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Ductility Analysis of Beams Reinforced with Super Elastic Shape Memory Alloys

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Abstract: ***Ductility of the beam is important phenomenon while calculating the strength of any structure. This paper discusses the ductile behavior of beam reinforced with super elastic shape memory alloys. Before initiating the experimental program preliminary properties of shape memory alloys (SMA) were defined and concrete properties are defined by casting standard cubes. Experimental program consists of two point load test on a beam reinforced with SMA. Beam is loaded to know the ultimate deflection. Load deflection characteristics and deformation of the beam are analysed to study the ductile characteristics.***

Keywords: ***Ductility, SMA, Load deflection characteristics, deformation.***

I. INTRODUCTION

Reinforcement in structures is provided to increase the tensile strength of concrete as concrete is high in compression. Usually in natural practice HYSD, Mild steel bars are used as reinforcement in concrete. SMA is the recent most used material in construction and researches were conducted to improve the characteristics of the material. SMA are highly replaced with reinforcement due to strength emitting properties and advantages in different temperatures.

Present study gives the ductility of reinforced concrete beam reinforced with SMA. NiTi shape memory alloys are used as reinforcement in the beam.

II. MATERIALS

A. Concrete

Ordinary Portland cement of 53grade and fine aggregates passing 2.75mm sieve are taken. Coarse aggregate of 12mm are used. Water reducing agent GELINIUM is adopted. Machine drum mixing is used and placed in column. Mix ratio of 1:1.71:2.96:1.63 is adopted for concrete.

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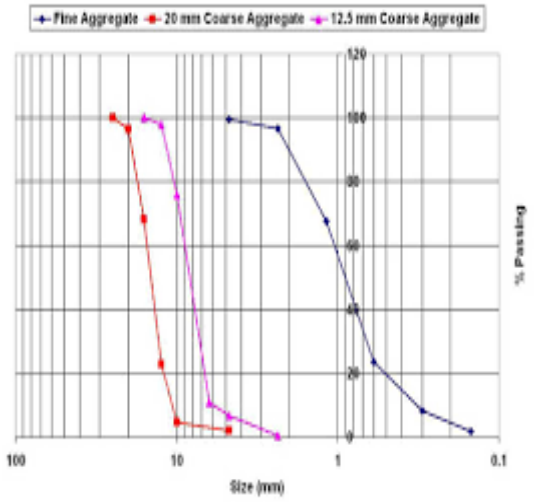


Sieve analysis of aggreagtes

B. Reinforcement (SMA)

Super elastic NiTi shape memory alloys are adopted for this study. A reference beam using steel rebar as reinforcement is used. Test values are compared to find out the ductility. Properties of SMA are given in the table 1 using FEM analysis.

Fig 1: Shape memory alloy rebars

Table 1: Property of SMA using FEM analysis

S.no	Property	Value (MPa)
1	Modulus of elasticity	65
2	Austenite to Martensite starting stress	410
3	Austenite to Martensite finishing stress	520
4	Martesite to Austenite starting stress	320
5	Martesite to Austenite finishing stress	106

III. EXPERIMENTAL SETUP

Two SMA rebar of 10mm diameter is setup at the bottom and 2 bars of 8mm diameter are placed at the top. 3mm SMA sleeves are used as stirrups. Point welding is done at the joints to ensure non-breakage during pouring and compaction. Detailing of beam is shown in Fig 1

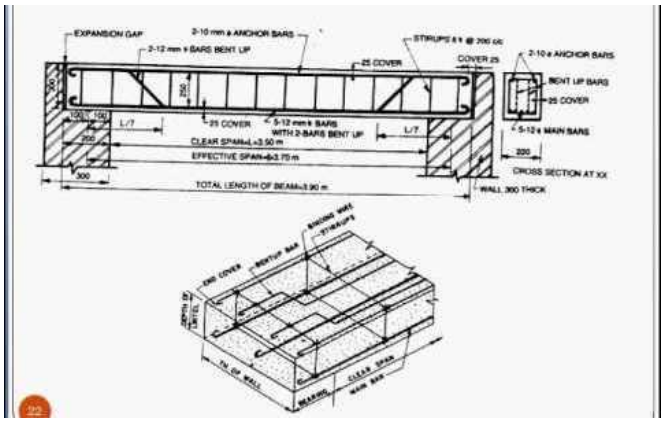
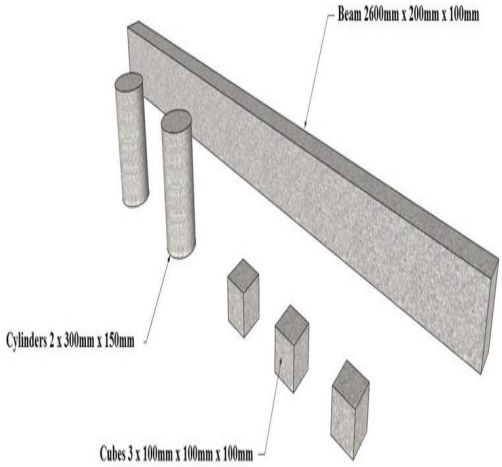


Fig 2: Detailing of beam with SMA

IV. TESTS CONDUCTED

Before calculating ductility of beam different specimens are prepared to find out the compressive strength, split tensile strength and flexural strength. Details of specimens repared is shown in Fig 2



V. TEST RESULTS AND DISCUSSION

Two point bending test is done to predict the ductility of the beam. Ductile characteristics are defined from deformation and first crack load on the beam. Hairline cracks are investigated using magnification glass. Test setup is shown in fig 3.

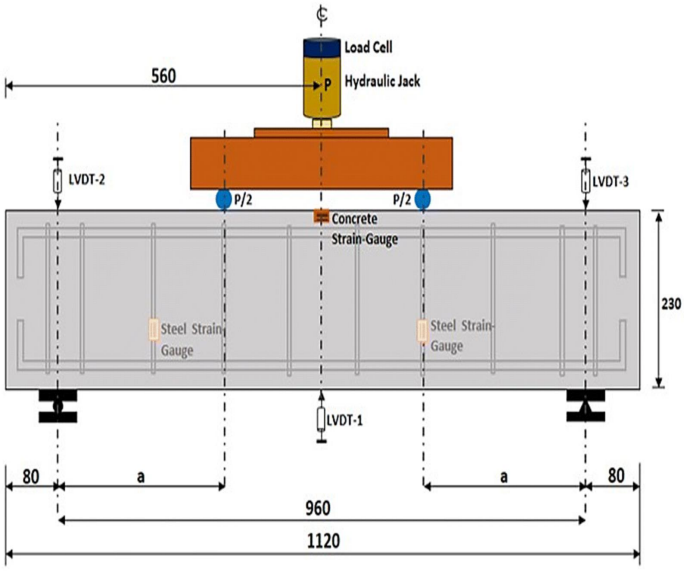


Fig 3: Two point Bending test

First crack was observed at 12KN in beam reinforced with steel where as it is 15KN for beam reinforced with SMA. Considering the deformation, displacement of the beam reinforced with steel is 4mm and for SMA reinforced beam value of displacement is 2mm.

VI. CONCLUSION

From the test results it is evident that

- Cracking load of beam reinforced with steel is early compared to that of the SMA reinforced concrete beam.
- Deformation of steel reinforced beam is high compared to the SMA reinforced concrete.
- Temperatures should be analysed to give the detailed value of the ductility, as ductility is one of the important factor that should be analysed.

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