Creep behavior of cylindrical specimens under natural environmental and controlled conditions.

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1. Introduction.

Concrete creep and the associated long-term deflections are both influenced by environmental conditions, mixing proportions, material properties and applied stress. Throughout it service life, concrete structures will be exposed to loading in conjunction with variable environmental conditions. However, the long term behavior of concrete under such variable environmental condition merits further investigation.
Actual Structures are exposed to cyclic outdoor environmental conditions but in the prediction of creep effect on the long term deflection of concrete structures, data for creep strains are obtained from experiment conducted in controlled conditions. Further-more, if creep characteristics of concrete are determined by tests, the environment conditions of such texts should be approximate to those of the actual structure. The effect of outdoor exposure mitigates in the accurate prediction of time dependent deformations.

2. Experimental Study.

2.1. Test specimens.

Hollow cylinders were selected for this study with two different sealing conditions. One types of specimen were unsealed and exposed to radial and axial drying with a volume to surface ratio of 25mm, while the second specimen was radially sealed and exposed to drying in its axially direction, with a volume to surface ratio of 100mm.
The specimens were exposed to natural environmental condition and controlled room condition of 20 degrees Celsius and 50 % relative humidity.

2.1.1. Test set up for Creep behaviour

The creep behaviour of plain concrete were carried out to investigate the creep behaviour under outdoor conditions. The type of cement used was ordinary Portland cement. The compressive strength and Young's modulus in **Table 2** were obtained by compressive test using ϕ100*200 mm cylinder specimens after 7 days and 28 days after moist curing respectively.

Six Hollow cylinders of dimensions 200 mm in height and 100 mm outer diameter and 30 mm inner diameter were cast with (high volume/surface area V/S = 100 mm) radially sealed specimen and (with lower volume /surface area V/S = 25 mm) for Unsealed specimen. The lateral surface of the radially surface was treated with epoxy to prevent moisture loss for its lateral surface.

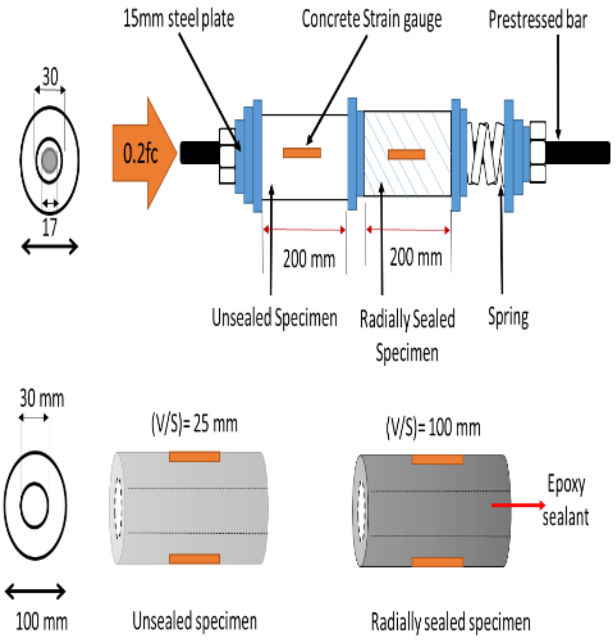

Fig 1: Specimen dimensions and sealing conditions

A sustained compressive load; 20 percent of concrete compressive strength, was applied to the specimens by hand fastening the prestressing steel bars with nuts. The applied stress was calculated by checking the average strain value obtained from two 2 mm electric strain gauges attached to the lateral surfaces of the specimens as shown in Fig. The applied stress was approximately 20% of the compressive strength of concrete at 7 days and 28 days respectively.

After the stress were applied, the specimens were exposed to natural environmental and control room conditions. The longitudinal strains were measured using electric strain gauges attached on lateral surface of the specimens.

2.1.2. Environmental conditions.

The hollow cylindrical specimens were loaded at 7 days and 28 days after curing respectively and exposed to natural environmental conditions and control room conditions on 6th August and 26th of August 2019 respectively, at the campus of Nagaoka University of Technology, the average weather distribution of the test location is situated at the Nagaoka University of Technology campus.

3. Results & discussion.

Figure 2 shows the variable weather data that were recorded regularly during the tests period.

3.1. Creep Strain.

Figure 3 shows creep strain curve for the specimens under natural environment conditions and control room conditions. The development of creep strain in unsealed specimen increases considerably during the first ten days and converges beyond twenty days. High early creep strain was noticed in the creep strain curve for environmental exposure and control room condition for specimens loaded at 7 and 28 days respectively, however creep stain curves for unsealed specimen was highest in control condition specimen over time.

The creep strains of curves of radially sealed specimens increase considerably during the first five days and exhibit linear tendencies. During low temperature and high relative humidity periods, swelling is noticeable in specimen loaded at twenty-eight days. The creep strain curve for specimen in loaded at 7 days in outdoor environment is highest.

Age at loading effect on creep behaviour was investigated. In specimens loaded at 7 days and exposed to Outdoor environment, High drying creep strains were measured with a relative high basic creep.

In specimens loaded at 28 days and placed in Outdoor field, High drying creep strains were also measured with a lower basic creep due noticeable swelling at the first ten days after loading. Specimens loaded at 28 days and placed in control room environment exhibited low drying shrinkage compared to specimens in Outdoor environment, However, it was also noted that shrinkage strains were higher than creep strains. Hence in control room environment, the moisture loss in unloaded specimen is higher than loaded specimens

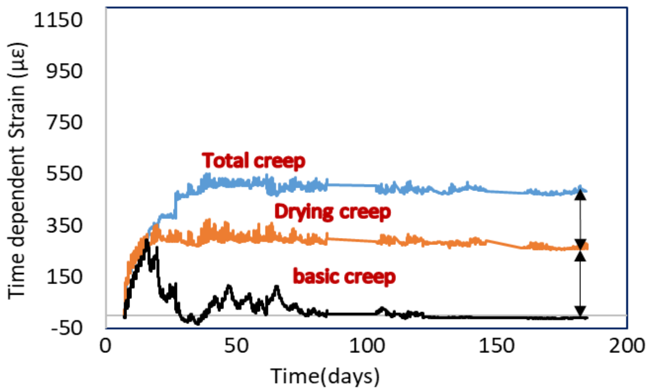

Fig 3a. Time dependent strains of specimens exposed to outdoor environment 7 days after

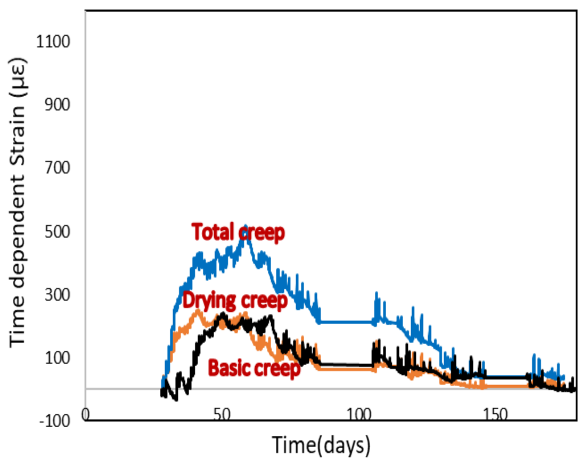

Fig 3b. Time dependent strains of specimens exposed to outdoor environment 28 days after curing

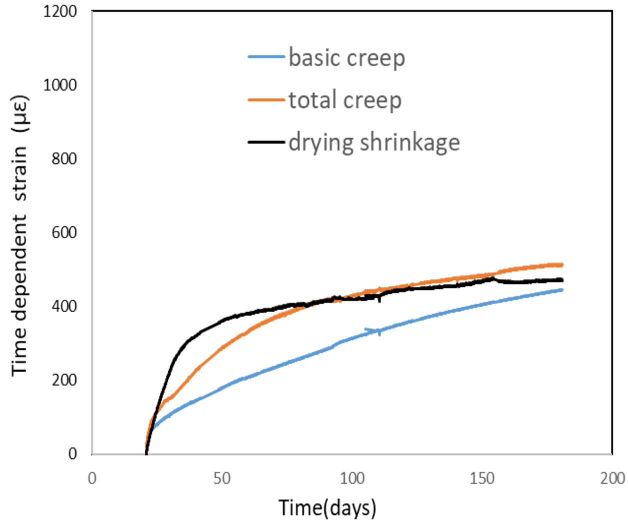

Fig 3c. Time dependent strains of specimens exposed to control conditions

5. Conclusions.

An experimental investigation on the effect of age at loading and outdoor natural environment on concrete creep was carried out.

1) The effects of age at loading saw a considerable increase in basic creep strains for specimens exposed to outdoor environment conditions.
2) Rainfall, low temperature and high relative humidity inhibited the progression of drying shrinkage leading to swelling.
3) The magnitude of shrinkage strains was observed to be higher for specimens exposed to drying in control conditions.
4) Rainfall inhibited the progression the progression of total creep during early ages.
5) Creep coefficient was observed to be higher for specimens exposed to outdoor environmental conditions.
6) Rainfall is noticed to be an influential parameter for time dependent strains of specimens exposed to natural environmental conditions.

References.

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