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Structural Study of High Pressure Water Jet Measured by High Speed PIV

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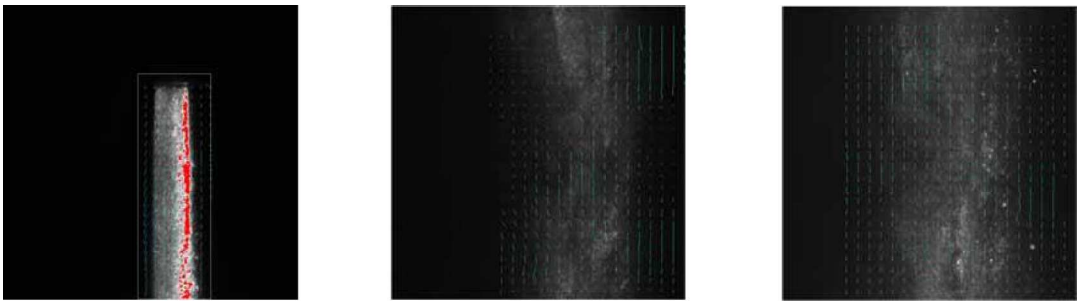
The high pressure water jet is utilized in various industrial application such as cutting various materials and soil. In particular, the jet grouting for the soil improvement is one of the most important application of water jet under high pressure and high liquid flow rate. In order to improve the efficiency and the performance of the jet grouting, it is quite important to clarify the hydrodynamic structure of water jet under high pressure and high flow rate. However, the fundamental researches on this subject are quite insufficient both analytically and experimentally. In the practical use of the water jet grouting, the water pressure is very high, reaches up to 30 ~ 200 MPa, and sometimes the jet velocity exceeds the supersonic. The nozzle diameter of the jet is several millimetre. The flow rate of the jet reaches several hundreds kilograms per minutes. The water jet is injected into the stagnant air, so the very strong shear stress acts on the gas-liquid interface. Because of this strong shear stress, the water jet seems to be suddenly broken down into the droplet flow just after injected in the stagnant air. The water jet utilized in jet grouting is usually two-phase dispersed flow, where liquid droplets flow in continuous air with interacting each other. The structural characteristics of the high pressure water jet as droplet flow such as the flow velocity, droplets diameter, void fraction, etc. are the subjects of interest for the improvement of the performance of jet grouting, In addition, the effects of the nozzle shape on the jet structure should be made clear for the farther performance of jet grouting.

In this study, the structural studies of high pressure water jet utilized in jet grouting were carried out. The double-pulse Laser and the CCD camera with image intensifier made it possible to capture a couple of fine picture of jet. The high speed PIV technique was employed to get the velocity profiles. The hydrodynamic structures of the water jet such as the droplet diameter, the spread angle of jet profile were investigated. Figure 1 shows the typical velocity vector profiles of the jet. In this figure, (a) ~ (e) shows the vectors captured at several distance from the nozzle exit.



(a) 0D (b) 100D (c) 200D

Fig. 1 Typical velocity vector profiles of high pressure water jet
(Nozzle diameter: 4.6mm, Pressure: 10Mpa, Flow direction: downward)