MODELING THE BEHAVIOR OF MR DAMPERS FOR OPTIMIZING THE SEISMIC BEHAVIOR OF STRUCTURES

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MR dampers are new devices use to control the seismic behavior of structures. These kind of dampers are categorizes semi-active comparing to active and passive devices. Bingham, Spencer and Black-Box (NARX(2,2,2)) models are amongst the more advanced and widely used models in research activities (Spencer et al., 1996; Sergio et al., 2005). In this research, Spencer model is used for analysis purposes(Dyke et al., 1996). To reach the more accurate results, geometric complexities of the structure are ignored and a one story building was chosen for further investigation. Then, the damper is modeled according to dynamic Bouce-Wen model which is used as a benchmark. For the ease of evaluation switching model (Bang-Bang) is introduced to obtain a stable and efficient control system. The results presented in this paper show the efficiency of the proposed method.

MR damper usage is one of the structure behavior control solutions in wind or earth quack force presence. Structure behaviour control can be passive, semi-active or active method. MR dampers use magneto rheological fluid which consist tiny magnetic particles. These fluids viscosity change from liquid to semi-solid shape. These changes can produce variable forces which are modeled via dynamic equations.

Comparisons between dynamic models such as Bingham, Spencer and NARX Black Box models which are gathered in table below clearly show that the Spencer dynamic model can estimate the MR damper dynamic behaviour better than Bingham and the others, on the other hand, it should be noted that Bingham model is matched more with real behaviour of damper in low viscosity only and is not able to model the damper behaviour in semi-solid viscosity situation.

Table 1. Model error in percent term in different current applies

Damper Current	I=0.0A	I=0.6A	I=1.2A
Bingham	2.34%	13.25%	28.02%
Spencer	1.48%	2.25%	2.00%
NARX(2,2,2)	0.75%	0.88%	0.95%

In this paper, a 1-story structure model with MR damper model is presented to study seismic behaviour of this structure. In the structure modeling the complexity is ignored to earn the global results, therefore a linear model of 1-story structure is applied.

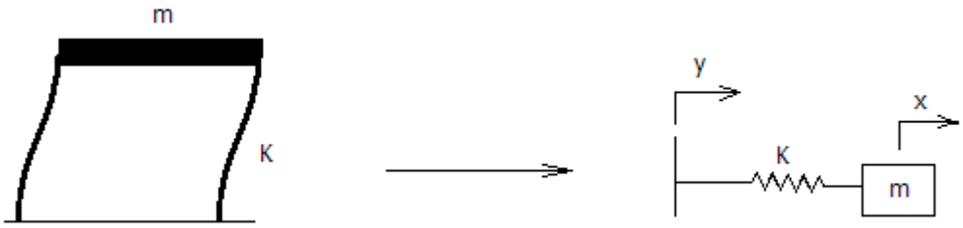

Figure 1. One story structure linear model

In this study a Bouc-Wen method in damper modeling is used. The modeled structure has been controlled via a simple useful Bang-Bang controller and makes the structure stability. The result shows about 32 percent acceleration reduction that is acceptable results for a semi-active controlled structure.

The structure seismic behaviour has been studied in three different earth quake spectrums (Bam, Tabas and El-Centro). The simulation results are compared in different spectrum presence. Table 2 presents the displacement, velocity and the acceleration reduction in percent term.

Table 2. Simulation results in Tabas, Bam and EL-Centro earthquakes presence

	Reduction of Acceleration RMS	Reduction of Velocity RMS	Reduction of Displacement RMS
Bam	52%	74%	80%
Tabas	31%	74%	75%
EL-Centro	59%	85%	91%

REFERENCES

Dyke SJ, Spencer BF, Sain MK and Carlson JD (1996) Modeling and control of magnetorheological dampers for seismic response reduction, *Smart Materials and Structures,* 5, 565-575

Spencer BF, Dyke SJ, Sain MK and Carlson JD (1996) Dynamical model of a magnetorhological damper, *Proceedings of Structures Congress XIV*, ASCE, Chicago, I.L., 361-370

Sergio M, Sergio B and Mauro M (2005) Identification of semi-physical and black-box non-linear models: the case of MR-dampers for vehicles control, *Automatica*, 41,113-127