- Have the normal hydration products of Portland Cement (mainly mixed hydrates of calcium silicates, aluminates and ferrites) but improved etttringite formation and stabilisation (as a result, no compromise on early strength but improved shrinkage and durability).
- Exhibit similar compressive strength gains.
- Exhibit similar setting times and placing and finishing characteristics.
- Compatible with existing admixture technology.

3.0 EXPERIMENTAL PROGRAMS

It was acknowledged early in the research program that the quantity of activated SCM used in the new product can be varied to achieve a range of desired hardened state properties. But as one of the key criteria was to achieve a low carbon footprint concrete with similar strength gain and setting times to "conventional" concrete, a blend of 40% Portland cement and 60% Zep® was focussed on. Subsequent trial mixes were performed on different strength grades to assess the performance of the concrete in various applications. The laboratory trials were performed as per AS 1012.2 (lab trials), AS 1012.8 (curing), AS 1012.9 (compressive strength), AS 1012.11 (flexural strength), AS 1012.13 (drying shrinkage), AS 1012.16 (creep), AS 1012.18 (setting time), AS 1141.60.1 (alkali silica reaction), DIN 1048 (water permeability), ASTM C1585 (water absorption), Nordtest NT Build 443 and 492 (chloride diffusion/migration coefficient tests).

4.0 EXPERIMENTAL RESULTS

4.1 32 MPa concrete with 60% Portland cement reduction

Initial work[2] was done with a typical 32MPa concrete mix design, containing 330kg/m^3 cement (either SL or SL/Zep® blend), 750kg/m^3 20mm crushed river gravel, 300 kg/m^3 10mm crushed river gravel, 500kg/m^3 coarse river sand, and 300kg/m^3 fine sand. The cement mass is air dry mass while all aggregates are SSD mass. Water was added for a slump of 80±5mm.

The water demand, air content, setting time and drying shrinkage are presented in Table 1 while the compressive strength gain is showed in Figure 1.

4.3 40 MPa pavement concrete

With the low shrinkage exhibited by the Envisia® concrete, it was potentially suitable for warehouse floor applications. A “conventional” mix design suitable for this application was compared to an Envisia® mix with a 50% Portland cement reduction. The aim was to assess the relative flexural strengths of both concretes.

Strength results are summarised in table 2. While it was anticipated that the Envisia® concrete would perform well in flexural strength, the extent of its outperformance was surprising. It achieved a very high 7 day flexural result of 8.8 MPa, 91% higher than that of the “conventional” SL/Fly ash concrete. At 28 days the difference was also significant with the 9.7 MPa achieved being 51% higher.

Properties	Unit	SL/FA Control	Envisia®
3 days Compressive Strength	MPa	25.6	26.1
7 days Compressive Strength	MPa	28.1	35.5
28 days Compressive Strength	MPa	**42.3**	**43.3**
56 days Compressive Strength	MPa	**49.0**	**47.8**
7 days Flexural Strength	MPa	4.6	8.8
28 days Flexural Strength	MPa	**5.4**	**9.2**

durability requirement in its B80 Concrete Work for Bridges specification. Table 3 outlines the trial details.

It can be seen from Table 3 that, as expected, the NT Build 492 and NT Build 443 results of conventional marine concrete outperformed the conventional SL/FA control concrete. But this marine concrete only complies with B2 exposure limit. By contrast, the Envisia® concrete performed the best, meeting the requirements of Cla