A SEISMIC COLLAPSE ANALYSIS CODE FOR FRAMED STRUCTURES USING ASI-GAUSS TECHNIQUE

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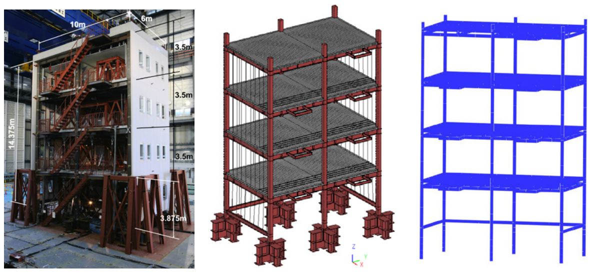
1. INTRODUCTION

An adaptive finite element code using the linear Timoshenko beam elements based upon the adaptively shifted integration (ASI) technique and its refined version, the ASI-Gauss technique [1], has been developed to analyze various dynamic problems of framed structures. It gives highly accurate solutions with a minimum number of elements per member, by adaptively shifting the numerical integration point in an element to a location where that of a plastic hinge can be precisely expressed. The finite element code using the technique drastically decreases memory resources and computational time.

In this presentation, capabilities of the numerical code in seismic response analyses are shown by comparing the results with detailed numerical simulations performed by the parallel finite element analysis code, the E-Simulator and experimental results obtained by the full-scale shake-table test using the world's largest shaking table, the E-Defense [2].



(a) E-Defense (b) E-Simulator (c) ASI-Gauss

Figure 1. Four-story steel frame models

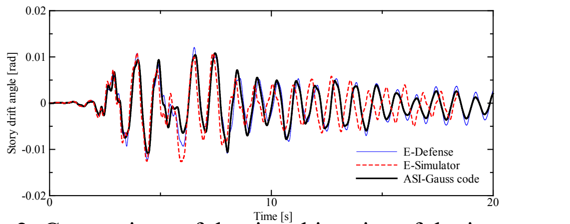
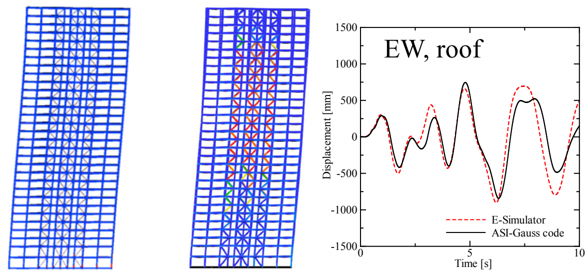


Figure 2. Comparison of the time histories of the interstory drift angle on the 1st floor (X-direction)



(a) E-Simulator (b) ASI-Gauss (c) Displacements

Figure 3. Comparison of the deformation (magnified 10 times) at 6.21 s and displacements for the 31-story steel building frame

2. NUMERICAL RESULTS

The performance of the seismic response analysis code using the ASI-Gauss technique is validated by being compared to an experimental result obtained by a full-scale shake-table test using the E-Defense for a four-story steel frame, as shown in Fig. 1(a). Figure 1(b) shows the detailed model constructed for the E-Simulator, where the mesh has 5,181,880 hexahedral solid elements, 7,523,255 nodes and 22.57 million degrees of freedom (DOFs) [3], and Fig. 1(c) shows the beam element model for the ASI-Gauss code constructed with 1,388 elements, 995 nodes and 5,970 DOFs. The 60 % JR Takatori seismic wave recorded on the shaking table is used as the input wave. Although the computational cost using the ASI-Gauss code is very small compared to that of the E-Simulator, the numerical results for the four-story steel frame obtained by the ASI-Gauss code has no demerit to be confirmed compared to those obtained by the detailed analysis performed by the E-Simulator, and they also showed good agreement with the experimental results obtained by the E-Defense, as shown in Fig. 2.

Figure 3 shows a comparison of the deformations of the 31-story steel building frame models obtained by both codes at 6.21 s of the input ground motion, where a large relative displacement at the top of the corner column of the 31st story is observed. The deformations agreed well as a whole.

3. CONCLUSIONS

The ASI-Gauss code can obtain highly accurate seismic response solutions of building frames as well as their collapse modes. An example of a seismic pounding and collapse analysis is also to be shown in the presentation.

REFERENCES

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