Paul Brown, Global Cement Magazine

VISITING THE FIVES FCB RESEARCH & TESTING CENTER

Global Cement recently visited the Fives FCB Testing & Research Center, close to its headquarters in Noyelles-lès-Seclin, near Lille, France. Loïc Pottier, Senior Area Sales Manager and Jean-Michel Charmet, Pyroprocessing Product Manager, welcomed Paul Brown for discussions and gave a tour around the facility, with a focus on clay calcination.

Above: The Fives FCB Testing & Research Center in Noyelles-lès-Seclin, close to Lille, France. It was inaugurated in 2014.

***GC:* Where do you see the geographical focus of clay-calcining opportunities right now?**

Loïc Pottier (LP): There are opportunities in West Africa, which suffers from a lack of limestone reserves and is a net importer of clinker. The potential is shown by projects in Ghana and Cameroon being handled by other entities. Projects are generally opex-driven. Europe is also important, as the topic of CO_2 is very high on the agenda. There are commitments from both the countries and the cement companies based there. Otherwise, there are only a few countries outside of Europe that have applied a carbon tax. However, we do see a trend that some major exporters, for example Türkiye, are aware of the need to be aligned with the emissions standards of the EU and pay attention to such developments.

***GC:* What is the first thing that happens when a client's clay samples arrive at the Research & Testing Center?**

LP: As soon as sufficient test material has been received, ideally 3t to be able to conduct all of the required tests, it is handled in the laboratory's preparation and assessment area. These clays, which are often fairly sticky, are reduced from around 30mm to ~80-90μm in a jaw crusher and then samples are dried before being crushed. A report comprising a full chemical and mineral analysis is then delivered to the client to inform its next steps.

These provide the information regarding the required setting points of the calcination, basically defining the most appropriate temperature of calcination and, in some cases, the residence time needed in a flash calciner. The report informs the client, and Fives, how large the plant should be. In some cases it can also suggest that a project is not actually feasible. After all, the materials must be of sufficient quality and the payback conditions must be worthwhile.

Jean-Michel Charmet (JMC): The pilot plant is set up for clay but it can also handle other materials, for example alumina. A recent upgrade has taken the maximum temperature to 1300°C. Explorative testing of further materials in new fields is also high on the agenda.

Returning to clay, clients often struggle with variations in composition, not only from different quarries but also from different deposit layers in the same quarry. This is why it is crucial that we receive all possible variations in material samples for testing, hence the need for at least 3t.

GC: Is the final colour of the manufactured calcined clay cement an important issue?

JMC: Absolutely. Clients do not like their cement to have any reddish colour. So our laboratory can control the colour. Darker cement is often preferred, as a darker colour characterises greater strength in many markets. In reality there is no link, of course.

GC: What is the grindability test procedure used by Fives to test materials?

LP: We have a small-batch mill that uses 30kg of material for grindability tests. We feed the mill with the feed material(s) and run it for a couple of minutes to measure the torque and define the energy. Then we stop the mill, remove a small portion of material to analyse its particle size distribution, run the mill for another couple of minutes, take another small sample of material, and so on.

When we reach a given fineness, we empty the mill, change the ball charge to smaller balls and repeat the procedure. This provides the grinding specific energy as a function of the fineness. This helps to size a mill when we are required to provide the appropriate mill capacity.

We process these parameters into what is known as the FCB Index. This gives the specific energy required to grind in the test mill, i.e: a ball mill in closed circuit with a high-efficiency separator. We then apply this to other technologies, including the Horomill, using correction factors. We have used this test for decades, with thousands of references for clays, alumina, clinker and other minerals.

GC: Can you explain the role that the FCB TSV™ classifier plays in the pilot plant?

LP: We have a small TSV classifier, in fact several versions, depending on the desired particle size. The one currently in use is connected to both the FCB Horomill®, for fine products, and the FCB Rhodax® mill, for coarse products. The Rhodax is connected to a screen and is furnished with different flaps to allow recirculation, if required. The Horomill is also connected to a flash dryer that we use for different applications.

There is a wide range of options within the pilot plant to model the industrial scale design. We can run the Rhodax very flexibly, just with the screen or with both the screen and the classifier. Here we are talking about the preparation of the clay. Once we have dried it and crushed it, we grind it in the Rhodax which is normally a crushing-grinding machine. However, for clay, as it is connected to the classifier, once it is dry, we can grind it to 80-90µm prior to calcination.

GC: Could you provide some details about the Rhodax mill and Horomill used for tests?

LP: The Rhodax mill is a '300' model, the smallest we make. Many are found in mineral processing operations rather than in conjunction with a cement kiln, as they are used for selective crusing (or grinding) and for rather hard and abrasive materials.

Below: Jaw crushers and ball mill for material preparation.

Above: FCB Index grindability test.

The Horomill is smaller than industrially-available models, but is still representative of what we can achieve on an industrial scale. It is cubic, but all the components are present, so we can adjust all settings, pressures, etc. It is used for general testing needs, for example in an ongoing project with Ciment Québec in Canada. Customers send us samples and we undertake trials prior to commissioning. This determines, as closely as possible, the operating parameters needed. It also provides an initial overview to train the operators so they are able to produce different products in a timely fashion. In essence, we are performing some pre-industrial tests on this machine. It is a very reliable guide.

***GC:* What other facilities are there at the Fives FCB Testing & Research Center?**

JMC: We have a both physical and chemical laboratories where we perform physical testing, employing particle-size analysis, laser granulometry, Blaine measurement, calorimetry, XRF, equipment for kiln curve analysis and so on. We have a specific test for clinker burnability, which simulates the decarbonation of limestone in the calciner.

We calcine the raw mix and then measure the free lime according to different temperatures. This is of course different from the situation in a rotary kiln, but as with the grindability tests, we can make adjustments. For example, if we have 2.5% free lime in our static kiln, we know that we will have 1% in a rotary kiln. This will tell us the temperature we need to reach for the required level of free lime in the rotary kiln.

There are also several types of test to determine reactivity of calcined clays and we have recently installed new equipment in order to perform such tests. For the French standard it is known as the Modified Chapelle's test, which is similar to R3 for e.g. calcined clays. This measures the quantity of lime absorbed by a unit of cementitious material.

LP: It is also important to point out our industrial references. Over the past 20-30 years we have gained considerable experience from building industrial-scale plants and measuring their performance. With every plant, we become more accurate in our correlations between the laboratory and real world environments. This has provided great benefits and insights for our client base.

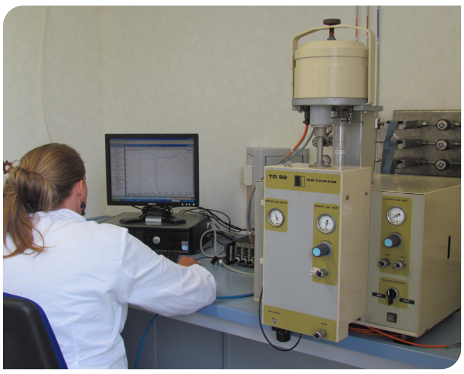
***GC:* What equipment is used for abrasivity tests?**

JMC: Abrasivity tests use a very customised piece of equipment in which the material - of a normalised grain size - is passed through a metallic device. By measuring the loss of metal material (g/t) we can correlate back to find the material's abrasivity index. We then specify which wear protection materials are suitable for the mill in question. When supplying our mills we are required to give warranties on wear rates, so this is crucial information. We have also developed another test, focussed on the concentration of the abrasive material in closed circuits, comprising a mixture of chemical and physical measurements.

***GC:* How does Fives install a Horomill at the client's site?**

LP: Massive equipment, such as a 4.2m-diameter mill, is delivered in pieces and erected on site. The arms, the roller, the jack, swivels and casing all arrive separately. The roller normally comes ready, with the shaft and the tyre fitted and, as the case may be, with the roller bearings.

We place springs on a traditional concrete foundation. There is then a separate block on the springs that holds the Horomill. The springs isolate the mill from the ground, such that we no longer have any issues with vibration. We have learnt



Below: Raw mix characterisation.

Below Right: Physical testing laboratory.

a great deal over the years regarding the mill's behaviour and have gained far better control. We have developed remote monitoring systems so, if necessary, on very rare occasions, we can detect default and low trend deviations and advise or alert the plant. As regards lead time, around two years would be normal but, with fast-tracking, around 18 months can be achieved.

***GC:* There was also an issue with roller wear in the past. How was this addressed?**

LP: There have been various developments that have reduced wear, some of which was associated with feeding material with moisture at 3-4%, where there is a peak on the abrasivity curve. Now we can incorporate a flash dryer in the circuit, with the goal to reduce the feed material moisture to below 2%, far below the critical zone.

The second point is that we have increased the diameter of the roller by 7%, which has the beneficial impact of reducing the rotation speed by 7% so there is less exposure to wear, as well as reducing the shrinkage stress. The larger roller can still be accommodated in the same-sized shell.

Also, a great deal of internal research has been undertaken on the composition and nature of wear materials and where material accumulates during operation. This same study has also aided us in avoidance of potential roller cracks. In addition, we have fitted a gauge to monitor and measure wear so the operator can decide for itself whether it wishes to have a short stoppage and perform a quicker, smaller refurbishment. Or, during a strong sales period, it might opt to continue the campaign, stopping at a later stage for a more extensive refurbishment. One can notice that, even in worn out condition, the roller keeps delivering the initial throughput. Some clients have a second roller so they can swap components, should the need arise.

***GC:* Please could you describe the main attributes of the calcining installation used in the Testing & Research Center?**

JMC: We have a heat generator at ground level to generate the hot-gas flow. The material is introduced at the top where we have just one stage of pre-heating - we cannot go higher owing to building height restrictions - with hot gas, the material falls down the long duct to be calcined. Then quenching is performed in the upper section. We also have a small rotary kiln which was transferred from a previous facility which we will reconnect to the calciner in the future. Some customers still wish to use a rotary kiln for clay calcination and want to compare results. It's not the best solution in process terms we believe, but if the material has few impurities it is worth a calcining trial.

Above: FCB Flash Calciner pilot plant.

The second part of the calcination process involves injection of reducing gas, so that cooling is performed in the cooling loop where colour control is also conducted. Final cooling takes place via a water-cooled screw, which also saves on height. A dedusting filter is installed, as well as a gas analyser to check the atmosphere. Heat is recovered from the cooling process and fed back to the burner.

You can see that we have invested heavily in the future. Further plans include enlarging the facility, for storage purposes. We always keep a certain amount of clients' samples that we have tested, so that we can compare them with actual material produced later on during plant commissioning.

To make sure that we blend work with pleasure, each December we also sample French wine here in celebration of the Patron Saint of Metallurgy, St. Eligius!

***GC:* Gentlemen, many thanks indeed for your greatly appreciated time today.**

LP/JMC: Our pleasure!