CHAPTER 2

LITERATURE REVIEW

Recent advances in civil structures such as high rise buildings, towers and long span bridges go with an additional flexibility and insufficient inherent damping, which lead to an increase in their susceptibility to external excitation. Therefore, these flexible structures are susceptible to be exposed to excessive levels of vibration under the the actions of a strong wind or earthquake. The protection of such structures from natural hazards puts an important task for engineers and researchers. To ensure the functional performance of flexible structures against such undesirable vibrations, various design alternatives have been developed, ranging from alternatives structural systems to modern control systems with the use of various types of control devices. In general, we could classify modern control, namely passive, active, semi active and hybrid (Azar *et al.,* 2010).

Among these modern control systems, the semi active approach has recently received considerable attention, because it offers significant adaptability without large power requirements. Actually, semi active control systems are consisted of improved passive devices which have controllable dynamic properties that alter at any moment according to the feedback or feedforward data to achieve an optimal performance. One of the example of semi active device uses controllable fluids. The advantage of controllable fluid device is that they contain no moving parts other than the piston, which makes them very reliable (dyke 1996).

Two fluids that are viable contenders for development of controllable dampers are (i) electrorheological (ER) fluids and (ii) magnetorheological (MR) fluids. The essential characteristic of controllable fluids is their ability to reversibly change from a free-flowing, linear viscous fluid to a semi solid with a controllable yield strength in milliseconds when exposed to an electric (for ER fluids) or magnetic (for MR fluids) field. Recently developed MR fluids appear to be an attractive alternative to ER fluids for use in controllable fluid dampers (Carlson 1994; Carlson and Weiss 1994). MR fluids typically consist of micronsized, magnetically polarizable particles dispersed in a carrier medium such as mineral or silicone oil. When a magnetic field is applied to the fluid, particle chains form and the fluid becomes a semi solid and exhibits viscoplastic behaviour similar to that of an ER fluid. Transition to rheological equilibrium can be achieved in a few milliseconds, allowing construction of devices with high bandwidth. Additionally, Carlson and Weiss (1994) indicated that the achievable yield stress of an MR fluids is an order of magnitude greater than its ER counterpart and that MR fluids can operate at the temperature from -40 to 150° C with only slight variations in the yield stress. Moreover, MR fluids are not sensitive to impurities such as are commonly encountered during manufacturing and usage, and little particle field separation takes place in MR fluids under common flow conditions. The MR fluid can be readily controlled with a low voltage, current driven power supply outputting only 1-2 amps. Table 1.1 provides a comparison between the key physical characteristics of the MR and ER fluids.

Table 1.1 Summary of the Physical Characteristic of MR and ER Fluids (Dyke, 1996)

Property	MR Fluids	ER Fluids
Yield stress, τ_y	>80 kPa	3.0-3.5 kPa
Operable Temperature Range	-50 to 150°C	-25 to 125°C
Plastic viscosity, η_p	0.10 to 0.70 Pa-sec	0.10 to 0.70 Pa-sec
Stability	Not affected by most chemical impurities	Cannot tolerate impurrities
$\eta_p / \tau_y^2{}_{(field)}$	$\approx 5x10^{-11}$ sec/Pa	$\approx 5x10^{-8}$ sec/Pa
Power Supply	12-24V, ~1A	~4000V, ~1 mA
Response Time	Milliseconds	milliseconds
Particle sedimentation	Little	Little
Raw Materials	Nontoxic & enviromentally safe	Nontoxic & enviromentally safe

to take full advantage of the unique features of the MR damper in control applications, a model must be developed that can accurately reproduce the behaviour of the MR damper . The prototype MR damper obtained for evaluation is a fixed orifice damper filled with a magnetorheological fluid. The MR fluid is a proprietary formulation, VersaFlo^{TM} MRX-135GD developed by the Lord Corporation, that consists of micron-size, magnetically soft iron randomly dispersed in a hydrocarbon oil along with additives that promote homogeneity and inhibit gravitational settling. It has a density of 3.28 g/cm^3. The damper is 21.5 cm long in its extended position, and the main cylindr is 3.8 cm in diameter. The main cylinder houses the piston, the magnetic circuit, an accumulator and 50 ml of MR fluid and the damper has a ± 2.5 cm stroke. As shown in Fig. 2.1, the MR fluid valve is contained within the damper piston and consists of an annular flow channel having an inner diameter of 27 mm and an outer diameter of 28 mm. the magnetic field is applied radially across the resulting 0.5mm dimension, perpendicular to the direction of fluid flow. The magnetic field can be varied from 0 to 200 kA/m for currents of 0 to 1 amp in the electromagnet coil, which has a resistance of 4 Ω. The peak power is less than 10 watts, which would allow the damper to be operated continously for more than an hour on a small camera battery. For this example, the current for the electromagnet is supplied by a linear current driver running off 120 volts in the range 0-3 V. Forces up to 3000 N can be generated with the device and are stable over a broad temperature range, varying less than 10% in the range of -40 to 150° C (Calson and Weiss, 1994).

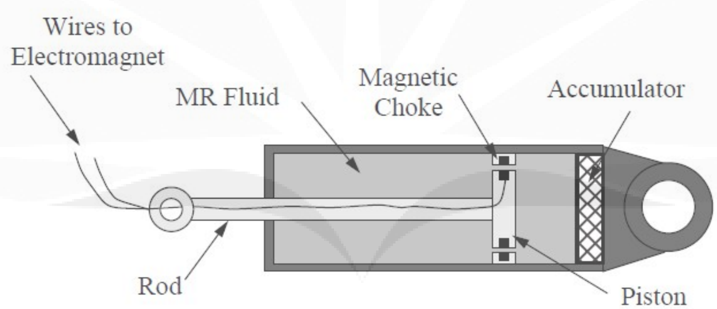

Fig.2.1 Schematic of MR damper

(Dyke, 1996)