A Thesis for the Degree of Ph.D. in Engineering

Response of shock loading and effect of pressure on ultrasonic propagation in magnetorheological fluids

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SUMMARY OF Ph.D. DISSERTATION

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Title

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Abstract

In this research, the behavior of magnetorheological fluid when subjected to high excitation or shock loading is investigated experimentally. In order to fully understand the behavior of cluster formation in this fluid under pressure that caused by shock loading, another experimental analysis is performed. Ultrasonic measurement technique is applied since magnetorheological fluid is opaque. The properties of ultrasonic propagation change when cluster structures formed in magnetorheological fluid. Therefore, cluster formation in this fluid under various magnetic fields and pressures can be analyzed based on the change of ultrasonic propagation properties. This dissertation is organized into six chapters.

Chapter 1 introduces the basic characteristic of magnetorheological fluid, background and objectives of the research, contributions and outline of this dissertation.

Chapter 2 summarizes the previous studies on the behavior of magnetorheological fluid under shock loading. The experimental apparatus, experiment procedure, preliminary results and repeatability of the experiment system are also described.

Chapter 3 discusses the effect of magnetic field, orifice inner diameter and volume fraction on the performance of magnetorheological fluid to handle the shock loading. At low impact velocity, magnetic field has significant effect. However, the effect becomes not significant at high impact velocity. Damping force is relatively similar under different field. It because the force, which caused by shock loading, is much higher than the viscous force, which generated by the magnetic field. Performance of magnetorheological fluid under shock loading is also affected by orifice inner diameter and volume fraction of this fluid. The smaller orifice inner diameter is stronger to handle the shock loading. Moreover, the higher volume fraction, the bigger cluster is formed. In addition, bigger cluster is stronger to handle the shock loading.

Chapter 4 summarizes the previous studies about the inner structure in magnetorheological fluid. It also describes the experimental apparatus and method of ultrasonic technique, procedure and experiment results. Temperature has significant effect on the cluster formation. The cluster size becomes smaller when higher temperatures are applied. In the application of magnetic field, magnetic particles begin to form cluster in seconds. The cluster size becomes bigger when higher magnetic fields are applied. Frequency of alternating magnetic field also affects the cluster size. The cluster size becomes smaller when higher frequencies are applied.

Chapter 5 describes the experimental apparatus, procedure and the results of the investigation of cluster formation in magnetorheological fluid under pressures. At low magnetic flux densities (100 and 200 mT), the cluster size becomes smaller under higher pressures. However, at high magnetic flux densities (300 and 400 mT), the effect of pressure becomes not significant. At that range of magnetic field, cluster formation is strong enough to handle the pressure. These results confirm that magnetic field has effect on the performance of MR fluid to handle pressure that caused by shock loading. The higher magnetic flux densities produces bigger cluster. The bigger clusters are stronger to handle the amount of pressures that caused by the shock loading.

Chapter 6 summarizes the results in this study.