EXPERIMENTAL ASSESSMENT OF THE EFFECT OF VARIOUS CYCLIC LOADING PROTOCOLS ON THE MECHANICAL BEHAVIOR OF REINFORCED SELF-COMPACTING CONCRETE BEAMS CONTAINING STEEL FIBER

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After prevalence of seismic design, basis on the performance of the structures (PBD method) by design codes, the need for defining representative loading paths became more essential. The most reasonable way to assess the performance of the structural elements is to replicate and simulate the load and deformation histories, an structural component will undergo during an earthquake. The objective of a loading protocol is to achieve this in a conservative manner. There is no unique and best loading history because no two earthquakes are alike in reality. The overriding issue is to account for cumulative damage effects through cyclic loading. If there is no cumulative damge, there is no need for cyclic loading. The number and amplitudes of cycles applied to the specimen may be derived from analytical studies in which models of representative structural systems are subjected to representative earthquake ground motions and the response is evaluated statistically. Numerous loading protocols with somewhat different loading histories have been recommended by various standards that in most cases the difference is more in detail than in concept. Some of these loading protocols are studied in this paper.

For this purpose, four mixture design of concerete beams containing self-compacting concrete with steel fibers (0.1, 0.2 & 0.3 by volume) and the concrete without fiber as reference design have been tested under 4 loading protocols until the behavior characteristics of this kind of concerete is studied and compared under various types of loading protocols. For the purpose of comparison of parameters such as cyclic strength, cyclic stiffness, dissipated energy and equivalent viscous damping, 4four loading protocols is applied to the specimens. One of the protocols which used in this paper is recommended by ATC standard (ATC-24) and three other protocols contain 30 cycles with constant amplitude of 50%, 100% and 150% yield displacement. All the protocols used in this study are in displacement control conditions. By using steel fibers in concrete, behaviour characteristics of concrete beams with each mixing design would be different from others. Hence, determination the amplitude of the loading protocol needs a monotonic test for the concrete beam of each mixing design. Result is illustrated in Figure 1.

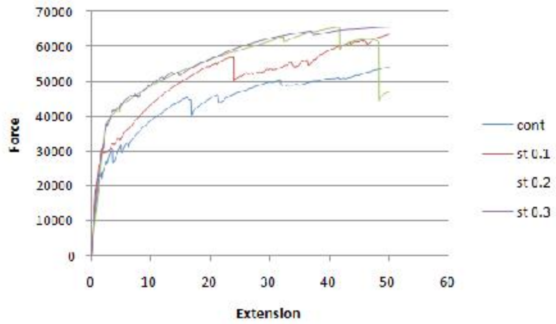

Figure 1. Monotonic test result

Loading protocol amplitudes based on the yield displacement of each mixing design is shown in Table 1.

Table 1. Loading protocol amplitudes

Mix design	Yield displacement (mm)	Loading protocol amplitude (mm)
Cont	1.45	2.175
St 0.1	1.85	2.775
St 0.2	2.3	3.45
St 0.3	2.6	3.9

Finally, the parameters mentioned before would be normalized and studied. Variation of cyclic strength is presented in Figure 2 as an example.

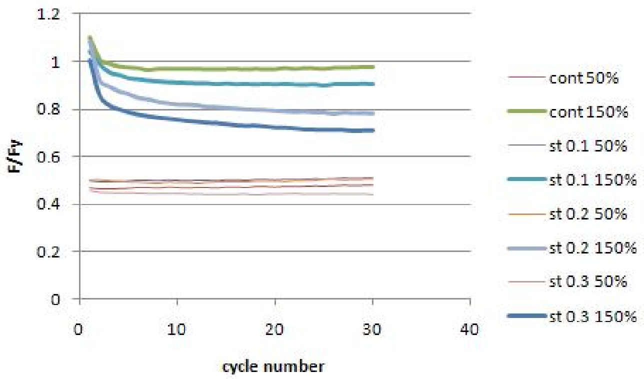

Figure 2. Cyclic strength degradation

The results achieved from this research show that for all of the loading histories, the specimen will behave elastically until the cyclic loading amplitudes are small and parameters like stiffness and strength will not change significantly with applying more cycles, as well as energy dissipation and damping values will be negligible, however after arrival to the inelastic region, stiffness and strength will decrease by increasing the number of cycles, in one hand, and energy dissipation and damping values will increase considerably according to the loading protocol, in the other hand.