1 General Introduction
Among all types of CFRP (carbon fiber reinforced plastics), the most common matrix resin is thermosetting resin such as epoxy. CFRTS (CFRP with thermosetting resin matrix) shows several superior performances like heatproof and high specific strength, leading to a considerable potential of weight-lightening. As a result, CFRTS has been applied to special industrial fields such as aircraft, F1 and space usage [1]. However, long time and expensive equipments are necessary for CFRTS's molding, which causes high processing cost, then CFRTS's application field has been limited.

On the other hand, CFRTP (carbon fiber reinforced thermoplastics) is expected to realize low-cost and high-cycle molding, along with improvement of process ability, repair ability and recyclability. Hence, though there remain some technical difficulties in such as weaker interfacial adhesiveness between CF and thermoplastics, and impregnation of thermoplastics into CF-bundle, CFRTP has a possibility to lighten the weight of mass production automobile drastically. Especially, the largest difference between CFRTP and CFRTS is the manufacturing concept. Because CFRTS is a brittleness material, CFRTS is molded as possible to avoid making holes and joint parts. Therefore, manufacturing facilities of CFRTS are large-scale and expensive such as autoclave, which is major reason of the limited application field of CFRTS [2]. However, CFRTP can be easily deformed and jointed by heat, then press molding and welding joint like metals can be used for their manufacturing.

Then, to apply CFRTP to various industrial fields as structural material, it is necessary to establish affordable jointing methods. Mechanical fastening, such as bolt connection, rivet connection, adhesive bonding and welding are well known as jointing methods for structural members [3]. In this research, we focused on welding joint by using the thermal plasticity of CFRTP itself to apply to automotive structural members [4]. Especially, we dealt with the behavior of joint part of carbon fiber reinforced polypropylene and simulated the strength of joint part, the stress distribution and the fracture mode.

2 Literature Review
K.S. Suresh et al. created a model of temperature distribution in ultrasonic welding of thermoplastics [5]. They made comparisons between the simulated results and the experimental results for various joint designs. As a result, simulated and experimental results are found to be in agreement for the conditions they examined.

A. Levy et al. investigated a forming process of ultrasonic welding of thermoplastic composites by the finite element simulation [6]. They created the model of polymer layers at the interface and simulated the behavior of them, considering heat transfer, vibration and flow. As a result, they showed the physical phenomena that ensure welding.

3 Numerical Study
3.1 Single Lap Joint
We used Abaqus/CAE 6.11 as a solver of each model below. We made the model of single lap joint shown in Fig.1. The size of each plate (assuming that it is longitudinal unidirectional material) is 100 x 15 x 2 mm, and we put a PP sheet of 25 x 15 x 0.2 mm on the joint part. To avoid the rotation moment from the shape of structure, a tab of 20 x 15 x 2.2 mm are added on each side of the specimen. Assuming that we put it to the tensile test, we fixed one side completely and applied 30 N of load at the other side. Fig.2 shows the result of shear stress
distribution. We confirmed that the shear stress concentrates at each edge of joint part.

3.2 Cross Joint

We made the model of cross joint shown in Fig.3. The size of each plate is the same as that used in single lap joint, and we put a PP sheet of 15 x 15 x 0.2 mm on the joint part. We fixed the bottom surface of the lower plate completely and applied 5 N of load to vertical upper direction at each upper corner of the upper plate. Fig.4 shows the result of peel stress distribution. We also confirmed that there is a stress concentration at each edge of the joint part.

4 Conclusion

In this study, we focused on ultrasonic welding which uses the characteristics of thermoplastics effectively. We confirmed that there is a stress concentration at the joint part of single lap joint and cross joint at the elastic range. The behaviors at plastic range, the joint strength and the fracture mode will become clear.

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