I-267 AN EXPERIMENTAL STUDY ON CREEP OF CONCRETE FILLED STEEL COLUMNS

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1. INTRODUCTION : As an attempt to improve the compressive strength of steel members, studies on steel columns made out of rolled pipes filled with concrete have been carried out. However, besides the load carrying problem of such structures, the creep phenomenon, peculiar to concrete structures is relevant when considering the serviceability limit state for design, as well as maintenance along the structure life-time. This study is an attempt to evaluate the phenomenon, both qualitatively and quantitatively by determining the relevant visco-elastic parameters. In addition, measurements of strain were obtained simultaneously.

2. THEORETICAL MODEL : The adopted visco-elastic structural model is a Kelvin model, considering the applied stress, $\sigma(t)$, variable with time, t, according to the following equation:

$$\sigma(t) = \sigma_0\{\alpha + (1-\alpha)\,e^{-\lambda t}\} \quad \cdots (1)$$

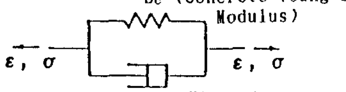

Fig. 1 Analytical Model

where σ_0 is the applied stress and α and κ are parameters to be obtained experimentally. The model is governed by the following equation:

$$E_c\,\varepsilon(t) + \eta\frac{d\varepsilon(t)}{dt} = \sigma(t) \quad \cdots (2)$$

where ε refers to the strain. This yields:

$$\varepsilon(t) = \frac{\sigma_0}{E_c}\left\{\alpha\,(1-e^{-\beta t}) + \frac{1-\alpha}{1-\kappa/\beta}\,(e^{-\lambda t} - e^{-\beta t})\right\} \quad \cdots (3)$$

Where $\beta = E_c/\eta$. Thus, if the material visco-elastic constants (E_c and η) were determined, a more reliable prediction of the structural behavior will be possible.

3. EXPERIMENTAL METHOD : The specimens consist of steel pipes with an external diameter of ϕ = 165.2mm and 1.0m long, filled in with concrete. The three types considered have different wall thicknesses : 4.5mm, 5.0mm and 0.0mm (pure concrete). For the shrinkage strain measurements one specimen of each type were used and for the creep test, two of each type, each being submitted to different load levels.

4. EXPERIMENTAL RESULTS : Table 1 shows the parameters values obtained from the experimental data. The parameter α is smaller than the one obtained for pure concrete (α = 0.801), where the load drops more significantly, whereas κ is greater (κ = 0.0504) for the same case.

With the parameters obtained experimentally, the theoretical curves were plotted and compared with the experimental data.

An example applied to one of the specimen is shown in Fig. 2 through Fig. 4.

Table 1 Parameters Evaluated from the Experimental Data

PARAMETER / SPECIMEN	α	κ	β		
			CONCRETE (AXIAL)	STEEL (AXIAL)	TOTAL EXTERNAL DISP.
CR-60-4.5	0.869	0.0435	2.03×10^{-2}	1.87×10^{-2}	2.42×10^{-2}
CR-60-5.0	0.878	0.0457	2.46×10^{-2}	1.80×10^{-2}	2.11×10^{-2}
CR-80-4.5	0.890	0.0464	2.20×10^{-2}	1.86×10^{-2}	2.06×10^{-2}
CR-80-5.0	0.882	0.0460	2.26×10^{-2}	1.99×10^{-1}	1.62×10^{-2}

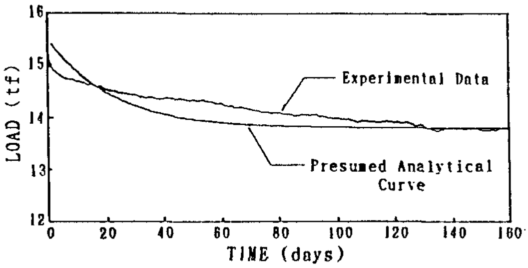

Fig. 2 Applied Load Variation with Time

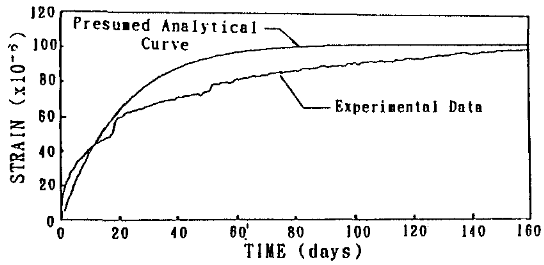

Fig. 3 Strain Variation with Time

5. CREEP COEFFICIENT : With the calculated strain values, creep coefficient was evaluated for each case (1.44 to 1.61, and 2.72 to 2.84, in case of pure concrete) and compared with the ones obtained from the method stated in the Japanese Specifications for Concrete (2.26), which was around 1.4 times greater than that of the concrete filled steel pipes.

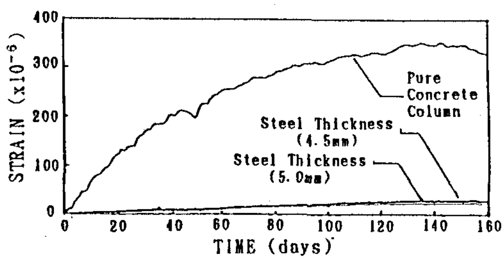

Fig. 4 Measured Shrinkage

6. CONCLUDING REMARKS : (1) The observed drying shrinkage strain is small and can be neglected for the design of concrete filled steel columns; (2) The creep strain of the concrete filled columns were 10% to 15% of that from the pure concrete columns; (3) The analytical model proved to be efficient to evaluate the final creep strain, although needing some adjustment to evaluate the time dependent behavior more accurately; (4) The creep coefficient obtained through the present method for concrete filled steel columns was around 0.7 times the one conforming to the Japanese Specification for concrete columns.

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