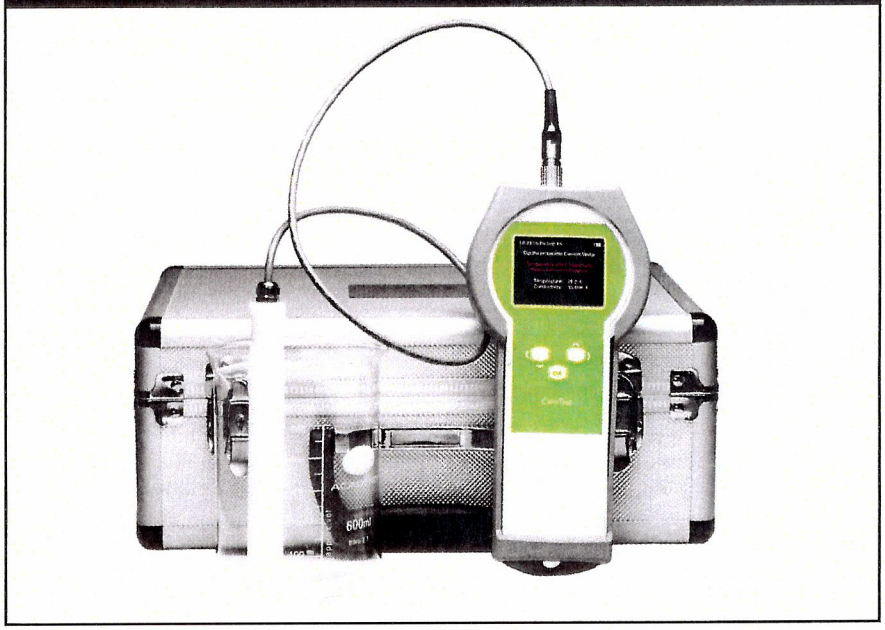
Cement testing accelerated

With cement producers and users historically experiencing long delays in confirming the strength of their cement and concrete mix, the CemTest instrument has been designed to accelerate traditional laboratory cement strength tests. Several performed tests have confirmed that the new instrument meets BS EN 196-1 standards, as discussed below.

■ *by **CST Instruments Ltd**, UK*

CemTest accelerates traditional laboratory cement strength tests to achieve BS EN 196-1 standard strength test accuracy in minutes with less effort. Current testing is typically lab-based, requires specialist equipment and expertise, and can take up to 28 days to complete. This is time lost on a fast-moving construction project especially if a batch is found to be faulty. The CemTest method dramatically reduces this laborious process to produce an accurate analysis of the compressive and flexural strength of a batch of cement within minutes. Figure 1 shows the CemTest kit.

Figure 1: CemTest – designed to accelerate traditional laboratory cement strength tests



HeidelbergCement collaboration

CST Instruments has been working with several companies to establish the testing system in the marketplace. HeidelbergCement Georgia Ltd's Rustavia cement plant laboratory was among the first to work with CST Instruments to rigorously test the performance of CemTest. Tests were carried out on several cement types comparing traditional methods against the CemTest system to EN 196-1 Standards. The results were compelling and demonstrated the efficacy of the CemTest system (see Table 1).

How the CemTest works

The CemTest hand-held tool can test samples comprising less than 15g of cement combined with just 500ml of ionised water. It measures the electrical conductivity of the cement and water solution in the first 50s of the hydration process using a specially designed probe. An experienced user can complete a test in under three minutes using a simple three-step procedure:

1. A water/cement sample is prepared using any type of Portland cement, produced by simultaneously grinding clinker and gypsum together (with or without mineral additives) combined with deionised water. The sample is stirred continuously for 50s.

2. The measuring probe is placed in the solution to measure Specific Conductivity and temperature (preset at 20 °C). The measurement begins once the test mode button is pressed.

3. To measure a product sample accurately, the nine key parameters listed below are drawn from the product's data sheet and entered into the CemTest device along with the data from the analysis:

- cement type (Rapid, Normal, Slow)
- cement density
- consistency of normal paste
- fineness of cement
- additive size
- additive type
- water/cement ratio per the applicable standards
- curing time (1-60 days)
- curing temperature.

The CemTest device uses a unique algorithm to calculate the strength of the cement in the following:

- R Comp – Compressive strength
- R Flex – Flexural strength
- R Bend – Flexural strength for oil wells.

By varying the input parameters, it is possible to conduct several tests on a single sample to arrive at a detailed analysis of the cement. The tests do not require laboratory conditions and can be carried out quickly and easily in the field. This is a radical departure from traditional testing methods which typically require environmentally controlled testing facilities, are time consuming and high cost. This system is particularly useful to support the development of new cement mixes facilitating shorter lead times for new mixes to reach the marketplace. Batches of cement can be quickly assessed and refined based on the quantitative analysis of the CemTest system. Figures 2a and 2b show screenshots from the

Table 1: results from HeidelbergCement Georgia testing

Sample	Cement type	EN 196-1	Device CST	EN196-1	Device CST
		Comp. strength 7 days (MPA)	Comp. strength 7 days (MPA)	Comp. strength 28 days (MPA)	Comp. strength 28 days (MPA)
1	CEM II B/P 32.5N	38.5	36.8	46.0	44.0
2	CEM I 42.5R	38.8	36.1	51.1	53.5
3	CEM II B/P 32.5N	34.3	35.6	45.1	43.3
4	CEM I 42.5R	45.0	42.1	54.4	53.5
5	CEM II B/P 32.5N	36.1	38.8	46.8	44.6
6	Clinker (lab mill)	43.1	41.1	57.0	56.2
7	Clinker (lab mill)	38.9	34.3	51.9	49.6
8	CEM II B/P 32.5N	27.9	26.3	37.8	38.4
9	CEM II B/P 32.5N	26.8	26.8	37.0	38.7
10	Clinker (lab mill)	39.2	36.1	50.9	48.4
11	CEM II B/P 32.5N	30.3	28.6	39.9	38.6
12	CEM I	39.2	38.1	53.5	51.4
13	CEM II B/P 32.5N	33.2	31.4	46.6	46.0
14	Clinker (lab mill)	38.9	39.8	48.5	47.8
15	CEM I 42.5R	42.3	44.9	49.2	53.6
16	CEM I 42.5R	43.6	44.2	52.0	52.8
17	CEM II B/P 32.5N	29.8	28.9	38.8	38.3

CemTest device (ie, summary and final results).

The construction sector is governed by Standards and CemTest has been rigorously assessed by the UK Accreditation Service (UKAS) and other independent laboratory tests. These have confirmed that the system provides accurate results for CEM I and CEM II cement ranges typically within +/- 5-7 per cent of the EN196-1 standards. A conversion matrix being developed by CST Instruments will enable results to be converted to ASTM standards.

The construction sector face many challenges rising from poor quality cement including significant financial penalties caused by major delays as remedial work is required when cement fails. The range of devices developed by the CST Instruments address the challenges posed by poor quality cement head on. They approach the issue in several ways: by detecting faulty batches to enable them to be discarded before use, by facilitating the development of new mixes and by helping construction managers to mix cement accurately to achieve desired specifications. By using technology and designing sophisticated algorithms to arrive at these innovations, CST Instruments is providing credible low cost and high speed solutions to meet the industry's needs.

Extending activities

As CemTest gains traction in the construction sector revolutionising cement testing, the team is extending its activities to develop related technologies. Recent funding from Innovate UK has supported the development of ConcTest. ConcTest will be finalised this year and it is capable of rapidly analysing the compressive strength of freshly mixed concrete to accuracies of +/-5 per cent before it is poured. The team believes that this quick and easy test will reduce failure rates

Figure 2a: CemTest screen – final result

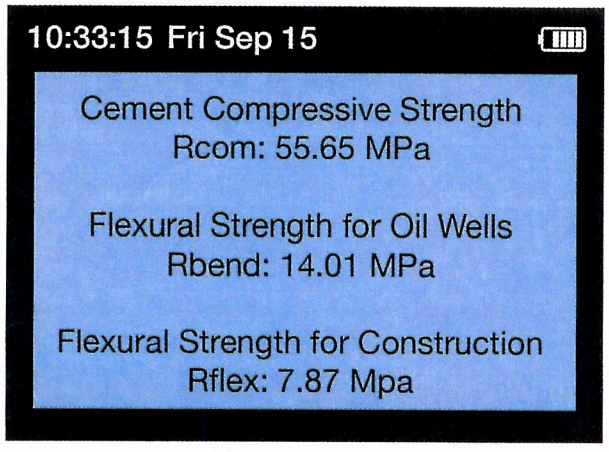
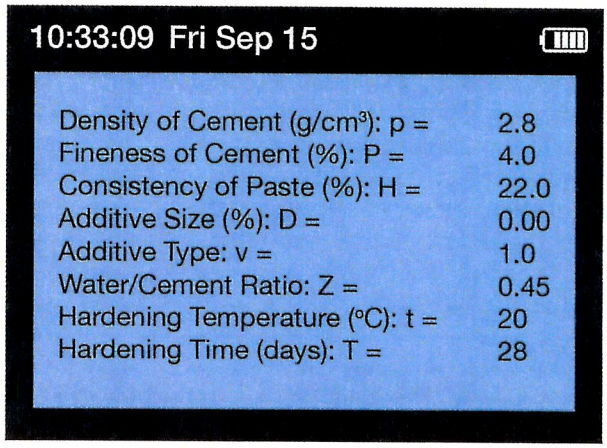


Figure 2b: CemTest screen – summary



The evolution of CemTest

Since the 1970s, innovator Akaki Iromashvili has worked in the construction sector developing his career to become a leading expert in building materials in his home country of Georgia. During the 1980s he developed 'ultrasonic impulse testing' to assess the quality of concrete blocks. The method quickly became commonplace in the Georgian building industry as a reliable, low-cost testing method credited with reducing failures and saving both time and money for the sector.

Evolving his ideas, he built on his original concept to develop a new method and instrument to determine the quality of cements by measuring the 'conductivity' of a cement-water mixture, coining the term 'conductometria'. This resulted in the IAC-1, which went through several iterations before its descendant IAC-3 came to dominate the cement industry of the former Soviet Union as the ideal testing tool.

Spurred by this success, in 2010 Mr Iromashvili set out to develop a new instrument based 'Conductometria' specifically targeted at the near testing of fresh mixed concrete and cement for its compressive and flexural strength. Around the same time, he joined forces with fellow Georgian, Vano Natidze, who was now living and working in the UK. Together, they produced the first prototype MELANI-1 and initial trials showed promising results. Their quest to produce the perfect testing tool proved successful and they have been able to redesign MELANI-1 and to perfect the CemTest system. CemTest is now marketed via CST Instruments Ltd, the company the two inventors founded in 2012.

thus preventing the necessity for costly remedial actions.

CST Instrument's goal is to develop a suite of new technologies. Also in development is the ConcVolumiser which will estimate the volume and quality of each aggregate required for a concrete mix based on the strength and specification required.

Accurately defining the 'recipe' in this way will reduce the tendency of construction workers to over use certain base materials to compensate for perceived weaknesses in the mix. This will create considerable savings by reducing unnecessary use of materials and over production of concrete. With such a vast marketplace, the team is also looking at specific solutions for sub-sectors. An immediate objective is to develop a dedicated instrument to test the flexural and compressive strength for the concrete used in the oil and gas industry where the integrity of materials is of paramount importance to maintain safety.

With a pipeline of innovations building, CST Instruments is providing practical solutions to the needs of the sector. ■