plate panels between longitudinal stiffeners, longitudinal stiffeners themselves and overall stiffened plate panels, and the column buckling and for evaluating the interactive behavior.

Development of Overall Pseudo-Dynamic Testing System Considering Multi-Phase Interaction by Using Internet

Yoshihiro KISHIMOTO, Takashi YAMAGUCHI, Toshiyuki KITADA, Kazutoshi NAGATA (Graduate School of Kyoto University), Eichi WATANABE (Graduate School of Kyoto University) and Kunitomo SUGIURA (Graduate School of Kyoto University)

Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.415-424, August 2001

Recently, larger and complex structures have been sometimes constructed in cooperation with development of bridge and computer technologies. It is very important for designing these structures rationally and economically to know the interactive behavior among structural elements of these structures. A pseudo-dynamic test is one of methods to investigate the seismic interactive behavior of these structures experimentally. But a lot of experimental facilities are needed to carry out the pseudo-dynamic test of one of these structures. If several exiting experimental facilities for the pseudo-dynamic test located in different places can be connected by any means, the interactive behavior can be investigated by using some of these existing experimental facilities. The objective of this study is to develop a pseudo-dynamic testing system connected by the Internet. And effectiveness of this developed system is discussed based on the results obtained by the pseudo-dynamic test of an elevated bridge model supported by two piers made of steel subjected to a seismic load. It is concluded that the developed pseudo-dynamic testing system can be applicable for understanding the mechanical behavior of these complex systems considering the interaction among their structural elements.

Experimental Study on Seismic Retrofitting Method by Setting Energy Absorption Segment in Existing Bridge Pires

Masahide MATSUMURA, Toshiyuki KITADA and Yukitoshi OTOGURO (Hanshin Expressway Public Corporation)

Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.425-435, August 2001

Proposed in this paper is a new seismic retrofitting method for a column member in an existing steel bridge pier, which improves current retrofitting methods drastically in a practical and economical point of view. It is intended in the method that plastic deformation is generated intensively and substantially in a pre-selected steel cross section in a bridge pier. The validity of the method is investigated experimentally by using 5 specimens subjected to gradually increased cyclic horizontal displacement and constant axial force. It is concluded that the sufficient ductility of the column member can be obtained with a little increment of their ultimate strength due to the retrofitting by using the proposed retrofitting method.

Experimental Study on Seismic Retrofitting Method of Steel Bridge Piers by Using Carbon Fiber Sheets

Kazuaki TANI, Masahide MATSUMURA, Toshiyuki KITADA and Hidenao HAYASHI (Hanshin Expressway Management Technology Center)

Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.437-445, August 2001

As for the seismic retrofitting of steel bridge piers, a method filling them with concrete is often used to enhance their ductility because of the easiness of construction and for inexpensive reason. However, in case that the ultimate strength of a pier column exceeds that of the anchorage system by filling concrete, the anchorage system of the bridge pier or its foundation may be damaged and either of them must be strengthened. However, the repair of the anchorage system or the foundation is very expensive. In case that, therefore,

another retrofitting method in which additional steel members are attached to existing longitudinal stiffeners and between them is also used. But this method is also expensive and inconvenient in repair work. Accordingly, our attention is paid to carbon fiber sheets often used for seismic retrofitting of RC bridge piers to improve the seismic performance of steel pier columns. Since carbon fiber sheets are of light and strong material, it is possible to improve strength and ductility of various places of bridge piers easily. In this study, a loading test is carried out for 4 steel bridge pier models with rectangular section largely scaled down subjected to bending increasing in cyclic and constant axial compression force in order to investigate the effect of the retrofitting by carbon fiber sheets pasted on component steel plate panels by epoxy resin upon the seismic performance of the steel bridge piers. It is concluded that the retrofitting method can improve the ductility with little loading capacity increment of the bridge pier due to the prevention of local buckling. In the future, the bond characteristics between steel plate panels and carbon fiber sheets should be investigated both analytically and experimentally in detail in order to evaluate the effectiveness of this retrofitting method in precise.

Deformation Capacity of Large Diameter High Strength Bolts with Waisted Shank Subjected to Axial Tensile Force

Takashi YAMAGUCHI, Toshiyuki KITADA and Takashi NAKANO
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp.447-453, August 2001

In case of applying axial tensile force to a high strength bolt, in general, stress is concentrated at the bottom of the threaded portion. As a result, its failure mode is brittle due to the lack of ductility. In this study, the mechanical behavior of high strength bolts with waisted shank subjected to axial tensile force is numerically analyzed by FEM considering both material and boundary non-linearities. Based on these numerical results, an optimal diameter of the waisted shank of the large diameter bolts is discussed paying attention to their energy absorption capacity. It is concluded from the FEM analysis that the optimal diameter of the waisted shank is a little smaller than the effective diameter of the bolts specified in the Japanese Industrial Standards, JIS.

Post-Tension Strengthening Method with High Tensile Steel Plates for Existing Steel Girder Bridges

Takashi YAMAGUCHI, Hironori NAMIKI (Kyobashi Construction Corporation), Toshiyuki KITADA, Noriyo HORIKAWA (Ritsumeikan University) and Shigeru YAMAMOTO (Ritsumeikan University)
Proceedings of the 6th Japan-Korea Joint Seminar on Steel Bridges (JSSB-JK-6), Tokyo, Japan, pp. 565-570, August 2001

There are many methods for repairing and strengthening existing steel girder bridges with damage or with insufficient safety factor due to recent heavy vehicles and their dense traffic. These methods are roughly classified into 2 categories. One is the method by stiffening or strengthening with additional materials, such as steel wire cables, steel plates and carbon reinforced plastic sheets. The other is the method, which controls stress resultants by introducing pre-stress into these additional materials or by jacking up and down the bridge girder. Described in this paper is the outline of these stiffening and

strengthening methods, their advantages and disadvantages, and a concept of selecting the best one from these methods. Then, three practical methods for introducing pre-stress into additional steel plates are proposed such as the methods using tension of oil jacks, thermal heating and wedge force. And their effectiveness and constractibility is discussed.

Study on Ultimate Strength and Buckling Design Method of Columns Made of High Strength Steel

Nobuhito OCHI (Akashi National College of Technology), Toshiyuki KITADA and Toshitaka MUKAIYAMA (Akashi National College of Technology)
Steel Construction Engineering, Vol.8, No.31, JSSC, pp. 89-96, September 2001 (in Japanese)

In the current Japanese Specifications for Highway Bridges, the design methods for compression members made of high strength steel are not coded. The design of such members is, therefore, carried out on the basis of the concept similar to that of mild steel, and the design concept is not rational for the members made of high strength steel. In this study, the ultimate strength of columns made of high strength steel is investigated through a parametric study based on elasto-plastic and finite displacement analyses considering the inherent characteristics of residual stress distribution and stress-strain relationship of high strength steel. Then the buckling design method for columns made of high strength steel is investigated through the numerical results.

Deformation Capacity of Large Diameter High Strength Bolts with Waisted Shank subjected to Axial Tensile Force

Takashi YAMAGUCHI, Toshiyuki KITADA and Takashi NAKANO
Steel Construction Engineering, Vol.8, No.32, JSSC, pp. 1-8, December 2001 (in Japanese)

In case of applying axial tensile force to a high strength bolt, in general, stress is concentrated at the bottom of the threaded portion. As a result, its failure mode is brittle due to lack of ductility. In this study, the mechanical behavior of high strength bolts with waisted shank subjected to axial tensile force has been analyzed numerically by FEM considering both material and boundary non-linearities. Based on these numerical results, an optimal diameter of the waisted shank of the bolts is discussed paying attention to their energy absorption capacity.

A Consideration for Future Steel Bridge Structures and Constructions in Japan

Toshiyuki KITADA and Masahide MATSUMURA
Memoirs of the Faculty of Engineering, Osaka City University, Vol. 42, pp.41-54, December 2001

Steel bridge industries in Japan are coming onto a new stage, that big projects of constructing long span bridges crossing straits or bays have been almost completed, that is to say, demand for a large amount of steel materials tends to become smaller. On the other hand, need for seismic retrofitting and maintenance of existing steel bridges is becoming larger in this decade. Under such circumstances, however, requirements for steel bridges focus on not only load carrying capacity and/or ductility but also seismic performance, environmental consideration, appearance, economical aspect and so on. Presented in this paper are considerations about the recent and new trends of steel bridge structures and their

constructions in Japan. And the prospect for the future in the field of bridge engineering is also mentioned.

Mechanical Behavior of High Strength Bolted Tensile Joints for Steel Box Members Subjected to Tension and Bending

Yasuo SUZUKI, Takashi YAMAGUCHI, Toshiyuki KITADA and Hisayuki AKIYAMA (Komai Tekko Inc.)

Memoirs of the Faculty of Engineering, Osaka City University, Vol. 42, pp.61-69, December 2001

Most of the past studies on high strength bolted tensile joints have dealt with parts of connections, such as split tee joints subjected to only tension, due to simplicity. However, in order to apply these joints to bridge structures, the mechanical behavior of overall connections must be made clear under actual loading states. In this study, therefore, the loading tests for connections using this type of joints for box cross sections are carried out, paying attentions to the mechanical behavior of the connections subjected to combined load, i.e. both bending and tension simultaneously. Based on the experimental results, the mechanical behavior is discussed in detail considering geometrical configurations, especially, bolt arrangements and its applicability to the connections of bridge structural members.