Analytical Study on Mechanical Behavior of Semi-Rigid Column Anchor Connections with High Strength and High Ductility Long Bolts

Shugang SONG, Takashi YAMAGUCHI, Toshiyuki KITADA and Kunitaro HASHIMOTO (Shinko Wire Company)

Steel Construction Engineering, Vol. 12, No. 46, pp.59-68 (2005) (in Japanese).

In this research, high strength and high ductility long bolts with waisted shank are applied to semi-rigid column anchor connections as a type of long bolted tensile connections. The mechanical behavior of the semi-rigid column anchor connections with the waisted shank long bolts is investigated by a FEM analysis considering the contact/non-contact behavior between the bottom base plate and the footing concrete. Discussed in the paper is the effect of the long high strength bolts with waisted shank on the ultimate strength and the behavior up to the ultimate state of the anchor connection of the column specimens subjected to bending. The performance of the column anchor connection with high strength bolts with waisted shank is compared with that of the connection with normal high strength bolts. The connection with high strength bolts with waisted shank can increase the ultimate horizontal displacement of the top of the column specimens with this type of anchor connection and improve energy absorption capacity due to the high deformability compared with the column specimens with the anchor connection by normal high strength bolts.

Nonlinear Static/Dynamic FEM System for Analyzing Spatial Bridge Structures Consisting of Thin-Walled Steel and Composite Members

Masato KANO (JIP Techno Science Corporation), Katsuhiro TANAKA (JIP Techno Science Corporation) Takashi YAMAGUCHI and Toshiyuki KITADA

The 3rd International Conference on Structural Stability and Dynamics, Florida, USA (2005).

Two computer programs, EPASS and USSP, have already been developed by the authors et al. EPASS is a program for the elasto-plastic and finite displacement analysis of spatial framed steel bridge structures. USSP has been developed for predicting the ultimate strength of stiffened plates and plated structures on the basis of an elasto-plastic and finite displacement theory formulated by a finite element method. Recently, EPASS/USSP, a multi-purpose static/dynamic FEM solver for the spatial bridge structures consisting of thin-walled and composite members has been developed through combining those programs mentioned above. This paper describes the outline of EPASS/USSP and several numerical and practical examples are analyzed to verify the accuracy of the program.

Ultimate Bending Strength of Open-Box-Girder Bridges with of Slant Webs

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The 3rd International Conference on Structural Stability and Dynamics, Florida, USA (2005).

In recent years, the reduction of total cost for public works is required severely in Japan. Inside of such a situation, open-trapezoidal box-girder bridges are sometimes constructed from the viewpoint of structural rationality and labor-saving for fabrication and construction. This type of the bridge is having the slant webs. This feature makes possible to reduce the width of the lower flange and the piers. However, the mechanical behavior of this type of the bridge is not sufficiently investigated concerning the local buckling behavior of the slant web. This paper presents the characteristics of the ultimate bending strength of the slant web considering the influence of geometrical imperfection analytically.

International Collaborative Pseudo-Dynamic Testing Method for Continuous Elevated Bridges by Using Internet

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*Advances in Experimental Structural Engineerin*g, Volume 1, pp.371-376 (2005).

In order to assess the response characteristics of a large-scale structural system, a multi-degree of freedom-system has to be necessarily taken into consideration. From this viewpoint, in this research the parallel pseudo-dynamic seismic loading testing system is proposed to be developed with the view to incorporating experimental stations located at far distant to each other all over the world through remote control. The feasibility of this system has been assessed by connecting experimental stations through the Internet. The model structure considered herein is an elevated bridge consisting of steel and RC piers and superstructure. It was found that this system was proved to work very well. As a conclusion, this system is proved to be highly effective to evaluate the response characteristics of a large-scale structural system.

A Fundamental Study on the Improvement and Refurbishment of Existing Bridges
Takashi YAMAGUCHI and Toshiyuki KITADA
Bridge Management 5, London, UK, pp.647-653 (2005).
In Japan, many bridges have been constructed to establish an efficient highway road network since the World War II. The attention has been, however, paid mainly to the construction of safe and standard bridges with uniform quality in design loads as much as possible and neglecting harmony between the safety and surrounding environment of bridges until recently. Nowadays, however, most of them have some troubles, such as fatigue cracks in steel members, cracks in RC slabs, corrosion of steel members and existence of overweight vehicles much heavier than specified in design specifications and so on. As a result, many bridges require substantial strengthening and repairing works. In this paper, the importance of consideration of the harmony between the bridge safety and its surrounding environment in the bridge design and maintenance is discussed by introducing some actual examples in Osaka considering the refreshment and re-creation of some superannuated bridges.

Strengthening the Strength and Ductility of Existing Box Columns Built Up with Insufficient Corner Welding
Toshiyuki KITADA, Masahide MATSUMURA, Mitsuo ARINO (Kinki Regional Development Bureau, Ministry of Land, Infrastructure and Transport) and Mitsuyoshi KIJITANI (Japan Bridge Engineering Center)
Bridge Management 5, London, UK, pp.654-662 (2005).
Presented in this paper is a strengthening technique and its effects in improving both the load carrying capacity and ductility capacity for constituent steel box columns of the arch ribs in an existing deck-type steel Langer bridge. Fillet welded corners of the arch rib cross section have a possibility of causing brittle fractures when the component plate panels are buckled by an unexpected large seismic load. Also the bridge safety against working stress due to increased traffic weight and volume has been reduced year by year. To reduce the working stress and to increase the ultimate strength and ductility of the box columns, the cross section is strengthened by attaching L-shaped steel angles with the Ultra-Twist Fastener, which enables to fasten the angles to the corners of the box columns from the outside by using a high-strength bolt. Two types of experiment using full-scaled corner part specimens and full-scaled box beam specimens are carried out to verify the strengthening effect by the method and to guarantee the FEM analysis of the bridge strengthened by the method on the basis of elasto-plastic and finite displacement theory as a framed structure.

Design of Hybrid HPS Box Girder with Concrete Slab
Taro TONEGAWA (Sumitomo Metals Industries), Eiichi WATANABE (Kyoto University), Kunitomo SUGIURA (Kyoto University), Takashi YAMAGUCHI and Ryuichi ANDOU (Sumitomo Metal Industries)
Advanced Materials for Construction of Bridges, Buildings and Other Structures-4 (2005).
Recently, high strength steels with yield strength of 500 MPa have been developed in Japan, which is superior in manufacturing cost and weldability compared to existing high strength steels. In this paper, proposed is the bridge system consisting of thin-walled HPS hybrid narrow twin box girder and steel concrete composite sandwich slab. The preliminary bridge design for span length of 100m based on the ultimate strength obtained by experiments concludes that the cost of the bridge construction can be reduced by about 10% comparing with the cost of pre-stressed concrete box girder bridge with corrugated steel web.

Elasto-Plastic and Finite Element Analysis Using Beam-Column Element for Concrete Filled Steel Tubes Subjected to Torsion
Yongri AN, Toshiyuki KITADA and Masahide MATSUMURA
Proceedings of the 8th Korea-Japan Joint Seminar on Steel Bridges, Nagoya, Japan, pp.419-425 (2005).
Presented in this paper is mechanical properties and shear stress-shear strain curve for encased concrete into a steel tube subjected to pure torsion. The concrete-filled steel tube is idealized by the assembly of beam-column elements consisting of the steel tubes and encased concrete for an analytical program on the basis of elasto-plastic and finite displacement theory, now being developed by the authors. The validity of the suggested stress-strain relationship for the encased concrete is verified through the comparison of the analytical results with the experimental results. Moreover, concrete filled steel tubes with circular cross-section subjected to both compression and torsion is analyzed.

Analytical Study on Mechanical Behavior of Semi-Rigid Column Anchor Connections with High Strength and High Ductility Long Bolts
Shugang SONG, Takashi YAMAGUCHI and Toshiyuki KITADA
Proceeding of the 8th Korea-Japan Joint Seminar on Steel Bridges, Nagoya, Japan, pp.523-532 (2005).

The objective of this study is to investigate the applicability of the semi-rigid tensile column anchor connection with high strength and high ductility long bolts. F.E. analysis considering the contact/non-contact behavior between the bottom base plate and the footing concrete is carried out. In the analysis, the different failure modes of the connection are dealt with by varying the bolt diameter of the shank and the thickness of the plate of the column. Discussed herein is the behavior up to the ultimate state of the column anchor connection subjected to bending and the effect of the long high strength bolts with waisted shank on the ultimate strength. It is concluded that the connection with high strength bolts with waisted shank can increase the ultimate horizontal displacement of the top of the column specimens and improve energy absorption capacity.

Fundamental Study on Shear Strength of Steel I Girder with Cracks in Vicinity of Sole Plate
In-Ho KIM, Takashi YAMAGUCHI, Toshiyuki KITADA and Masahide MATSUMURA
Proceedings of the 8th Korea-Japan Joint Seminar on Steel Bridges, Nagoya, Japan, pp.545-552 (2005).
Investigated in this study is the load carrying capacity of steel I-shaped girders with some fatigue cracks in the vicinity of the sole plates where shear force predominates. Static loading tests are carried out for 3 types of specimens with cracks of different length. It is founded that the load carrying capacity of a steel I-shaped girder with a crack subjected to shear force does not decrease significantly. These results also indicate that the shear buckling strength of a steel I-shaped girder with a crack can be figured out by numerical approach.

Experimental Study on Vibration Control of Steel Poles Using Wire Rope
Tomohiko ISHIBASHI, Toshiyuki KITADA and Masahide MATSUMURA
Proceedings of the 8th Korea-Japan Joint Seminar on Steel Bridges, Nagoya, Japan, pp.701-706 (2005).
Recently, it is pointed out that the bridge vibration due to the traffic causes damage to a pole type steel structure like a lighting pole or a marker pole on an elevated bridge. As some damage induces collapse in the severe case and the collapse may cause secondary accident resulting in injury, vibration problem of the pole type steel structure is to be solved as soon as possible. As the number of such steel poles is too large to maintain sufficiently, it is important to avoid resonance and to improve damping effect of the steel pole by some economical technique. Then the authors present in this paper a vibration controlling technique for a steel pole by using a wire rope and the effectiveness of the technique is investigated experimentally. It is found through the vibration test that the wire rope attached to the steel pole effectively works; one side of the vibration mode of the pole can be controlled and the response displacement of the pole at the resonance frequency can be reduced to about half that of the steel pole without the wire rope.

Ultimate Strength Interaction Curves of Steel Decks Subjected to Biaxial In-Plane Forces and Wheel Load
Kazuhiro FUKUMOTO, Toshiyuki KITADA and Daisuke OZAKI
Proceedings of 6th Japanese-German Bridge Symposium, pp.33-34, Munich (2005)
Steel deck plates are generally used in long span steel bridges such as suspension bridges, cable stayed bridges, continuous box girder bridges and so on to decrease the dead load. These kinds of long span bridges are constructed on highways in bay areas. Accordingly, not only longitudinal in-plane stress but also transverse in-plane stress has to be considered in designing the wide deck plates in some of these bridges because the width of these bridges tends to become larger than that of ordinary bridges. The ultimate strength and their interaction curves of wide stiffened plates subjected to the biaxial in-plane stresses and the wheel loading as out-of-plane loading simultaneously is investigated in this study for proposing a more rigorous design method for wide steel deck plates. Used in this study is a computer program, USSP which can analyze the elasto-plastic and finite displacement behavior of stiffened plated structures on the basis of FEM in order to analyze the ultimate strength of wide stiffened plates subjected to the biaxial in-plane stresses and wheel loading.

Fundamental Performances of Enegy Absorbing Connectors and Their Damage Control Effects on Steel Bridges Girders
Kentarou TANAKA, Hiroshi ZUI (Setsunan University), Toshiyuki KITADA and Masahide Matsumura
Proceedings of 6th Japanese-German Bridge Symposium, pp.53-54, Munich (2005).
Investigated in this paper are the energy absorption performances of steel bellows, one of the energy absorbing devices. The steel bellows are set between adjacent steel girders in a row or between girders and abutments. The characteristics of the loading and unloading paths in both the longitudinal and transverse directions of the steel bellows are investigated by the loading tests and the FEM analyses on the basis of elasto-plastic and finite displacement theory. Also, the adaptabilities of the bellows are investigated by non-linear time-history analyses for a three-span girder bridge isolated by the lead rubber bearings against the Level 2 & Type 2 Earthquake accelerations specified in the Japanese Specifications for Highway Bridges. It is confirmed that the steel bellows

show large energy absorption performance and are effective to reduce the relative displacements between the superstructure and abutments in both the longitudinal and transverse directions substantially.

Development of Thin-Walled Hybrid HPS Box Girder with Steel Concrete Composite Sandwich Slab
Taro TONEGAWA (Sumitomo Metals Industries), Eiichi WATANABE (Kyoto University), Kunitomo SUGIURA (Kyoto University), Takashi YAMAGUCHI and Ryuichi ANDOU (Sumitomo Metal Industries)
Proceedings of 6th Japanese-German Bridge Symposium, Munich (2005).
Recently, high strength steels with yield strength of 500 MPa have been developed in Japan, which is superior in manufacturing cost and weldability compared to existing high strength steels. In this paper, proposed is the bridge system consisting of thin-walled HPS hybrid narrow twin box girder and steel-concrete composite sandwich slab. The preliminary bridge design for span length of 100m based on the ultimate strength obtained by experiments concludes that the cost of the bridge construction can be reduced by about 10% comparing with the cost of pre-stressed concrete box girder bridge with corrugated steel web.

Repair/Strengthening of Damage and Retrofitting of Existing Steel Bridges in Japan Using a Deck-Type Steel Langer Girder Bridge with Span Length of 112m as an Example
Toshiyuki KITADA, Sigeyuki MATSUI, Tetsuya YAMADA (Nara National Highway Office, Ministry of Land, Infrastructure and Transport) and Mitsuyoshi KIJITANI (Japan Bridge Engineering Center)
Proceedings of 6th Japanese-German Bridge Symposium, pp.55-56, Munich (2005).
In this paper are summarized the present situation and repair/strengthening methods of fatigue damage, retrofitting due to revised design methods and increased design live load, and steel bridges in Japan by using the Maitani Bridge consisting of two deck-type steel Langer length of 112 m, constructed in 1965 and 1970 as one of the representative examples.

Necessity for Refreshment of Existing Elevated Highway Bridges in Urban Areas and Environment Surrounding them for Future Sustainability of Bridge Construction in Japan
Takashi YAMAGUCHI, Toshiyuki KITADA and Masahide MATSUMURA
Proceedings of 6th Japanese-German Bridge Symposium, pp.117-118, Munich (2005).
In Japan, many bridges have been constructed to establish an efficient highway network since the World War II. The attention has been paid mainly to the construction of safe and standard bridges with uniform quality in design loads as much as possible, because governments could not afford to consider the harmony between the bridges and their surrounding environment until recently. Refreshment is necessary in existing elevated highway bridges for future sustainability of bridge construction in Japan. In this paper, issues on the refreshment of the bridge environment, methods for solving the issues and creating desirable bridge environment are investigated. It is concluded that the most important thing to realize the desirable bridge environment is the communication among the people concerning the bridge environment. For creating the desirable bridge environment and changing the current bridge environment to the desirable one, it is also suggested that a new organization should be founded which can help to communicate among the people easily, to find out valuable and useful strategies and to develop core technologies necessary to solve many problems on the bridge environment.

Development of Dynamic Response Analysis System for Bridge Structures Considering Elasto-Plastic and Finite Displacement Behavior
Masato KANO (JIP Techno Science Corporation), Katsuhiro TANAKA (JIP Techno Science Corporation), Takashi YAMAGUCHI and Toshiyuki KITADA
Journal of Constructional Steel, JSSC, Vol. 13, pp.425-430 (2005) (in Japanese).
Two computer programs, EPASS and USSP, have already been developed by the authors et al. EPASS is a program for the elasto-plastic and finite displacement analysis of spatial framed steel bridge structures. USSP has been developed for predicting the ultimate strength of stiffened plates and plated structures on the basis of an elasto-plastic and finite displacement theory formulated by a finite element method. Recently, EPASS/USSP, a multi-purpose static/dynamic FEM solver for the spatial bridge structures consisting of thin-walled and composite members has been developed through combining those programs mentioned above. This paper describes the outline of EPASS/USSP and several numerical and practical examples are analyzed to verify the accuracy of the program.

Development of Thin-Walled HPS Composite Box Girder
Taro TONEGAWA (Sumitomo Metals Industries), Eiichi WATANABE (Kyoto University), Kunitomo SUGIURA (Kyoto University), Takashi YAMAGUCHI and Takashi IWAGAWA (Sumitomo Metals Industries)

Proceedings of the 6 th Symposium on Research and Application of Hybrid Structures, Committee on Hybrid Structures, JSCE, CDROM, pp.13-1-13-8 (2005) (in Japanese).
Although the hybrid girder requires a certain limitation to width to thickness ratio of web, it is demonstrated experimentally that the composite action of hybrid girder with much thinner web plate to RC slab can assure the ultimate bending strength in positive flexure up to fully plastic bending moment. The ultimate strength for the hybrid girder consisting of different grades of steel for the web and the flange which is classified as the non-compact section, a parametric study is carried out by varying the ratio of width to thickness ratio of the web, material strength by using finite displacement analysis. And, by preliminary design, it is proposed that the thin-walled HPS composite box girder is very cost effective.

A Consideration on Electrolytic Corrosion Possibility of Steel Plates Bonding Carbon Fiber
Akihito NAKAI, Toshiyuki KITADA and Masahide MATSUMURA
Proceedings of the 6 th Symposium on Research and Application of Hybrid Structures, Committee on Hybrid Structures, JSCE, CDROM, pp.46-1-46-4 (2005) (in Japanese).
Recently, improvements in durability and developments of rational maintenance technique of steel bridge become one of the big issues. Then, researches on application of carbon fiber, which is advantageous in practical and environmental aspects, to steel structure are undergoing. However, carbon fiber is not applied to many actual steel structures, because the loading test and analysis is conducted in a limited condition and number and the occurrence of the electrolytic corrosion is pointed out in applying carbon fiber to steel members. In this paper, the occurrence of electrolytic corrosion of steel plates strengthened by carbon fiber reinforced plastics (CFRP) is investigated through a partial experiment using steel plates with CFRP plates.

On Vibration-Control Effect of Energy Absorbing End Connectors for Bridge Girders though Considering their Transverse Performance
Kentarou TANAKA, Hiroshi ZUI (Setsunan University), Toshiyuki KITADA and Masahide MATSUMURA
Steel Construction Engineering, Vol. 12, No. 48, pp.77-88 (2005) (in Japanese).
In this paper, the energy absorption performance of a steel bellows as one of the energy absorbing bridge girder connectors is examined by model experiments paying attention to not only the longitudinal but also transverse direction. The brittle fracture of the steel bellows is also investigated by an extremely low cycle fatigue test. The effectiveness of the steel bellows on the seismic behavior of a numerical model consisting of a three-span girder bridge is investigated by a non-linear time-history analysis. It is confirmed that the steel bellows possess the large energy absorption performance, and the displacements of the superstructure and bridge piers can be reduced substantially by using the steel bellows in both the longitudinal and transverse directions.

Applicability and Modeling of Steel Bellows Energy Absorbing Connectors to Steel Bridge Girders
Kentarou TANAKA, Hiroshi ZUI (Setsunan University), Toshiyuki KITADA and Masahide MATSUMURA
Memoirs of the Faculty of Engineering, Osaka City University, Vol. 46, pp.51-58 (2005).
The steel bellows will make important roles in restricting the movements of a bridge superstructure and in absorbing seismic energy due to strong earthquake. Investigated in this paper are the energy absorption performance of the steel bellows, and its applicability to steel girder bridges. The steel bellows are set between two adjacent steel girders in a row or between a girder and a abutment. The characteristics of the loading and unloading paths in both the longitudinal and transverse directions of the steel bellows are investigated by the loading tests and the FEM analyses on the basis of elasto-plastic and finite displacement theory. The occurrence of low cycle fatigue of the steel bellows is also observed in both experiments of the longitudinal and transverse directions. Also, the applicability of the bellows are investigated by non-linear time-history analyses for a three-span girder bridge isolated by the lead rubber bearings against the Level 2 & Type 2 Earthquake accelerations specified in the Japanese Specifications for Highway Bridges. It is confirmed that the steel bellows show large energy absorption performance and are effective to reduce greatly the relative displacements between the bridge superstructure and abutments in both experiments the longitudinal and transverse directions.

Elasto-Plastic and Finite Element Analysis Using Beam-Column Element for Concrete Filled Steel Tubes Subjected to Torsion
Yongri AN, Toshiyuki KITADA and Masahide MATSUMURA
Memoirs of the Faculty of Engineering, Osaka City University, Vol. 46, pp.59-63 (2005).
Presented in this paper is mechanical properties and shear stress-shear strain curve for encased concrete into a steel tube subjected to pure torsion. The concrete-filled steel tube is idealized by the assembly of beam-column elements consisting of the steel tubes and encased concrete for an analytical program on the basis of elasto-plastic

and finite displacement theory, now being developed by the authors. The validity of the suggested stress-strain relationship for the encased concrete is verified through the comparison of the analytical results with the experimental results. Moreover, concrete filled steel tubes with circular cross-section subjected to both compression and torsion is analyzed.

Analytical Study on Mechanical Behavior of High Strength Bolted Tensile Joints with High Strength and High Ductility Bolts

Shugang SONG, Takashi YAMAGUCHI and Toshiyuki KITADA

Memoirs of the Faculty of Engineering, Osaka City University, Vol. 46, pp.45-50 (2005).

In this study, in order to investigate in detail the mechanical behavior of the high strength bolted tensile joint with high strength and high ductility bolts, focusing on the failure modes of the joint and the effectiveness of the high strength and high ductility bolt, F.E. analysis has been carried out for some cases varying the thickness of the flange plate. Discussed herein are different failure modes corresponding to the thickness of the flange plate through comparing with the joints using normal high strength bolts. And it is concluded that the joint with high strength and high ductility bolts is effective with respect to deformability.

Advanced Static/Dynamic, Elasto-Plastic and Finite Displacement Analysis of Steel and Composite Spatial Structures

Toshiyuki KITADA, Masahide MATSUMURA, Yongri AN and Toshirou YAMANO (JIP Techno Science Corporation)

International Symposium on Advances in Steel and Composite Structures 2005, pp.58-81 (2005).

This paper describes the outline of the advanced computer program, EPASS/USSP for introducing how to analyze the static or dynamic, elasto-plastic and finite displacement behavior of steel or steel-concrete composite spatial structures. The program consists of two sub-programs, EPASS and USSP. EPASS is the program on the basis of FEM for analyzing the static or dynamic, elasto-plastic and finite displacement behavior of steel, steel-concrete composite and reinforced concrete spatial framed structures with residual stress and initial imperfections. USSP is the program also on the basis of FEM for analyzing the static or dynamic, elasto-plastic and finite displacement behavior of steel plated structures and solid concrete structures with residual stress and initial imperfections. The contents of this paper are the fundamental theories adopted in developing EPASS and USSP, available finite elements, and practical examples which EPASS, USSP and EPASS/USSP are used. Described briefly in this paper also are the issues to be solved and points to be developed in this program for the sustainable future development.

Analytical Study on Mechanical Behavior of Bolted Tensile Joints with Sealant

Yasuo SUZUKI, Takashi YAMAGUCHI and Kunitomo SUGIURA (Kyoto University)

The Eighteenth KKCNN Symposium on Civil Engineering, Taiwan, pp.871-876, December 19-21 (2005).

In this study, 3D-F.E.analysis of two types of high strength bolted tensile joints is carried out. One is the split tee joint type and the other is the joint which is contacted only at the center of tee flange plate with/without sealant. Discussed herein are the effects of the later type of joints on the mechanical behavior of this type of the joint and appreciate Young's modulus of the sealant installed the joint surfaces. It is concluded that the strength and the rigidity of the later type of the joint with sealant of which Young's modulus is about 0.01GPa is almost equal to those of the joint with no sealant.

Experimental Study on Strengthening Effect of L-Shaped Steel Angles Bolted to the Corner Part of Steel Box Column with Ultra-Twist Fastener

Masahide MATSUMURA, Toshiyuki KITADA, Toshio YOSHIZU, Mitsuyoshi KIJITANI (Japan Bridge Engineering Center) and Kazuyuki MURAMOTO (Japan Bridge Engineering Center)

Proceedings of the 9th Symposium on Ductility Design Method for Bridges, JSCE, pp.207-212 (2006) (in Japanese).

Fillet welded corners of cross section of box columns, when bridges are constructed in 1970s, have a possibility to cause brittle fractures when the component plate panels are buckled by an unexpected large seismic load. Therefore, such corner part is to be enhanced the ductility of the corners. Then investigated in this paper is a new strengthening technique to improve the ductility of the corners by attaching L-shaped steel angles with the Ultra-Twist Fastener, which enables to fasten the angles to the corners of the box columns from the outside by using a high-strength bolt. Static loading tests are carried out by using partial modeling specimens of the full-scaled corner part with differences in strengthening details. These test results verify the effectiveness of the

strengthening technique by attaching L-shape steel angles outside the corner part.

Response of Isolated Piers Subjected to Strong Ground Motions in Horizontal 2 Directions
Kazutoshi NAGATA (Nagoya Institute of Technology), Takato OZEKI (Kyoto University), Eiichi WATANABE (Kyoto University), Kunitomo SUGIURA (Kyoto University) and Takashi YAMAGUCHI
Journal of Structural Engineering, JSCE, Vol.52A, pp.583-592 (2006) (in Japanese).
Isolated structures have been adopted in elevated bridges to reduce severe damages due to huge earthquakes after the Hyogoken Nambu Earthquake. In this paper, the seismic response of isolated piers subjected to strong ground motions in horizontal 2 directions was assessed. At first, 2 dimensional mechanical behaviors of isolated bearings were evaluated by static loading tests. Secondly, pseudo-dynamic tests were carried out to evaluate the seismic response of isolated piers. It is found that the equivalent damping constant of isolated bearings may be reduced and the stiffness tends to increase, compared to these values in 1 direction input. Moreover, it was verified that the response displacement of isolated piers tends to decrease under 2-D earthquake input.

Fundamental Study on Mechanical Behavior and Strength Evaluation of Tensile Joints of Short Connection Type with High Strength and High Ductility Bolts
Takashi YAMAGUCHI, Shugang SONG and Toshiyuki KITADA
Steel Construction Engineering, Vol. 13, No. 49, pp.11-22 (2006) (in Japanese).
Carried out in this study is the experiment using a split tee joint subjected to monotonous tensile load in order to evaluate the strength and deformability of high strength bolted tensile joints with high strength and high ductility bolts. Then, the mechanical behavior of the joint with waisted shank bolts is discussed on the basis of the experimental results. Furthermore, the strength and the failure mode of the joints are evaluated according to the design standards, Euro-code and JSSC code for this type of joints. As a result, it is possible to apply these codes to the design of the joint with waisted shank bolts.