**8th. World Congress on Computational Mechanics (WCCM8)**
**5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)**
**June 30 – July 5, 2008**
**Venice, Italy**

# DYNAMIC NONLINEAR FINITE ELEMENT ANALYSIS OF ELASTO-PLASTIC COLLAPSE BEHAVIOR INCLUDING THE LOCAL BUCKLING FOR THE SQUARE STEEL TUBE USING THE MIXTURE OF BEAM ELEMENT AND SHELL ELEMENT

*** T.Ine[1], K.Yuge[2], T.Takayama[2], Y.Hashimoto[2] and K.Kajiwara[3]**

[1] National Research Institute for Earth Science and Disaster Prevention(NIED) 1501-21 Nishikameyama, Mitsuta, Shijimicho, Miki-shi, Hyogo-ken 673-0515, JAPAN
ine@bosai.go.jp
http://www.bosai.go.jp

[2] Department of Science and Technology, Seikei University 3-chome, Kichijoji-kita-machi, Musashino-shi, Tokyo-to 180-8633, JAPAN
yuge@st.seikei.ac.jp

[3] National Research Institute for Earth Science and Disaster Prevention(NIED) 1501-21 Nishikameyama, Mitsuta, Shijimicho, Miki-shi, Hyogo-ken 673-0515, JAPAN
kaji@bosai.go.jp

**Key Words:** *Nonlinear FEM, Local Buckling, Steel framed structure, Square steel tube, Beam Element, Shell Element, Elasto-plastic, Dynamic Collapse Analysis.*

## ABSTRACT

This paper reports the nonlinear finite element analysis results of the seismic collapse behaviours of the square steel tube column and steel framed structures with those tube columns including the local buckling [1].

In the seismic collapse phenomenon of the steel framed structures, it is remarkable that the flexural capacity of the thin walled section member deteriorates by the local buckling of the frame member and the local buckling affects the collapse mechanism and the maximum collapse strength of the whole steel framed structures [1-4].

In the ordinary constitutive law of the finite element method with the beam element, the fibre model (layered approach) using a material testing result and the generalized plastic hinge method applied the plastic flow theory with the generalized stress (member sectional force) are used.

Because these methods cannot deal with a change of the beam cross-sectional shape directly, the effect of the local buckling of the member cannot be evaluated by these methods [2-4]. Therefore, the nonlinearity relations between the sectional force and the deformation (for instance rotational angles) of the member edge are provided by the experiment, subsequently the nonlinear hysteresis relations between the sectional force and the displacement of the member edge are modelled.

In the conventional stress analysis of steel frame, the numerical integration scheme of bending deformation of the member [3] and the one dimensional finite element model[4] are

applied to the steel framed structure analysis using these mentioned hysteresis relations, as a relatively precise and simple method. Here, the above-mentioned experimental constitutive law of the member is named “non-linear member constitutive law”.

In general, the non-linear member constitutive law is complicated, in particular very complicated under cyclic loads. In addition, it is difficult to consider the changes of the flexural capacity by the axial-force fluctuation. They have incompleteness as the constitutive law. It is not convenient that experiments are necessary for modelling of the non-linear member constitutive law [1-4].

To overcome an above-mentioned defect, in this research, we use shell element for the extent of the local buckling of the frame member, and use beam element for the remaining part of framed structure. For cantilever column tests under the compression axial-force with varying bending load, reproduction computations are conducted. Moreover the seismic collapse analysis for the one-story steel framed structure considering local buckling is conducted. The rationality of this method is examined.

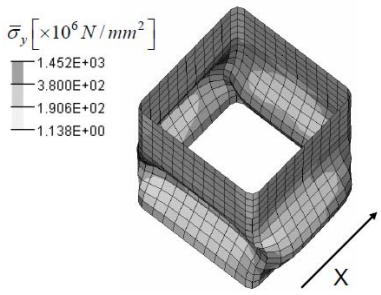


Fig.1 Local buckling deformation of FE analysis for the column base

## REFERENCES


[1] T. Tatsuhiko, K. Yuge, T. Takayama, Y. Hashimoto and K. Kajiwara, “Dynamic finite element analysisi of steel square pipe structure with local buckling under cyclic bending (Part1,2)”, *EProceeding of 47th AIJ. Kyushu Chapter Architectural research meeting*, (2008).

[2] N. Yasui, “Elasto-plastic analysis for local buckling behaviour of circular tubes subjected to compression and bending”, J. Struct. Constr. *Eng. AIJ*, No. **561**, pp. 201–208, (Nov. 2002)

[3] S. Yamada, H. Akiyama and H. Kuwamura, “Ultimate behavior of box section beam-columns under varying axial force”, J. Struct. Constr. *Eng. AIJ*, No. **461**, pp. 115–122, (Jul. 1994).

[4] Y.Uchida and S. Morino,”Limit of axial force ratio for degrading steel beam-columns involving local buckling”, J. Struct. Constr. *Eng. AIJ*, No. **425**, pp. 67-88, (Jul. 1991).