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The Comparison of the Experimental Result with the Numerical Analysis using the New Coupled Analysis Method based on the Enriched Free Mesh Method and the SUPG/PSPG Stabilized Finite Element Method

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The fluid-structure coupled phenomenon is becoming a very important issue in the numerical analysis field. As the popularity of a numerical analysis rising along advancement in a computer performance, demand of a coupled analysis is further increasing. A lot of new methods are proposed by many researchers to solve a fluid-structure coupled problem by a numerical analysis method.

The new fluid-structure coupled analysis method using the SUPG/PSPG stabilized Finite Element Method (FEM) [1] and the Enriched Free Mesh Method (EFMM) [2] have been already proposed by us[3]. The new method which is proposed by us has nodal consistency at the fluid-structure interface (Fig.1) and its calculation efficiency and accuracy are high. The SUPG/PSPG stabilized FEM is adopted for a fluid analysis, while the high-accuracy analysis method based on the EFMM developed by the authors is adopted for structure analysis. The EFMM has a feature that can be possible to obtain a high accuracy analysis result without high order elements. In short, as the common feature of these methods, it is possible to analyze a fluid or a structure rather accurately by using the first order triangular or tetrahedral elements. In addition, variables are exchanged exactly at the common nodes on the fluid-structure boundary without deteriorating an accuracy and a calculation efficiency due to the interpolation of variables between nodes. From these features, the SUPG/PSPG stabilized FEM and the EFMM have a very good chemistry. Therefore, the our proposed method can be possible to obtain a high accurate fluid-structure coupled analysis result without a high order element. However, the our proposed method had a shortcoming that is appeared when it is introduced into a parallel method. This shortcoming occurs due to the characteristics of the EFMM. Specifically, a parallel efficiency that is a very important factor of a large-scale analysis will be decreased. Generally, a domain decomposition method is certainly needed in the large-scale analysis field. But, an usual domain decomposition method will not be able to introduce. Because, a making stiffness matrix process by the EFMM is different from a conventional FEM. In particular, a cluster that is called a local elements cluster (Fig.2) is created to compute a stiffness matrix in the EFMM analysis. Therefore, we proposed a new parallelization method of the EFMM. The proposed new parallelization method is needed a different table for communication from an usual parallel FEM based on the element-by-element method. The Fig.3 shows a comparison of a conventional elemental based domain decomposition method and the domain decomposition method for the EFMM. The proposed method has a feature that a table for communication is little bit complicate compared with a conventional FEM using the element-by-element method but a communication cost is normally same. In this connect, in the EFMM analysis, the local elements cluster by local elements cluster treatment can be applied as same as the conventional element by element treatment. By applying the our proposed new parallelization method of the EFMM, the our proposed new fluid-structure coupled analysis method can be solved a large-scale fluid-structure coupled phenomenon. However, a fluid-structure coupled analysis method is very difficult to prove that an analysis accuracy.

In this paper, an analysis result computed by our proposed method is compared with an experimental data to prove the analysis accuracy of the our proposed method.

TABLES

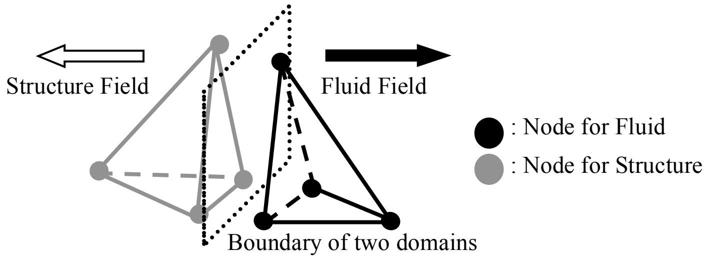

Fig. 1. Boundary of two types of analysis field retaining element formation consistent to each other

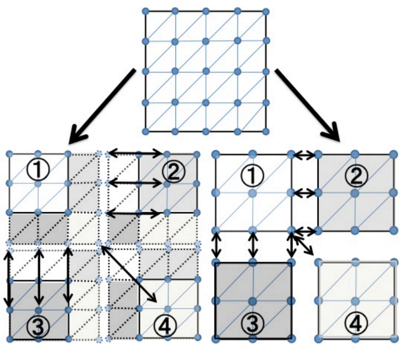

Fig. 2 Example of domain decomposition (L : For EFMM , R : For Conventional FEM)

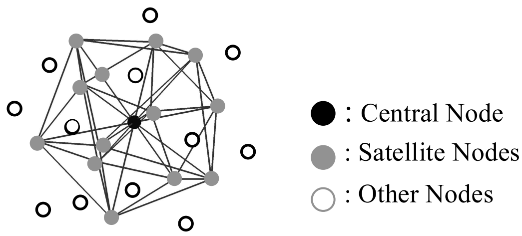

Fig. 3. Fundamental concept of local elements cluster

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