

Calculating the ductility coefficient (m) of composite columns by using experimental results and the finite element (F.E.M) software

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Abstract

In recent years, structures with CFT columns have gained a lot of popularity and they are used in high-rise structures and arched bridges, especially in the Far East region such as China and Japan. In this research, the purpose of which is the effect of concrete strength on the ductility coefficient of CFT columns, two models named models A and B were used and for modeling the designed samples, from the ABAQUS finite element software SOLID element was used to model concrete and shell element was used to model steel sections. According to the investigations, an unreasonable and illogical result was observed, which indicated the lower design of valid codes such as Eurocode (EC4) and AISC. Therefore, it is necessary to have the laboratory results presented by reliable laboratory sources and articles in reliable journals and the results of the experiments of this research, providing a correction coefficient about the current and final resistance provided by the relationships.

Keywords: plasticity coefficient, A, B models, CFT columns

INTRODUCTION

1. Statement of the problem

Composite columns are sections that are made from a combination of steel and concrete sections and have been widely used in engineering structures in recent years. This type of composite sections has many advantages over conventional steel sections or reinforced concrete sections. The main advantage of these sections is the interaction between steel and concrete; by using concrete, steel sections can be tied and restrained and local buckling of steel can be delayed. Other advantages of this type of columns can be more ductility and high strength in reciprocating and inverted loads, better weight and hardness to weight ratio compared to conventional reinforced concrete members, material savings And construction time of high heat and fire resistance, less deformation than columns (Liew & Saw) due to confinement by conventional steel (CFT) and also increase the compressive strength of concrete in steel pipe Held (1).

Steel sections surrounded by concrete (located inside the concrete)

Steel Reinforced (SRC Concrete)

In this type of composite sections, the steel part of the section is placed inside the concrete and the so-called technical literature of the steel section is covered by a concrete jacket. In this type of composite section, in order to control shear cracks (due to torsion and shear) or transverse main (due to bending), depending on the thickness of the concrete jacket cover, transverse steel reinforcements (khamoot) and longitudinal reinforcements will be required.

2. Research significant

First, the advantages of this type of columns will be stated and then the discussion will continue.

Advantages of CFT columns

In recent years, structures with CFT columns have become very popular and are used in high-rise structures and arched bridges, especially in the Far East such as China and Japan. The advantages of CFT column structures are:

1. Since in a conventional composite structural system, due to the effect of combined effects, the advantages of the two materials can be optimized and desired, their disadvantages can be covered and ignored, which is preferable to other conventional systems. [7] .

2. Compared to conventional steel structures, costs can be reduced by using a composite or dual system; This price reduction is due to less use of steel and increased hardness as well as improved fire resistance [7].

3. Steel pipes can be used as a formwork for concreting and piling in buildings; Also, CFT structures have a much better construction capability than conventional reinforced concrete structures [7].

According to the studies, an unreasonable and irrational result was observed, which indicates the design of lower regulations such as Eurocode (EC4) and AISC [1]. Therefore, it is necessary to provide the correction coefficient for the current and final resistance provided by the relationships, having the laboratory results presented by reputable laboratory sources and articles in reputable journals and the results that will be the result of the experiments of this research. Is, to be initiated. Also, the next point is to provide a relation for calculating the ductility coefficient of this type of columns. Comprehensive or even accurate information is not available about the ductility coefficient and behavior of this type of columns; for this purpose, using laboratory results and hysteresis curves and modeling them with finite element software and after validation, this will be the result of both laboratory results and software outputs.

3. Research background

Taghipour et al.(2018), studied the Study of the Application of Risk Management in the operation and Maintenance of Power Plant Projects.

Taghipour et al. (2015), studied Construction projects risk management by risk allocation approach using PMBOK standard.

Taghipour et al. (2015), studied Necessity Analysis and Optimization of Implementing Projects with The Integration Approach of Risk Management and Value Engineering.

Taghipour et al. (2015), studied Risk assessment and analysis of the state DAM construction projects using FMEA technique.

Jalili et al. (2015), studied Utopia is considered to be the physical form of an ideal human society where the goals are met.

Khodakhah Jeddi et al. (2016), studied The Analysis of Effect Colour Psychology on Environmental Graphic in Childeren Ward at Medical Centers.

Taghipour et al. (2015), studied Investiged the Relationship between Competitive Strategies and Corporates Performance. Seismic Analysis (Non-Linear Static Analysis (Pushover) and Nonlinear Dynamic) on Cable-Stayed Bridge.

Taghipour et al. (2015), studied Evalation of Tourist Attractions in Borujerd County with Emphasis on Development of New Markets by Using Topsis Model.

Taghipour et al. (2015), studied Analysing the Effects of Phisical Conditions of the Workplace on Employees Productivity (Including Case Study).

Medhat and Taghipour (2021), studied Investigating the Role of Social Capital in Recreating the Historical-Cultural Context of Shiraz.

Rezvani Befrouie A et al. (2015), discussed the design of high-rise building with ecological approach in Iran (Alborz Province).

Taghipour et al. (2022), studied iuithe effect of personal factors on increasing the productivity of low-level employees in the general welfare department of tehran municipality.

Taghipour et al. (2015), studied Risk analysis in the management of urban construction projects from the perspective of the employer and the contractor.

Rezvani Befrouei MA et al. (2015), discussed Identification and Management of Risks in Construction Projects.

4. Research question

What effect does concrete strength have on the ductility coefficient of CFT columns?

5. Modeling details in finite element software environment

In this research, we use two model samples called models A and B, therefore, modeling of designed samples, ABAQUS finite element software was used. SOLID element was used for modeling concrete and shell element was used for modeling steel sections. In the step of introducing material specifications in ABAQUS software, the behavior of materials in linear

and non-linear areas was considered. Also, the mechanical properties of mild steel (ST 37) and concrete with a compressive strength of 47.6 MPa have been used.

For example, model B, the specifications of S400 steel rebar were used, and also, the tie tie was used to connect all the welded edges to each other, and the contact tie was used to define the surface status of all contact plates, surface to surface.

5-1- Output results of the studied models, samples of groups A, B obtained from the analysis of Abacus program

5-1-1- Analysis of A-1 model results due to static and seismic loading due to nonlinear dynamic analysis

To see the results of the solution, the isolation medium should be used. If you run ABAQUS / Viewer, the same CAE window will appear, except that it only has a visual environment. In the following figures, the output and various contours of the model analysis parameters of the sample groups of samples A, B, and C can be seen. Also, after analyzing models A in the isolation environment, the contour of various analytical parameters can be observed. In the figure below, the contour displacement of the sample model A-1 can be seen.

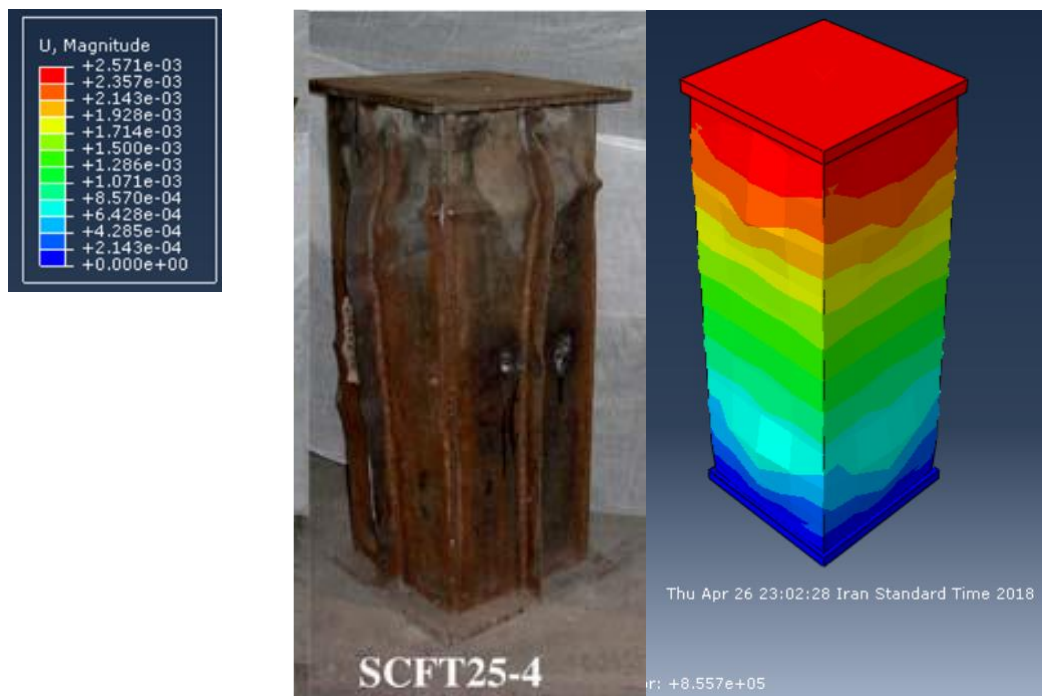


Figure 1: U-displacement distribution in model A-1

After analyzing the A models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the force-displacement diagram of the A-1 sample.

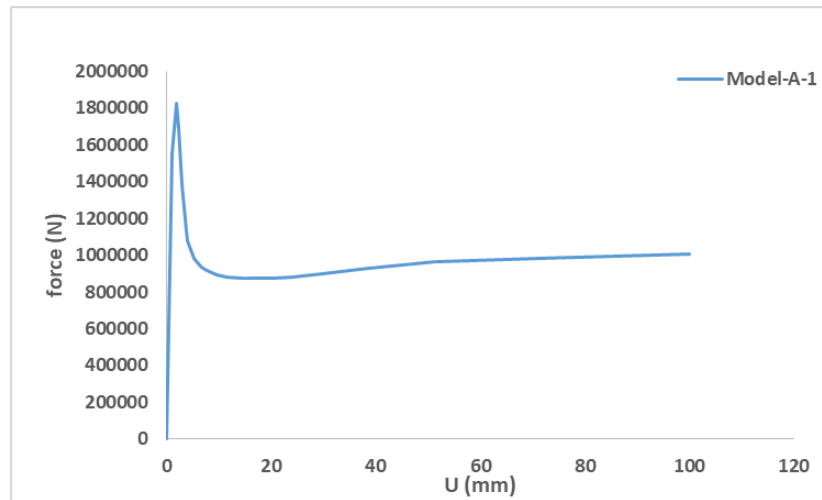


Figure (2) Force diagram - displacement of model A-1

After analyzing the A models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the force-displacement diagram of the A-2 sample.

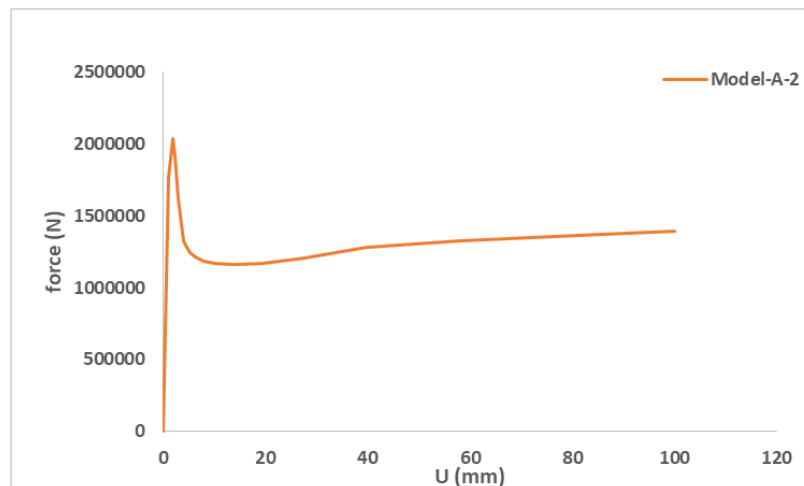


Figure (3) Force diagram - Model A-2 displacement

After analyzing the A models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the hysteresis diagram of sample A-2.

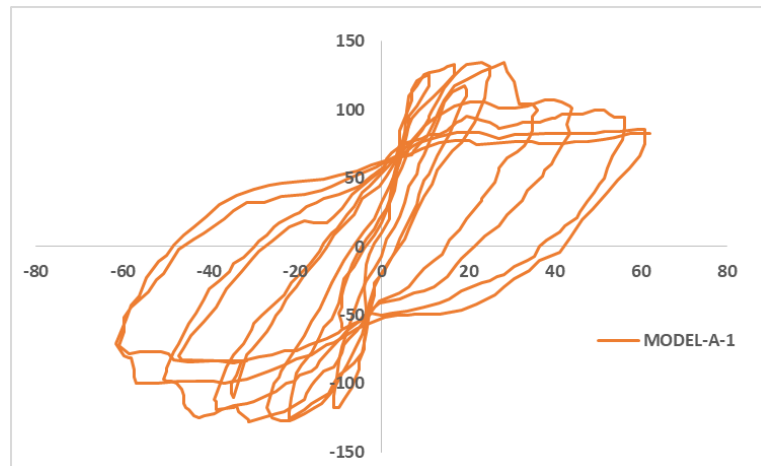


Figure (4) Hysteresis diagram of model A-1

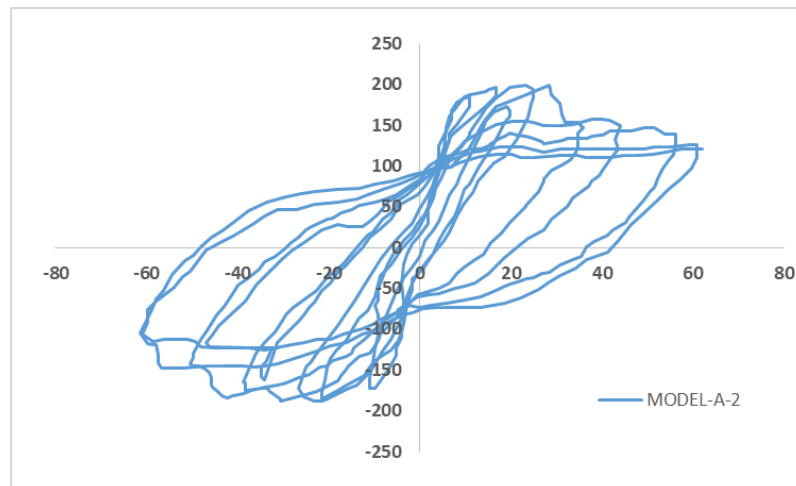


Figure (5) Model A-2 hysteresis diagram

After analyzing the A models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the hysteresis diagram of sample A-1.

After analyzing the B models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the force-displacement diagram of sample B-1.

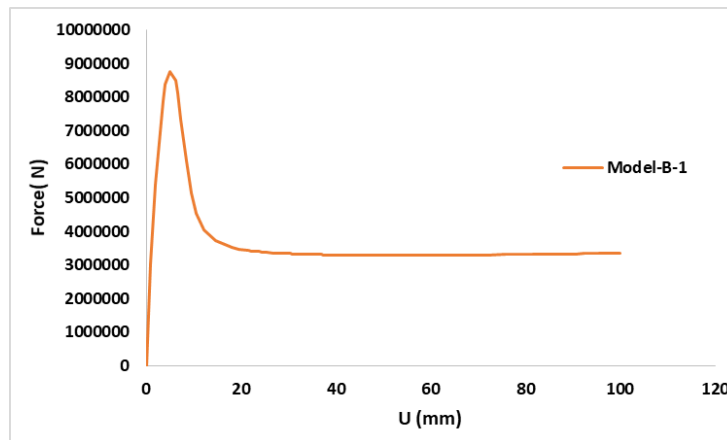


Figure (6) Force diagram - Model B-1 displacement

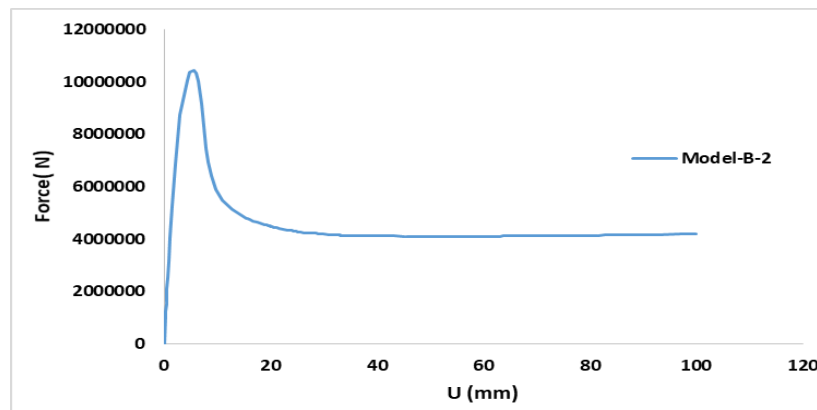


Figure (7) Force diagram - Model B-2 displacement

After analyzing the B models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the force-displacement diagram of sample B-2.

After analyzing the B models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the hysteresis diagram of sample B-1.

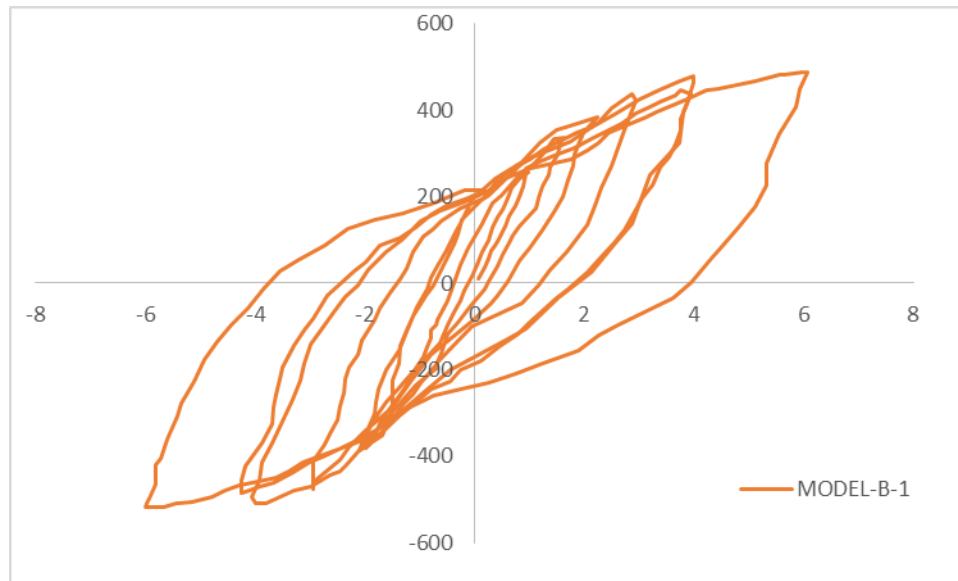


Figure (8) Hysteresis diagram of model B-1

After analyzing the B models in the Visualization environment, we can see the diagrams of various

analytical parameters. In the figure below, we can see the hysteresis diagram of sample B-2.

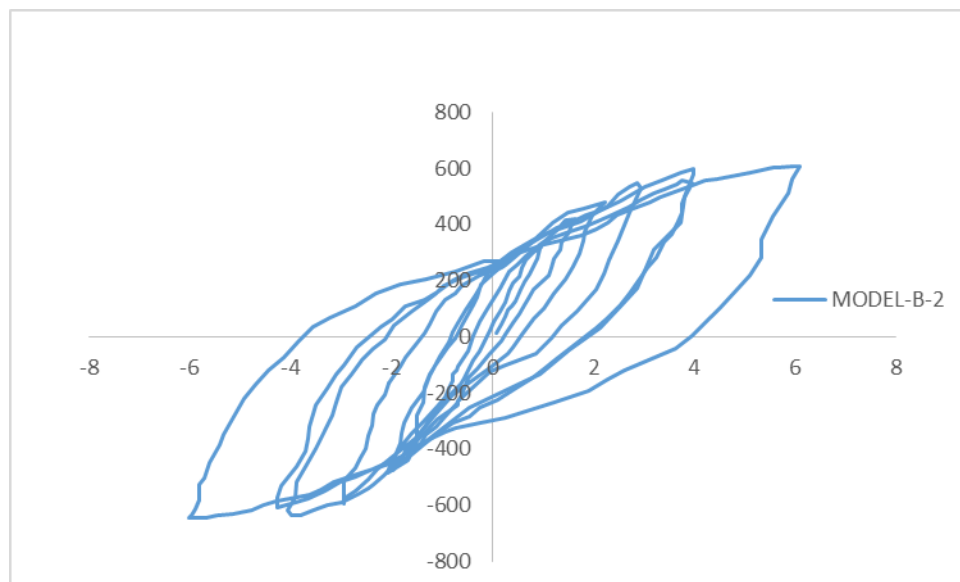


Figure (9) Hysteresis diagram of model B-2

7-2- Analysis of the results of model A-1 due to static load and seismic cycle due to nonlinear dynamic

analysis After analyzing the models of study samples of groups A, B, C in the Visualization environment,

a diagram of different analytical parameters can be seen.

In the following figure, we can see the force-displacement diagram of the sample of study groups A-1, A-2 under static loading and the hysteresis diagram of the study samples.

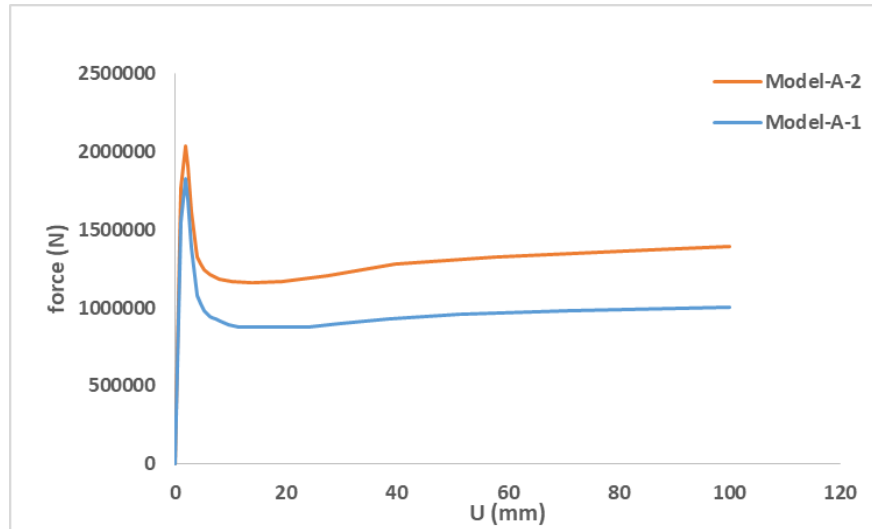


Figure (10) Comparison of force diagram - displacement of group A, model A-1, A-2

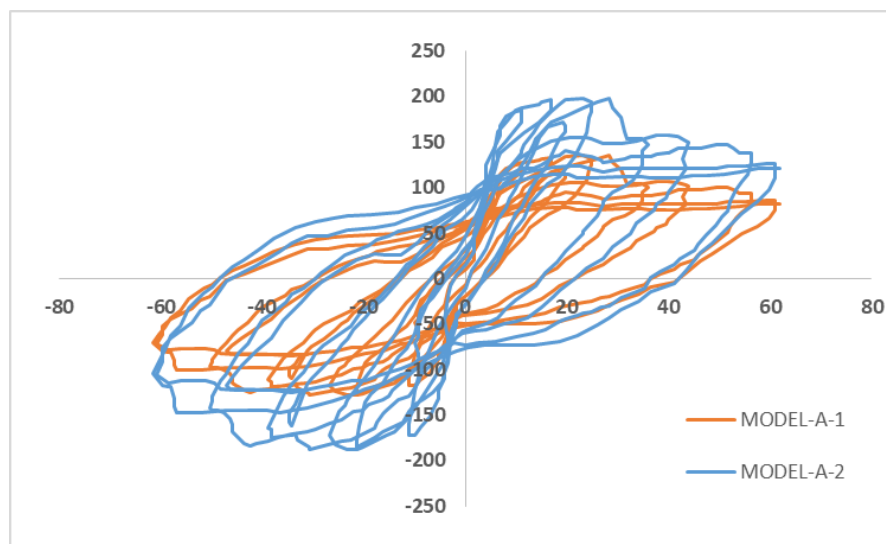


Figure (11) Comparison of hysteresis diagrams of group A models A-1, A-2

Also in the following figure, we can see the force-displacement diagram of the sample of study groups

B-1, B-2 under static loading and the hysteresis diagram of the study samples.

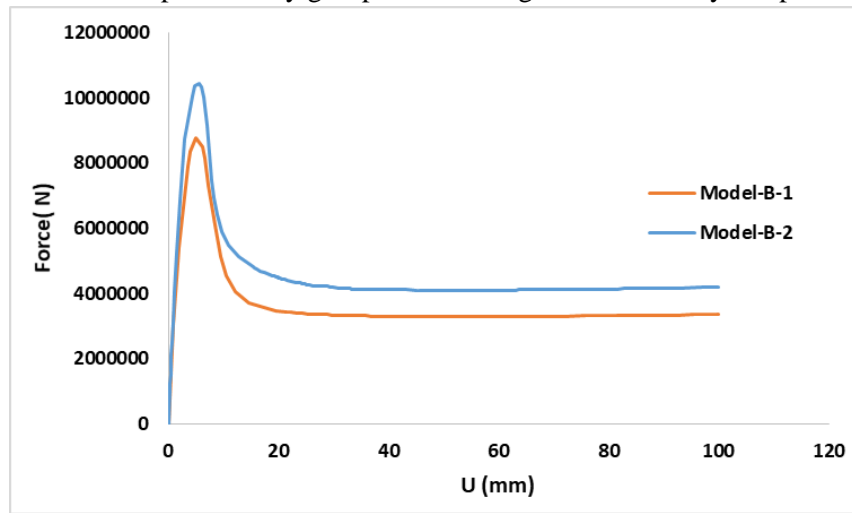


Figure (12) Comparison of force diagram -displacement of group B, model B-1, B-2

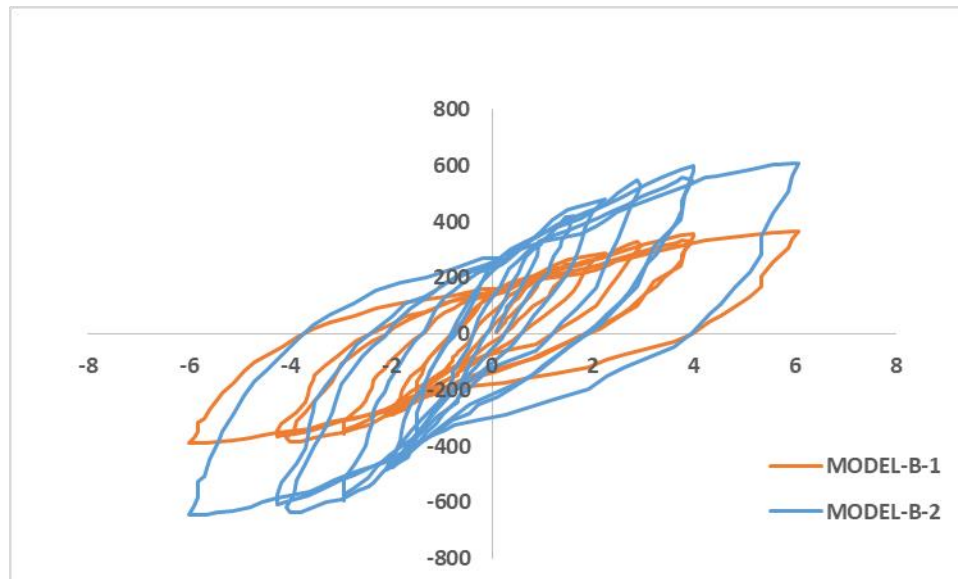


Figure (13) Comparison of hysteresis diagrams of group B models B-1, B-2

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