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Cement Lime Gypsum
Zement Kalk Gips

ISSUE
2016

ZKG INTERNATIONAL

SPECIAL 2016
Drymix Mortar
Construction Chemistry

DRYMIX MORTAR
CONSTRUCTION CHEMISTRY

Anke Bracht
Editor ZKG INTERNATIONAL

One step further …

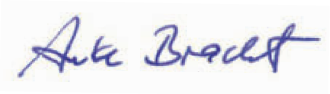
… is the major focus of the ZKG special edition Drymix Mortar | Construction Chemistry: Once the production process has been finished and the actual application of cementitious materials starts, the Drymix Mortar issue takes over from ZKG International as regards its thematic orientation. It's just one step further and yet another interesting and diverse industrial sector in the field of construction materials.

Once again, we are pleased to present product innovations and recent developments from the drymix mortar industry – and this in the fourth year of its appearance. In the 2016 edition, we also inform you about current activities of leading manufacturers and suppliers. Under the "Plant report" heading for example the project of two new drymix mortar screening plants in Thailand will be described (p. 25). The laboratory evaluation of three new polymers before the market launch is featured from p. 30 onward in the "Materials" sector. Another article analyzes the feasibility of plaster composites when reusing rice husk (p. 34).

We hope you will find this issue as stimulating as we did when preparing it for you and wish you interesting reading!

Yours most sincerely

Anke Bracht
Editor ZKG International



ZKG INTERNATIONAL

ISSUE 2016 **Drymix Special**
ISSN 2366-1313
Volume 69 „ZKG INTERNATIONAL“
Volume 105 „ZEMENT“

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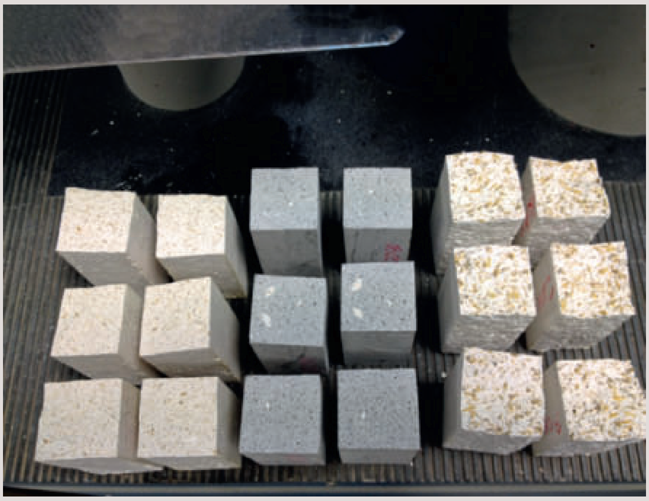
New PCEs – targeted selection of superplasticizers for various binder systems



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Federal German Association of the Gypsum Industry
Bundesverband der Gipsindustrie e.V.

This issue's front cover shows Mondi's HYBRIDPRO – the company's next generation of water-repellent paper bags. The HYBRIDPRO bag is especially designed for building materials. The traditional bag construction is turned inside out to have the HDPE layer as an outer ply. HYBRIDPRO offers uncompromising weather protection and significantly extends the shelf life of its contents, while being completely compatible with traditional paper bag filling equipment. Find out more about HYBRIDPRO www.mondigroup.com/hybrid-pro

WERKMÖRTEL E.V. (IWM)

Christoph Dorn is IWM's new chairperson

Christoph Dorn, Chief Executive Officer at Knauf Gips KG, is the new chairperson of Industrieverband WerkMörtel e.V. (IWM). He succeeds Peter Sarantis, who held the post from 2008 through 2015. With Christoph Dorn, a well-experienced top-level manager from the construction materials sector has taken the IWM chair. Prior to joining Knauf, i.e., up to 2012, 56-year-old Dorn was chief executive officer of Fermacell GmbH, a Xella Group subsidiary. Since 2014, Civil Engineer Dorn has served the Knauf Group as group managing director of the Germany/Switzerland division.

www.iwm.de

Industrieverband WerkMörtel e.V.

Christoph Dorn is the new chairperson of Industrieverband WerkMörtel e.V. (IWM)

19.04.–21.04.2016, NUREMBERG/GERMANY

Powtech 2016: Innovative measurement technology paves the way to "Process Technology 4.0"

At the Powtech 2016 from 19.04.-21.04.2016 in Nuremberg/Germany trade visitors can experience first-hand an entire range of mechanical processes – together with all the technologies that support and make the processing operations more efficient, including in particular measurement technology and analytics. The analysis of powders, granules, bulk solids, and fluids not only helps to ensure quality and optimise the end product. At the Powtech 2016, experts in bulk solids and powders can learn how they can also achieve more efficient production and reduce their energy costs based on strong real-time measurement results and innovative field devices.

In modern production environments, measurement technology is involved in the entire process chain, from initial development to the field level in the plant to shipping to ensure traceability. The nature of each individual particle – along with its shape, size, and surface tension – has an impact on the finished end product. Particle and process parameters, for example, influence the consistency of creams in cosmetics or the flow behaviour of ketchup. They are also an important factor when it comes to the correct distribution of active ingredients in tablets or, in the cement industry, they significantly influence the quality and use of the material.

Analytical methods for all industries

Particle and process measurement technology is an integral part of the range of products at the Powtech. After all, one must know about the particle properties and process parameters in order to specifically influence them and achieve the desired results.

At the trade fair, manufacturers will find numerous analytical methods for a wide variety of bulk solids, from pressure measurement technology to equipment for measuring temperature or moisture. The range of particle analysis technology extends from simple laboratory sifting equipment to the sizing of coarse granules to laser diffraction systems and systems that are based on dynamic light scattering and precisely output particle sizes in the micro- and nanometre range. There is a growing demand for optical methods for determining the particle shape to optimise the consistency and flow behaviour of a product.

On the path to "Process Technology 4.0"

Measurement and analysis technology provides precisely the kind of data that is driving the fourth industrial revolution and making it possible in the first place. Reliable figures and analyses, frequently supplied in real-time, provide a solid foundation for automation using man-machine communication and for in-depth analyses of big data. In this way, manufacturers are finding new approaches for product optimisation and for greater process efficiency.

At the Powtech, process industry experts can obtain many suggestions and useful practical tips regarding the integration of particle analysis technology and of process measurement systems in Process Technology 4.0. In addition to numerous product presentations in the three expert forums, more than 250 of the roughly 900 exhibitors in total at the trade fair will present solutions, concepts, and innovations relating to analytics and measurement technology.

The latest regarding particle technology

Held concurrently at the Exhibition Centre Nuremberg, the Partec is the International Congress on Particle Technology. At this congress, leading engineers and scientists meet to share information on the latest developments regarding processes for particle formation, agglomeration, and coating as well as measurement methods and diverse industrial applications for particles.

www.powtech.de

SIKA AG

Sika expands worldwide

New mortar plant in Philadelphia

Sika AG

North America: New mortar plant in Philadelphia

Sika has opened a state-of-the-art new mortar products plant in North America with huge market potential in interior finishing in the fast-growing cities on the US East Coast. The new plant is an extension of Sika's existing concrete admixture plant, the capacity of which has also been increased.

The opening of its second new mortar plant in North America in the last two years, in addition to the acquisition in March 2015 of the mortar products manufacturer and marketer BMI Products of Northern California Inc., gives Sika a network of 18 manufacturing sites in North America. Thus Sika is ideally positioned to take advantage of the improved market conditions in the construction sector in North America, which is benefiting from growth drivers such as commercial and infrastructure projects undertaken as part of the general urbanization megatrend. Forecasts for the US construction market predict an annual growth rate of 10 % for 2016.

Europe: New mortar production facility in Greece

Sika is opening a new manufacturing site for mortars in Kryoneri, near Athens. Complementary to Sika's existing concrete admixture plant in Thessaloniki, northern Greece, the state-of-the-art manufacturing plant will drive forward the mortar business in the country by broadening the current product portfolio and opening up new market segments.

In addition to the mortar production unit, which has a capacity of 20 000 t/a, the facility will house a modern laboratory, as well as a new concrete admixtures logistics hub for southern Greece. A production unit for liquid applied membranes for waterproofing and roofing applications will be installed in a subsequent step. The new premises in Greece enable Sika to offer its customers an optimized supply chain, a locally produced and enhanced product portfolio and a greater level of customer service.

Southeast Asia: Two new factories in Myanmar and Cambodia

Sika is systematically implementing its Strategy 2018 by entering into new markets and opening six to eight factories a year, and has now further expanded its presence in Southeast Asia. With one new production plant for concrete admixtures in Myanmar and another one in Cambodia, Sika is increasing its proximity to customers in these growing markets and continuing its successful expansion.

The new production facility in Myanmar represents a milestone. As the first construction chemicals supplier in the country, Sika is manufacturing locally in a factory near to Yangon.

Sika's additives for high-performance concrete have to date been used in construction projects such as Hanthawaddy International Airport and the "Friendship" bridge connecting Myanmar and Laos. The latest construction project currently being carried out with the help of Sika products in Yangon is the Lake Suites project, which combines offices, a hotel and apartments in one development.

By opening a new production plant for concrete admixtures in Phnom Penh, Sika is tapping into further potential in Cambodia's booming construction industry, which grew by 20 % in 2015. The whole country lacks infrastructure, while the younger generation is growing and moving to the cities. This is resulting in more investments, particularly from China, Korea and Japan, which are investing heavily in shopping centers, hotels and infrastructure and residential construction projects close to the capital. With its new local production facilities, Sika is meeting the growing demand for high-quality construction products even better, and is consolidating its leading market position in the country.

www.sika.com

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FELS-WERKE GMBH

Fels-Werke wins German Occupational Health and Safety Award for innovation

All Fels-Werke GmbH

1 The compact mortar can be processed quickly and easily on site

Fels compact mortar pellets reduce dust exposure in connection with the preparation of mortar and, in the process, crucially contribute to occupational health and safety at construction sites. Goslar-based Fels-Werke recently won Germany's 2015 Occupational Health and Safety Award for this patented innovation. The company's compact mortar pellets took first prize in the category "Technical Solutions, Large Companies". Of the more than 200 companies competing for the German Occupational Health and Safety Award, eleven made it onto the jury's shortlist. Thanks to this innovation, the list included Fels-Werke, a member of the Duisburg-based Xella Group.

Now, mortar arrives at the site not as a dusty powder but in the form of compact pellets that can be quickly mixed with water and applied without raising a lot of dust.

Dr. Ulf Boenkendorf, Head of R&D, calls attention to another benefit of this innovative product, which is scheduled to hit the market in 2017: "Our compact mortar pellets have a > 20 % higher specific yield than that of conventional dry mortar." For the companies concerned, this means savings in terms of less material expended, lower transport costs and faster on-site work progress. No more tedious, bothersome mixing of thin-layer mortar with big, heavy stirring gear.

Innovative Fels compact mortar pellets make it much easier for construction companies to comply with the new (2014) General Workplace Particulate Exposure Limit.

The decisive factors in the pellets' production are what is called "agglomeration by compression" and the pellets' large interspatial volume, which promotes an intensive capillary effect upon addition of water at the site. Consequently, the compact mortar lends itself to quick and easy on-site processing: Just pour the pellets into a tub, add water and mix with a trowel. No electric mixer is needed. It takes some minutes to thoroughly mix conventional mortar with an electric mixer and get it ready for use, but it only takes about 90 seconds to turn Fels pellets into ready-to-use thin-layer mortar.

www.fels.de

INFO

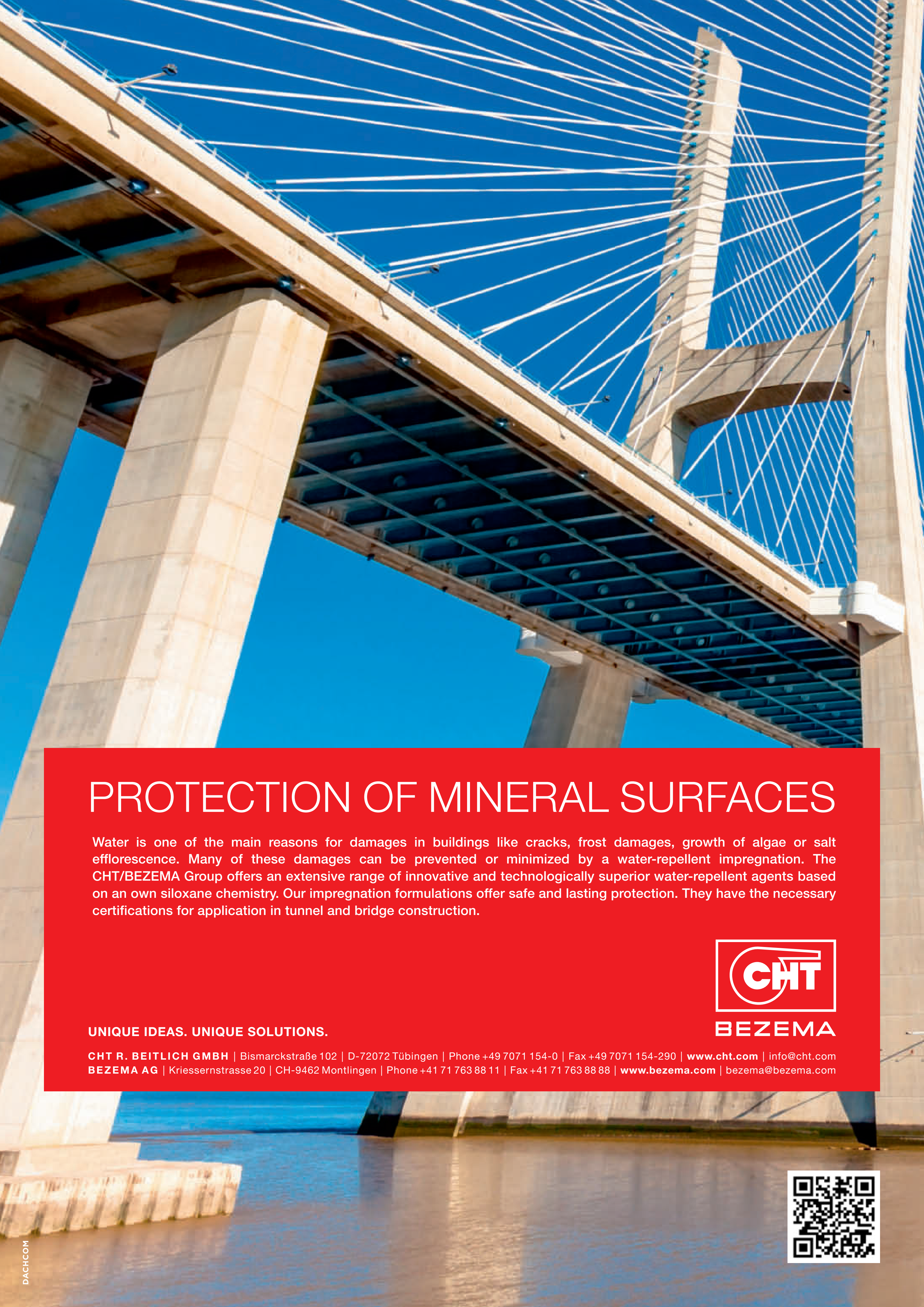
The workplace safety benefits of Fels compact mortar pellets:

» purely mineral premixed dry mortar
» free of organic binders
» occupational exposure limits (TRGS 900) for type-A and type-E dust bettered by far
» exposure category 1 (TRGS 559) – no special personal protective gear required
» back-friendly thanks to unrestricted portionability and low weight

Other benefits of the Fels innovation:

» very good dosability, accurate proportioning
» hand mixable after 90-second wait: ready to use
» > 20 % higher yield than for conventional mortar
» less weight to carry, lower transport costs
» no need for electric mixers, power cables, etc.
» significantly shorter set-up times

2 Fels pellets transform into ready-to-use thin-layer mortar in only 90 seconds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Water is one of the main reasons for damages in buildings like cracks, frost damages, growth of algae or salt efflorescence. Many of these damages can be prevented or minimized by a water-repellent impregnation. The CHT/BEZEMA Group offers an extensive range of innovative and technologically superior water-repellent agents based on an own siloxane chemistry. Our impregnation formulations offer safe and lasting protection. They have the necessary certifications for application in tunnel and bridge construction.
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BHS-SONTHOFEN GMBH

New twin-shaft mixers for dry building materials

All BHS-Sonthofen GmbH

1 A dry powder batch mixer of type DMX 3600 has proven itself for years in a German dry mortar plant

At Powtech 2016, BHS-Sonthofen displays dry powder batch mixers of the DMX series. They are adapted to the special requirements of mixing dry materials, such as cement, dry mortar, bonding compounds and dry shotcrete.

The mixers are specially tailored to the production of dry material mixtures. Since dry building materials encompass a wide range of aggregates, cements and admixtures, different application-specific drive variants are available for the mixers with different speeds and mixing tools. These can be individually configured according to the application, e.g., for abrasive or adherent input materials.

They are suitable for mixtures containing all manner of aggregates, cement, small dry components, plastic fibers and cellulose. With an extensive modular system and various options, they can be customized to the products of the user, from fine-grained materials such as cement to mortar mixtures with coarse particles up to 8 mm in size. BHS offers a range of machines with throughput rates of up to 300 t/h.

Compared with single-shaft mixers, they offer considerably better mixing with short mixing cycles. Furthermore, the DMX mixers are more compact than single-shaft mixers and also represent good value for money.

Homogeneous mixtures

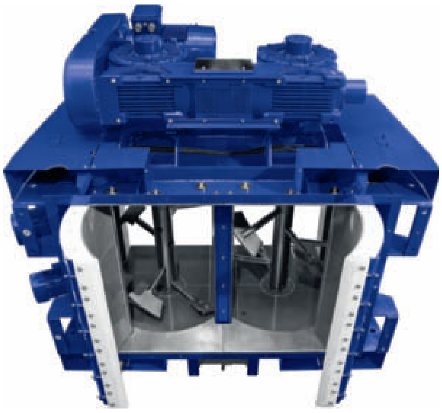
BHS has developed the DMX series on the basis of the twin-shaft batch mixers (type DKX), which have been used in thousands of concrete mixing applications worldwide. The mixing mechanism consists of mixing tools that are arranged in the form of a discontinuous spiral on each of two counter-rotating mixing shafts. They generate a three-dimensional spiral motion with intensive exchange of material in the turbulent zone of overlap between the two mixing cycles.

Thanks to the sophisticated mixing mechanism, the speed of the mixer can be less than that for comparable single-shaft or intensive mixers while still producing a greater mixing effect. This considerably reduces the energy consumption and is also gentler on sensitive components in the material to be mixed, such as perlite, styrofoam or expanded clay – the particles are not crushed.

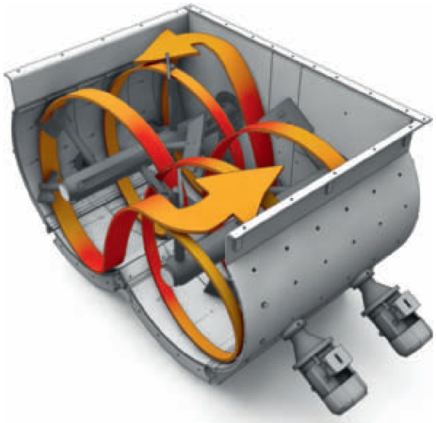
Compared with other mixing systems, twin-shaft mixers are filled to a much greater extent, making them more compact for a comparable throughput rate. In the case of new plants, these mixers are thus ideal because of their small dimensions; for modification to existing plants, they allow the installation of a more powerful mixer in the existing space.

Residue-free discharge

Since many manufacturers produce different products in succession, a residue-free discharge of the trough is important. In the case of the DMX, this is carried out by means of large, hydraulically operated discharge door wings that are available in two variants for fine and coarse-grained mixture products. The discharge door wing for fine-grained mixtures has a seal to prevent fine-grained materials, such as cement, from escaping; it is also waterproof. The mixing shafts are fitted with special sealing air seals.



2 Large, hydraulically operated discharge door wings that are available in two variants for fine and coarse-grained mixture products



3 Unlike single-shaft systems which move the mixture to the center of the machine, the three-dimensional mixing concept of the twin-shaft mixer results in a more intensive exchange of materials and thus in shorter mixing cycles with reduced energy consumption

Excellent resistance to wear

Depending on the abrasiveness of the mixture, various wear liners are available. All wearing parts in the mixer, such as mixing arms or blades, are screw-fitted and are thus easy to adjust or exchange. This simplifies maintenance and increases the availability of the plant.

Tests in the BHS technical center

Every dry material mixture has different characteristics; for this reason, BHS conducts tests at its in-house technical center on request. These tests give the customer the certainty that his outlay is well invested and that the new plant is future-proof.

www.bhs-sonthofen.de

BHS-SONTHOFEN GMBH

Rotor impact mills for the production of sand for dry mortar successful in Thailand

All BHS-Sonthofen GmbH

1 **Five BHS rotor impact mills of type RPM 1513 are operating at Siam Mortar's Khaeng Khoi III, Saraburi plant**

The BHS rotor impact mills produce well-graded sand in the proper shape with optimal grading curves which are exactly adapted to the "dry mortar" application. The good cubicity of the sand grains is crucial for enabling the mortar to be processed easily and for ensuring its good pumping capacity.

These properties have contributed to the fact that a large number of dry mortar plants worldwide are operated with BHS machines. One of the most important sales markets is Southeast Asia. Dry mortar in Southeast Asia is often not only used as plaster for outdoor and indoor surfaces or as masonry mortar or screed, but rather especially for fine finishing plasters. In contrast to Germany, colored plasters are frequently used in Thailand, as are rough plasters, which have a particularly decorative structure and are coated without priming.

The requirements for the fineness of these products and thus for the properties of the sand are equally extraordinary. Particularly high-grade products are manufactured specially in Thailand, where sand with a grain size between 90 and 300 µm is used. A grain with 0.5 mm diameter in Thailand is already considered a coarse grain.

Crushing the rocks and sifting out the oversized grains is not sufficient to achieve the specified grading curve. The crushed rock must instead be selectively broken down into fractions and then put back together into a precisely defined grading curve in accordance with prescribed formulas.

Rotor impact mills have particularly proven themselves here, since the properties of the discharged product can be precisely set by adjusting the circumferential speed of the rotor and the width of the annular gap. This makes it possible to produce sand with grading curves which precisely conform to the specification.

Twelve BHS rotor impact mills are currently operating on the premises of one of Thailand's leading dry mortar manufacturers, Siam Mortar, with ten more already having been delivered and set for commissioning in 2016. BHS delivered three additional machines for a project with another Thai manufacturer – also for dry mortar.

Moreover, Siam Mortar is operating four BHS VSI rotor centrifugal crushers of type RSMX for the crushing of granite – also for the production of dry mortar sand. In brief, more than 30 BHS machines are operating in the dry mortar industry in Thailand. Philipp Parnitzke, BHS Area Sales Manager for Asia and the Pacific, explains the success in Thailand: "Our unique selling point is the fact that the rotor impact mills produce sand with cubical grain shape in finely graded fractions with precisely the grading curve required for dry mortar sand. It meets the requirements of our Thai customers exactly. Moreover, they can be serviced easily and quickly and exhibit little wear in proportion to their high production output."

The rotor impact mills from Sonthofen have become the standard in Thailand. This is proven, for example, by the fact that Siam Mortar awards contracts for new dry mortar plants to various plant constructors, but still uses the BHS rotor impact mills in every single project.

The crushing of the feed material can be selectively controlled by variation of the rotor's circumferential speed on the one hand, and by changing the gap width between the rotor and the anvil ring on the other hand. The impact hammers can be adjusted with just a few hand movements.

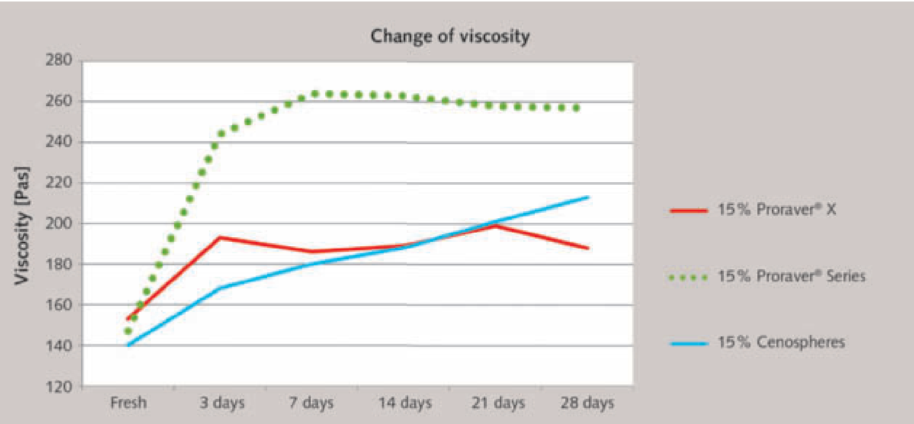
www.bhs-sonthofen.de

2 **Setup of the rotor impact mill of type RPM**

3 **Functional principle of the rotor impact mill of type RPM**

DENNERT PORAVER GMBH

Poraver X – the new lightweight aggregate for dispersion-based construction products



15% dosage by volume [Pas]	Fresh	3 days at room temperature	7 days at 40°C	14 days at 40°C	21 days at 40°C	28 days at 40°C	Change [%]
15% Poraver® X	153	193	186	189	199	188	23%
15% Poraver® Series	147	244	264	263	258	257	75%
15% Cenospheres	140	168	180	188	201	213	52%

All Dennert Poraver GmbH

1 Internal test results from Dennert Poraver GmbH

The tried-and-tested advantages found in the dry mortar sector such as a high yield, better workability and reduced weight are also interesting properties for ready to use systems. Therefore, manufacturers require effective and high performing lightweight aggregates.

Suitable aggregates must guarantee the desired parameters such as low density, high stability and good integration into the matrix. After filling, ready to use products must generally retain their set consistency and product characteristics even after having been stored for one year. This requires the aggregate to have a very low level of water absorption and a high chemical stability. A particularly light colour is advantageous in many products e.g. decorative fillers or marble adhesives.

The history of ready to use construction products (plaster/adhesive) can be traced back to the 1950s when it was realised that standard mineral systems could be combined with plastic dispersions as binding agents. The main difference between ready to use products and mineral-bonded construction materials is their fluid, organic and dispersion-based binding agent. Today, ready-mixed products are generally adhesives, fillers or decorative plasters based on polymer binding agents. In particular, commonly used products include water-thinnable dispersions based on vinyl acetate, copolymers/terpolymers, acrylate/styrene dispersions and pure acrylate.

The ready to use plasters and adhesives have an optimal consistency developed by the manufacturer, are highly flexible and do not form dust. It is not necessary to mix the products. This saves time on the construction site and also enables minor work to be completed in a short space of time. Depending on the requirements, the systems may be waterproof, suitable for damp rooms and useable indoors and outdoors.

2 Sample of ready to use base coat mortar with Poraver X

3 The multicellular structure inside Poraver X

Poraver X expanded glass granulate is the latest development by Dennert Poraver GmbH, one of the leading manufacturers in the area of expanded glass granulate. Due to the modified process technology and composition, it has been possible to optimise the product's water absorption, colour and chemical stability. The new lightweight aggregate expands the existing Poraver product range and was specially developed for use in ready to use products and applications with a low use of binding agents. Just like Poraver expanded glass granulate, Poraver X is also manufactured from environmentally friendly post-consumer recycled glass and is free of toxins and solvents.

A special combination of high-quality raw materials ensures that Poraver X achieves its closed surface. The water absorption of this lightweight aggregate is thus significantly reduced – without the addition of a water-repellent agent or a coating. As the granulate consists of pure glass, it is non-flammable (building material class A1 according to DIN 4102) and does not release any harmful gases in the event of fire. The very good pourability of the round grains enables easy conveying and dosing in the production process. Different grain sizes can be combined to achieve optimal packing densities and a high filling level. This can limit the binder content and reduce shrinkage.

Poraver X can be combined with most organic and inorganic binding agents and delivers long-term and stable viscosity and shelf life. Its resistance to water enables the formulation of permanently stable emulsions. In internal tests based on an adhesive and reinforcement mortar, the change in viscosity was investigated using Poraver, Poraver X and Cenospheres. The tests demonstrated that Poraver X performed as good as cenospheres at a dosage of 15 % by volume.

www.poraver.com

HAVER & BOECKER OHG

ROTO-PACKER mini ADAMS – the plastic film bag filling technology for 1 to 10 kg bags

For building products and minerals, especially in the DIY sector, there is a clear trend towards offering attractive, clean, product-protective packaging and in ever smaller sizes. Ultimately packaging appeal and the appearance of the brand and sales floor play a critical role in this product segment: "It comes down to appearance" and "the first impression counts". With impressive packaging, brand names acquire the power to change customer habits at the location of sales, i.e. to switch brand names. Therefore improved package print quality, brand promotion, enhanced brand name recognition and clean filling are more essential than ever.

Manufacturers often do not completely cover the entire range of packaging sizes, or they simply subcontract the smaller package sizes to an outside packing plant. However, when manufacturers expand their product spectrum to include the smallest packaging sizes, new business fields are the result. This means that the current trends to smaller DIY package sizes offer excellent opportunities to move into these business areas and there is now the possibility of benefitting from significant competitive advantages and higher sales.

Haver Building Products and Minerals is boosting this trend by offering a complete system for the smaller weight ranges. "Why shouldn't manufacturers take our machine for the smaller package sizes? Each individual packing system for the different weight classes has an optimum application range. We have the expertise in packing and palletizing technology, and we can offer all machines for all weight classes from a single source. Our customers are very familiar with the quality of our systems and they trust us," says Burkhard Reploh, Head of Haver Building Products and Minerals.

Haver & Boecker ROTO-PACKER mini ADAMS

In the sector of filling powder-type, loose product into water-tight PE packaging, Haver & Boecker is fulfilling the demands with its ROTO-PACKER mini ADAMS. The system uses the proven ADAMS technology and fills 1 to 10 kg packages. It extends the previous weight range to now include

1 The ROTO-PACKER mini ADAMS

NEW
Sika® ViscoCrete®-510 P and
Sika® ViscoCrete®-520 P

Sika® ViscoCrete® AND Retardan® HIGH PERFORMANCE ADDITIVES

If the production of consistent, high quality yet economical and low emission dry mortars is your goal, Sika additives are your solution.

Sika® ViscoCrete®
Superplasticizers, which are extremely efficient and provide excellent flow characteristics.

Sika® Retardan®
Very effective gypsum retarders, showing excellent performance in the adjustment of setting and workability time.

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www.sika.de

BUILDING TRUST

2 The Data Driven Services program

the smaller weights. Today durable PE bags made of flat film can be filled for the first time. Filling into tubular film bags or into every type of pre-made bag is also possible. Here the width of the bag may be between 80-220 mm and the length between 100-400 mm. The system can reach speeds of up to 1000 bags per hour, depending on the product's bulk density and flow properties and compaction characteristics.

Combining the control system with the in-house Haver & Boecker developed MEC electronic weigher system assures precise weight filling. Product compaction in the bag is the prerequisite for a clean and efficient overall result. Inner and outer vibration devices provide the required product compaction. "The secret is removing the air from inside the bag," says Reploh. Doing so results in compact bags with low volume. This means less consumption of packaging film when compared to conventional systems. The ADAMS systems are characterized by their minimal heights. They are compactly designed and completely housed in, which is a key advantage whenever replacing existing systems.

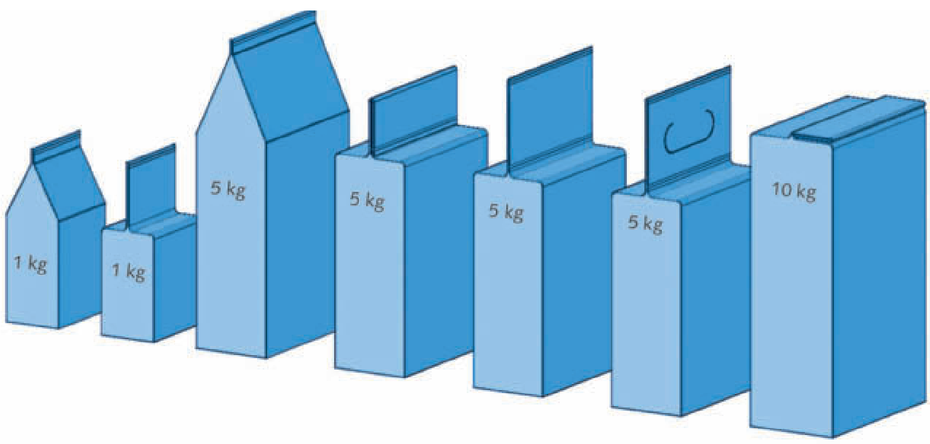
Data Driven Services boost productivity

All Haver & Boecker systems such as the ROTO-PACKER mini ADAMS are optionally equipped with a continuous online transmission of production and remote technical maintenance data. With the Data Driven Services program, production and machine data are recorded and thus ensures that operators are continuously supplied with up-to-date information and allows them to react immediately, flexibly and foremost pre-emptively under volatile conditions. This continuous improvement process allows machine operating times and productivity to increase.

Product protection, extended storage time and cleanliness

"With the ROTO-PACKER mini ADAMS we are not only keeping pace with the trend of smaller package sizes, but we are also leading the way for fulfilling the significantly higher demands concerning product protection, product storage time, and keeping the surroundings clean," says Reploh.

Not only manufacturers expect ever longer product shelf lives, but so do processors, professionals and end users. It has to be possible to store packages outdoors and over longer periods without incurring product quality loss. This can be accomplished only if the filled product is protected from every type of external influence by the packaging material. That is why it is essential for bags to be sealed shut and water-tight, especially in the case of hygroscopic products and protection against UV radiation. With the ROTO-PACKER mini ADAMS, Haver Building Products and Minerals offers the right technology for meeting these demands.



3 Examples for bag shapes

Advantages of the ROTO-PACKER mini ADAMS filling system:

- Packages that stand up because of high product compaction
- Perfect consumer packaging
- Rapid set-up times during format or product changeovers
- Easy cleaning between product changeovers
- High speeds with high weight precision
- Package printing and marking possible in the machine
- Bags have the standard dimensions of sales floor areas
- Spillage-free filling

Health-hazardous products are often processed in the building products industry. The often legally required higher worker safety and protection of personnel can be achieved by greater cleanliness. The Haver Building Products and Minerals has long since recognized this requirement and has contributed decisively to driving the trend with the development of the ADAMS technology.

Not only during filling, but also during palletizing, loading, transport and stocking of building products and minerals, everyone involved places great emphasis on the cleanliness of bags and surroundings. Optimizing bag filling using technical improvements and increasing bag tear-resistance ultimately provide for cleaner surroundings along the entire value-adding chain. Less product leakage, reduced maintenance expenditures and machine downtime due to dust lead to higher profitability. Also here the ROTO-PACKER mini ADAMS scores points.

Haver & Boecker will be exhibiting at the bauma 2016, Hall/Stand B2.149 and the Powtech 2016, Hall/Stand 1/1-535.

www.packyourpowder.com

ACTEMIUM SAINT-ÉTIENNE PROCESS SOLUTIONS

Horizontal dry mortar manufacturing plant with no cross-contamination

Typical dry mortar manufacturing mixing plants are either horizontal or vertical designs. Both plant designs have their own disadvantages which can have financial repercussions and major cost implications during a plant's lifecycle.

Horizontal Design

In a horizontal mixing plant, raw material silos are placed on the ground and often outside the building. The mixer is located inside the building and can be placed either on the ground or approx. 4 m above ground level, on top of the bagging machine. Compared to vertical designs where gravity helps the transfer of material from the silos to the mixer, the conveying system used in horizontal designs becomes a crucial component of the installation. Depending on location and product constraints, pneumatic or mechanical conveying systems can be used to transfer materials from the storage/dosing area to the mixer or from the mixer to the hopper located above the bagging machines.

Cross-contamination is one of the main disadvantages of both pneumatic and mechanical conveying systems. Retention is considerable with mechanical systems as it is very difficult to clean screws, bucket elevators or belt conveyors thoroughly while maintaining high productivity.

Pneumatic systems are not suited to the conveying of materials which are very sticky, colored, or have large particle sizes or high bulk density. Indeed, materials can stick to the wall of the conveying pipes thus contaminating other batches. Contamination can also occur at the level of the filtering system on the cyclone hopper at the end of the pneumatic transfer system.

Another disadvantage specific to pneumatic conveying systems is high energy consumption. Compared to a mechanical system, the ratio is around 7 (75 kW for a pneumatic system to 10 kW for a mechanical system). This is due to the fact that the production of compressed air required to transfer materials is a very energy-consuming process.

This transfer system also requires highly skilled personnel for its operation (control of pressure differential and airflow) and its maintenance. Misoperation and lack of maintenance could damage pipes, decrease productivity, and contribute to higher operational costs and reduced profit.

Vertical design

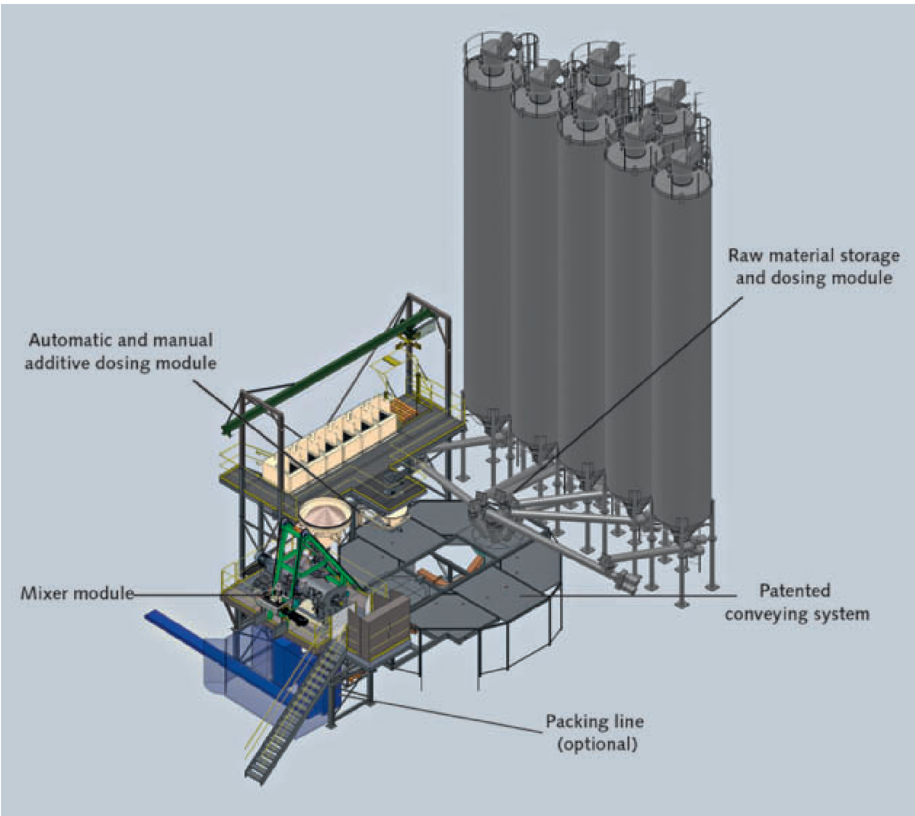
In a vertical mixing plant, raw material silos are located on top of the plant and the materials flow down to the mixer by gravity. The aim of this design is to limit contamination and reduce energy consumption. The vertical design requires a taller and stronger steel structure which means a much higher investment cost. The seismic constraints of the location can also drastically increase the amount of steel required.

The layout of vertical plants also presents disadvantages: as it is difficult or very expensive to add raw material silos, additive hoppers or another mixing line, it restricts possible future extensions of the plant, unless planned from the outset.

Another issue with vertical plant layout is that maintenance activities are often more difficult due to limited access.

Flexiplant

Considering dry mortar manufacturers' growing requirements for flexible manufacturing plants to meet the ris-



The new dry mortar plant design called Flexiplant ing and fluctuating demand for dry mortar products from emerging markets as well as their strong will to optimize both investments and total costs, Actemium Saint-Ėtienne Process Solutions has developed a new dry mortar plant design called Flexiplant with a scalable and modular layout.

Actemium Saint-Ėtienne Process Solutions' new concept offers a wide range of benefits. The overall size of the steel frame is reduced and the total frame height limited to 9 or 12 m depending on layout, which translates into lower building costs for investors.

Not only does Flexiplant provide a reduction in investment costs but operating costs are also lowered due to its patented breakthrough mechanical transfer technology combining a carousel and a skip. Unlike screw conveyors and bucket elevators, the Flexiplant conveying system ensures there is no cross-contamination thanks to the high surface finish of the mobile hoppers.

Furthermore, the Flexiplant mechanical transfer system consumes much less energy compared to pneumatic conveyors. Due to its simple design, this conveying system is easy to access, simple to operate and requires little maintenance. In addition, the conveying system with mobile hoppers leads to shortened production cycle times (= masked time) and higher productivity. Another benefit of Flexiplant is the high precision weighing system. The weigh scale module is completely independent from the mixer module and thus not exposed to vibrations from the mixer.

To ensure cleanliness of the plant during operation, the conveying system as well as the mixer module are fitted with a complete dust-removal system. Flexiplant can be supplied with the Prodose control system software.

To meet the market's requirements for short delivery and short mounting times while ensuring the highest level of quality, Flexiplant modules are pre-mounted and pre-tested in the workshop before shipment in containers.

Actemium will be exhibiting at the Powtech 2016 in Nuremberg/Germany from 19.04.–21.04.2016 – Hall 3 Stand 3–141.

www.mixing-process.actemium.com
www.sofraden.com

All Oliver Gerstenberger, on behalf of Sika Deutschland GmbH

1 and 2 The two SikaRock Anchor Mortar 1 and SikaRock Anchor Mortar HS dry mortars are used for anchoring of rock nails and grouting/filling of rockbolt holes in mining and in tunnel engineering

SIKA DEUTSCHLAND GMBH

Sustainable anchor mortars for mining and tunnel engineering

Sika Deutschland GmbH has in its product range two anchor mortars for anchoring of rock nails and filling of rockbolt holes in mining and tunnelling: SikaRock Anchor Mortar 1 and SikaRock Anchor Mortar HS are hydraulically setting, purely mineral dry mortars. The HS product variant has in addition a high sulphate resistance and is particularly suitable for use where water containing sulphate is present in mine or tunnel workings. SikaRock Anchor Mortar 1, a product based on Portland cement, can also be used for securing construction trenches and slopes.

Both SikaRock versions have good to excellent adhesion bonding with the rock and anchor bars. They are frost-resistant and pumpable, expand upon setting, exhibit high early and ultimate strength, and have a thixotropic consistency which also permits overhead application. Thanks to its high alkalinity, SikaRock Anchor Mortar 1, with a particle size of 0-1 mm, also provides good protection against corrosion.

The Civil Engineering Materials Testing Institute (MPA) in Hanover has tested the internal bonding of a rockbolt grouted using SikaRock in a tensile test in accordance with DIN 21521, Part 2. An extremely high rockbolt load-bearing capacity is certified for both mortars, the test report stating an ultimate load of between 560 and 749 kN.

The Ruhr District Institute of Hygiene has also tested the SikaRock mortars for use in contact with drinking water in accordance with DVGW Code of Practice 347 W. Here, too, they met all hygiene requirements in all applications. This means that contamination of the groundwater due to the use of these mortars is excluded, and that they can be used as lasting, sustainable products in mining and tunnelling.

The SikaRock anchor mortars are already practice-proven and are currently being used in two tunnels for the "Stuttgart 21" rail project: in the 962 m long double-track Widderstall Tunnel, being constructed using the cut-and-cover method on the Stuttgart-to-Ulm route, and in the 680 m long Heilbronner Strasse tunnel on the Stuttgart Rapid Transit System.

www.sika.de

3 SikaRock is a hydraulically setting, purely mineral dry mortar. The SikaRock Anchor Mortar 1 variant in addition offers high protection against corrosion, while SikaRock Anchor Mortar HS is resistant to water containing sulphate

4 Both products in the SikaRock range have been tested for quality and safety: internal bonding was verified in a tensile test in accordance with DIN 21521, Part 2, and hygienic safety for use in contact with drinking water in accordance with DVGW Code of Practice 347 W

IBAU HAMBURG/HAVER & BOECKER

Advanced turnkey dry mortar plants

High capacity mixing plant in concrete design

Premixed dry mortar plants comprise sand preparation, storage and feeding equipment, material metering, weighing and mixing systems and dispatch facilities, which usually include a packing plant. Advanced plant concepts are fully automated in order to cope with the high quality demands and the large number of major and minor components used. There are concepts for tower mixing plants and in-line mixing plants, depending on the way the installation needs to be set up.

IBAU Hamburg as part of Haver & Boecker is one of the few suppliers, who is able to install such a plant on a turnkey and EPC basis (Engineering, Procurement and Construction). All the key equipment such as the sand preparation, mixing plant, silo systems, conveying, packing equipment and automation are of their own design. More than 80 IBAU batch and continuous mixers are already operational. The turnkey delivery includes plant engineering and design of their own and third party technology, procurement, construction/fabrication and commissioning of equipment, structural analysis of steel structures, piling, foundation and formwork, workshop drawings of steel structures, incl. material lists for fabrication, as well as performance testing and guarantees.

IBAU Hamburg/Haver & Boecker is also responsible for the coordination of specific disciplines, such as steel, electrical and civil construction, performance testing, insurance and financing. A number of projects have already been completed in the sector and currently a new plant for TPI in Thailand has recently been commissioned. Up to now most of the customers are from the cement and related building material industries, who are implementing a vertical integration strategy.

IBAU Hamburg will be exhibiting at the bauma 2016 in Munich/Germany from 11.04.–17.04.2016 – Hall/Stand B2.149.

www.ibauhamburg.de

MONDI INDUSTRIAL BAGS

The next generation of water-repellent paper bags from Mondi

HYBRID^{PRO} is a technically demanding combination of paper and plastic

The HYBRID^{PRO} bag, which is marketed under the slogan "Made of PaPEr – combining the best of both worlds", represents a whole new concept in industrial bag design. Like a hybrid drive in a car, the HYBRID^{PRO} is an excellent combination of the available options: the inner ply is made of 120 g/m^2 Mondi Advantage ONE sack kraft paper; the outer ply is a 40 µm layer of high-density polyethylene (HDPE). The innovative step here is that the HDPE forms a protective layer on the outside of the paper. Other bags also use a combination of paper and PE, but not in this way. This is a considerable technical achievement that brings a new dimension to industrial bag design.

The HYBRID^{PRO} belongs to Mondi's next generation of water-repellent bags, developed as part of the company's focus on exciting new solutions achieved through ongoing R&D activity and collaboration with customers. The bag – for which a patent is pending – is yet another successful outcome of Mondi's strategic emphasis on collaboration with customers during the product development process.

The benefits

With the HYBRID^{PRO}, building materials such as gypsum and cement enjoy excellent protection against direct rain during shipping or on site. The bag also provides excellent protection against gradual moisture ingress during outdoor storage, thanks to the 40 µm thickness of the unperforated HDPE film. For example, according to building materials producer Knauf, who collaborated in developing the new bag, gypsum packaged in the HYBRID^{PRO} enjoys an eight-month shelf life when stored outdoors with no further protective layer – twice as long as if packaged in a standard paper bag.

This impressive performance outdoors makes the bag very user-friendly and has benefits when it comes to streamlining the supply chain of fillers and end-consumers: with longer shelf life, order sizes can be larger, for potential reductions in shipping costs.

Since the bag can be filled on conventional paper bag filling systems, investment in FFS systems, which tend to be expensive, is not required.

The bag's outer ply – which forms the barrier against rain, moisture and dust – is made of HDPE film, giving it an attractive, modern appearance, an important factor in many markets. The HDPE film can be printed in up to eight colours, including on the bottom patches, for a glossy, premium look, and the paper ply is available in a bleached or an unbleached version.

The HYBRID^{PRO} allows high-speed filling, with de-aeration twice as fast as with a standard three-ply bag (18 m^3/h versus 35 m^3/h tested on Mega Gurley equipment at Mondi's R&D centre BAC in Austria).

Workplaces, such as construction sites, are cleaner with the HYBRID^{PRO}, as less of the contents adhere to the outer layer – a benefit sure to appeal to end users.

The bag is an eco-friendly solution: the total grammage of material used is less than with standard three-ply designs used for the same purpose.

Last but not least, the plastic and paper components are easy to separate, for optimum recyclability.

Applications

The HYBRID^{PRO} is a high-quality packaging solution conceived for high-quality contents. It is particularly suitable for building materials, including gypsum and cement, as well as many other moisture-sensitive products. The bag is suitable for filling contents at temperatures of up to 90 °C.

www.mondigroup.com/hybrid-pro

Plant building with silos and screening tower

All Rhewum GmbH

After supplying two drymix mortar plants to Thailand's biggest cement and mortar manufacturing company in 2011 and 2013, in 2015 Rhewum GmbH was contracted with the supply of two additional drymix mortar screening plants with an annual production capacity of 1 000 000 t each.

TEXT **Dipl.-Ing. Thorsten Middelhof,** Area Sales Manager, Rhewum GmbH, Remscheid/Germany

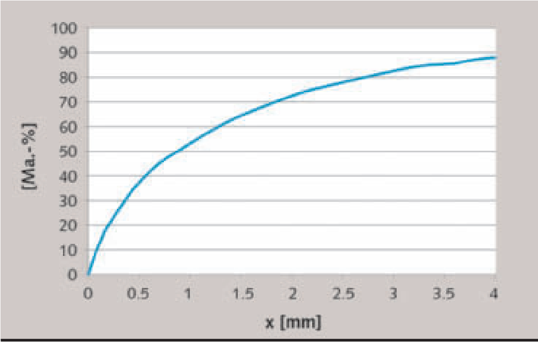
RHEWUM GMBH

High-performance screening plants for the production of high-quality drymix mortar in Thailand

1 Introduction

Rhewum GmbH is an independent family owned company which was founded in 1927 as "Rheinische Werkzeug- und Maschinenfabrik". The headquarters are based in Remscheid/Germany, an important center of metal processing in the so-called "Bergisches Land".

Since the beginning of the 1950s Rhewum has been developing and manufacturing screening machines as well as vibrating feeders. These cover the



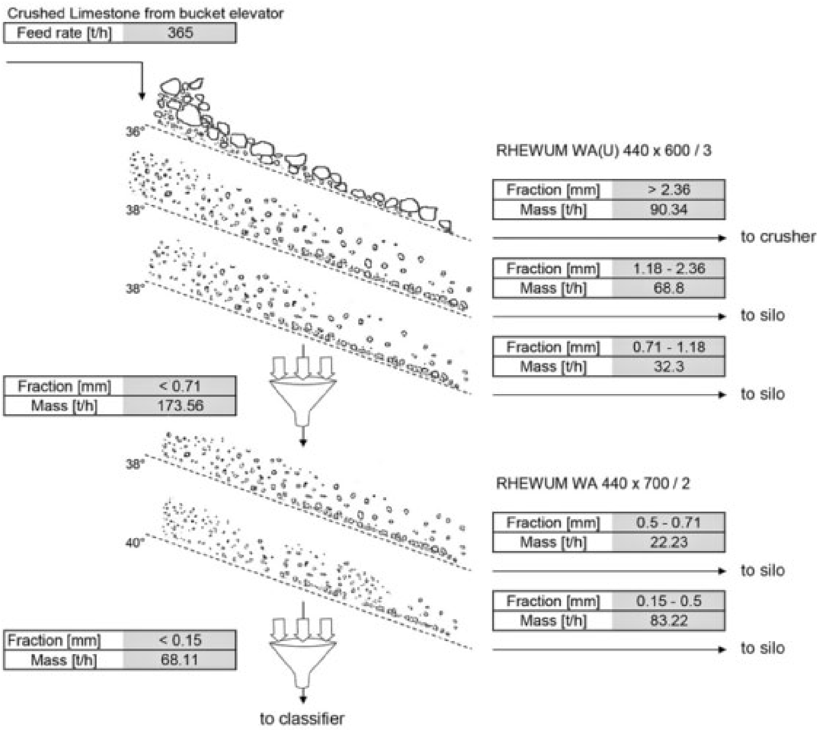
1 Particle size distribution of the feed material

entire field of dry and wet screens for a vast variety of applications for leading companies worldwide. The development of highly efficient air classifiers is the logical extension of our activities for the near future of the company.

2 Project description

Due to their references in the mortar industry Rhewum GmbH was initially approached in 2011 to supply a drymix mortar screening plant to Thailand with five different screen cuts ranging from 2.36 mm (8 mesh) down to 0.15 mm (100 mesh) and an annual product output of 500 000 t/a, which was delivered within the same year. In 2012 Rhewum was again contracted with the supply of another screening plant with similar properties, however with an annual product output of 1 million t to be supplied in the following year. Two more additional screening plants of the same size were ordered by the same customer in 2015 to boost their overall annual dry mortar production from 5.5 million t in 2015 to 7.5 million t in 2016.

These two screening plants shall handle a feed rate of already 365 t/h of limestone each in a wide particle range, which will be screened into six different fractions. Particles coarser than 2.36 mm have to be recirculated via a crusher. The five fractions needed to produce various grades of drymix mortar are 1.18 mm to 2.36 mm, 0.71 mm to 1.18 mm, 0.50 mm to 0.71 mm, 0.15 mm to 0.50 mm and 0 to 0.15 mm, which again are split into two fractions of 0 to 0.09 mm and 0.09 mm to 0.15 mm.



2 Mass flow diagram of the screening plant

3 Challenges

One major reason the client decided in favor of Rhewum with the supply of the screening machines was that the screening plant can be located high above the silos. To keep construction costs economical, this calls for screening machines which only barely transmit any dynamic load into the steel structure underneath. Due to Rhewum's patented drive system with direct-excited screen cloths and a static housing, dynamic loads are 20 times less compared to the old design of circular or linear motion screening machines.

Another reason the client chose Rhewum screens was that he required a high product purity of at least 85 % in all major fractions, especially the highly valuable fractions. Screening fine materials with a high efficiency at high feed rates requires a precise adjustment of all machine parts. This is only possible on precisely working, high quality equipment. The setting of the ideal amplitude for each screen deck has to be adjusted individually. Keeping in mind the fluctuation of granulometry of the heterogeneous limestone feed material, the amplitude on each screening deck has to be able to be adapted quickly to the steadily changing feed material characteristics. The electromagnetic drives of the Rhewum WA screening machine allow the customer to change the amplitude live in process, while screening machines driven by electromechanical eccentric motors cannot provide this unique feature.

Another challenge is the likeliness of crushed limestone particles getting stuck in the screen mesh, thus clogging the screen cloth and reducing the capacity of the process and the purity of the product. Both Rhewum's direct-excited WAU screening machine with small unbalanced motors and the likewise direct-excited WA with electromagnetic drives have pre-installed self-cleaning mechanisms to prevent clogging. While the WAU achieves accelerations of the screen cloths of up to

10 g, which is enough to keep meshes with openings of 1 mm and more reliably free, the WA achieves 15 g during the cleaning cycle, keeping even the 0.15 mm mesh free from clogging.

4 Plant setup

4.1 Installation of feeders

The limestone feed first enters the screening plant from the bucket elevator into the top-located, dust-tight flange connected chute. The λ-shaped chute embodies a pneumatically adjustable flap, which divides the on-coming material stream into two streams during standard operation. It is also possible to divert the material flow onto one half of the screening plant, which is practical either for maintenance purposes or in case the production capacity should be temporarily lowered.

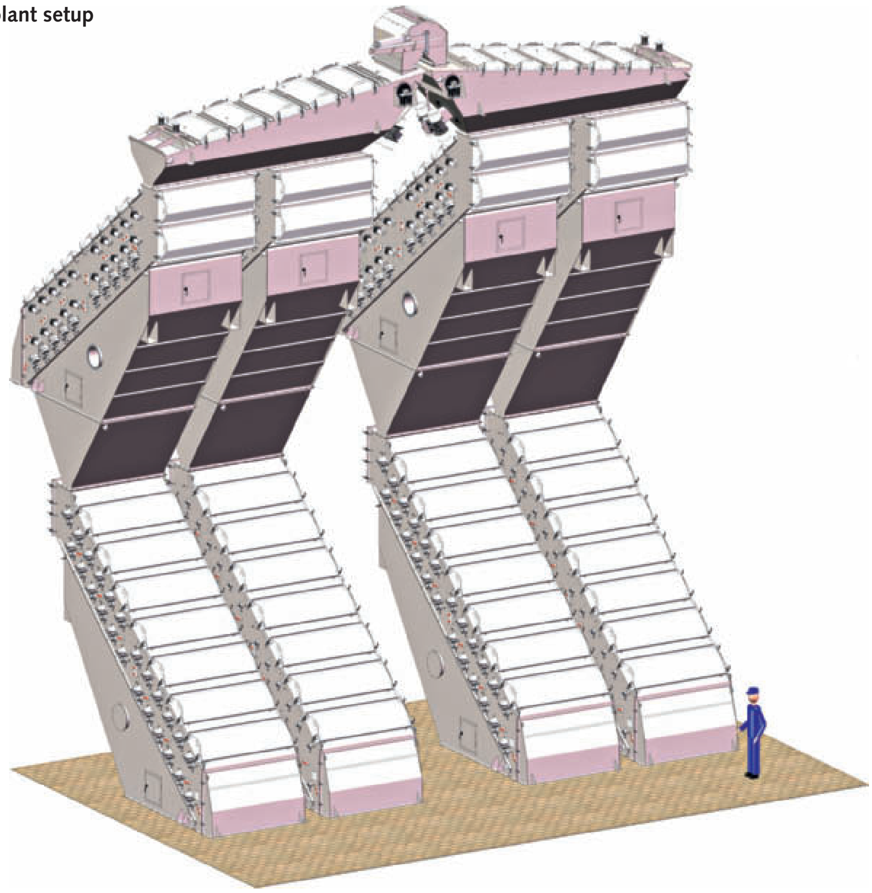
The two Rhewum SV 4400 screen feeders contain an inner distributing plate which conveys and distributes the limestone feed material equally over the full width of the downstream screening machines. The inner plate is driven by two counter-rotating unbalanced motors creating a linear motion, while the feeders' housing remains static. The static housing is crucial to ensure a permanent dust-tight flange connection of all machine parts, which is essential for processing fine materials.

4.2 Installation of coarse screens

The coarse screens are two direct-excited WA(U) screening machines with a screening surface of 26.4 m^2 each on all three screen decks on both sides. The upper deck for the 2.36 mm screen cut and the middle deck for the 1.18 mm screen cut are driven by small unbalanced motors (type WAU). The lower deck for the 0.71 mm cut is driven by electromagnetic vibrating heads (type WA). Both types of drives have a power consumption of only 0.16 kW per drive.

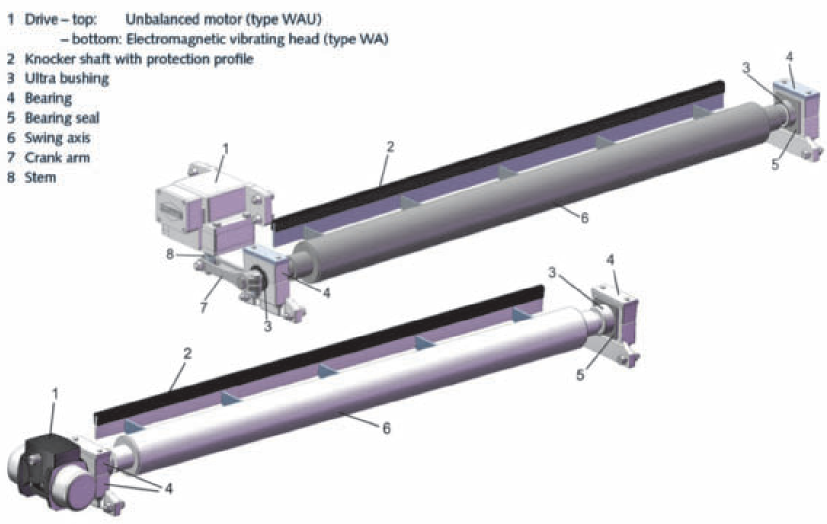
Due to the higher number of small drives compared to conventional screens with a small number of larger motors, Rhewum's direct-excited screens are highly reliable. In case one or two of the small drives fail during operation, the process does not have to be stopped, the drive can be replaced while the others are still running, continuing the process.

Each inlet and outlet half of each screen deck or screen cloth may have its individual amplitude and self-cleaning interval to maximize the efficiency for every fraction. Every screen cloth can be changed individually without removing the other, which is very useful considering that the wear of the screen cloths can lead to individual maintenance intervals. Overflows from each deck are collected and discharged via an overflow chute, which is pivoted to access the cloth tensioning system for the outlet half of each deck. The inlet half can be reached by comfortable inspection doors on the backside on top of the screening machines, just below the feeders. The tensioning system is optimized for quick tensioning



3 Screening plant setup

and easy changing of the cloths, which takes two skilled workers only about five minutes per mesh. The covers are made of aluminium for easy handling due to the low weight of only 18 kg. No cranes are required.



4 Rhewum drive units for direct excitation of screen cloths

4.3 Installation of fine screens

From the underflow hopper and chute the material finer than 0.71 mm enters the fine screens – two WA screening machines equipped with electromagnetic drives for direct-excitement of the screen cloths. The width of the fine screens is identical to the coarse screens, but the length is enhanced by additional 1000 mm to ensure the highest possible efficiency even for the more difficult to screen fractions below 0.50 mm and 0.15 mm. Also at this screening stage the overflow streams are collected and discharged into the silos by an overflow chute, while the underflow is being collected by an under hopper and conveyed into an air classifier to take out the filler material.

4.4 Electrical control unit

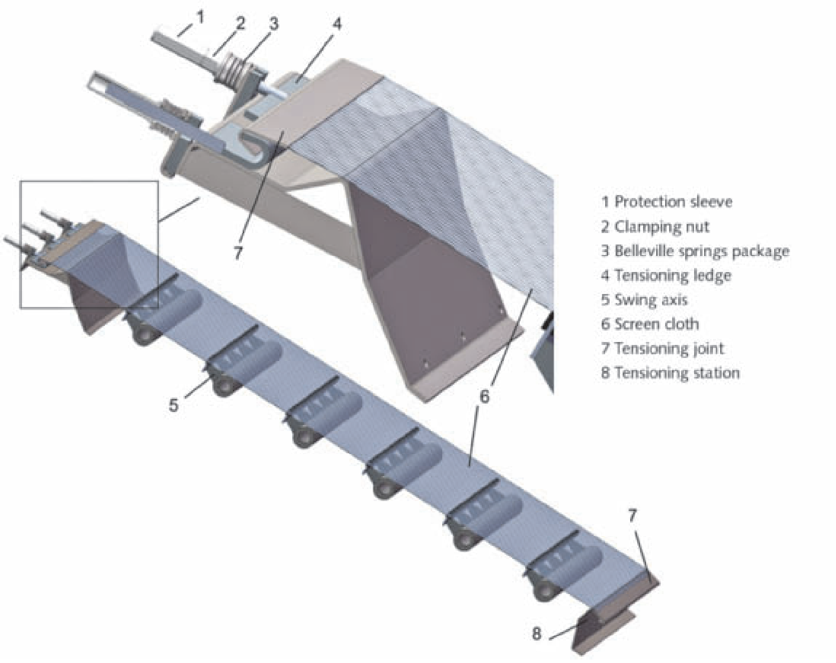
The screening plant is controlled by a centralized PLC and four decentralized control cabinets – one for each side of each screening stage. Positions for the flap of the λ-shaped chute can be set either via the PLC or manually from the control cabinet. The amplitudes of the electromagnetically driven screening decks can be adjusted separately for the screen inlet and outlet half of each deck via the thyristor controllers installed in the control cabinets. The automatically running self-cleaning cycles can be set either via the PLC or manually from the control cabinets. Motor brakes for the unbalanced motors of the SV feeders ensure a smooth starting and stopping phase.

5 Summary

Together with its customer, Rhewum GmbH designed, supplied and commissioned highly efficient and flexible drymix mortar screening plants, which contribute to strengthen the customer's position as the leader of drymix mortar manufacturers in Thailand. The entire screening plant consumes a total of only 43.4 kW, which means only 0.13 kWh per ton of processed material.

The supplied state-of-the-art screening plants are a product of Rhewum's tremendous experience in limestone screening gained over several decades and recent developments that were implemented to achieve and surpass the customer's challenging demands in terms of capacity and efficiency.

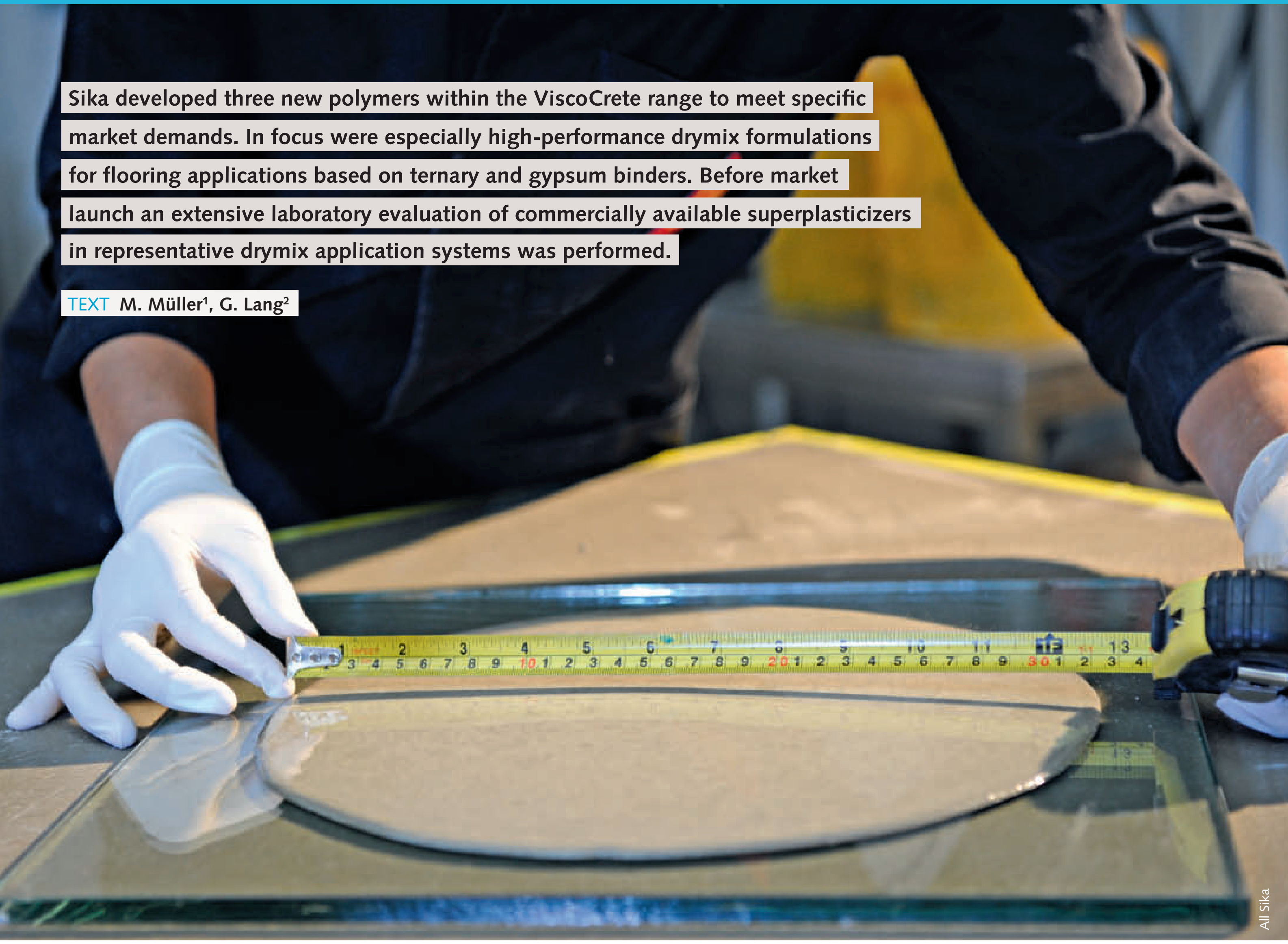
www.rhewum.com



5 Screen cloth tensioning system

Sika developed three new polymers within the ViscoCrete range to meet specific market demands. In focus were especially high-performance drymix formulations for flooring applications based on ternary and gypsum binders. Before market launch an extensive laboratory evaluation of commercially available superplasticizers in representative drymix application systems was performed.

TEXT M. Müller[1], G. Lang[2]



Slump flow testing

SIKA

New PCEs – targeted selection of superplasticizers for various binder systems

1 Introduction

One of the fastest developing additive segments is superplasticizer based on polycarboxylate ether (PCE). By varying the polymer structure, the properties of the resulting superplasticizer can be influenced. This allows adjustment of essential characteristics tailored to the respective application. In addition to various technical and economic advantages of PCEs versus conventional flow agents, their success is also due to EHS-related advantages, in particular the formaldehyde issue (versus melamine-based products). [1]

Sika developed three new polymers within the ViscoCrete range to meet specific market demands. In focus were especially high-performance drymix formulations for flooring applications based on ternary and gypsum binders. Before market launch an extensive laboratory evaluation of 13 different commercially available superplasticizers in 13 representative drymix application systems was per-

[1] Sika Services AG, Zurich/Switzerland
[2] Sika Deutschland GmbH, Leimen/Germany

formed, generating more than 3000 individual data. In the following, selected results are presented.

2 Methods

Standardized lab-test methods were applied to evaluate fresh and hardened mortar properties, including

- Initial slump flow and workability time using EN ring (SLU) or Hägermann cone (SLS)
- Flow time using the 6 mm Ford cup
- Fresh mortar density and air content
- Start and end of setting by the Vicat method
- Compressive and flexural strength using 40 x 40 x 160 mm prisms

In addition, the structure development was continuously evaluated using ultrasonic testing method.

3 Discussion of results

In the following, the mortar test results for two drymix systems are presented and discussed:

- Self-levelling underlayment (SLU) based on a ternary binder system (CAC-C\$-OPC)
- Self-levelling screed (SLS) based on natural anhydrite

3.1 SLU based on the ternary binder system (CAC-C\$-OPC)

The selected ternary binder system is widely used in the dry mortar industry for applications like high performance floor levelling compounds. It consists of CAC as the major component in combination with calcium sulfate and with minor amounts of Portland cement (see Table 1).

During hydration of the binder components predominantly ettringite ($C_3A \cdot 3C\$ \cdot 32H$) is formed. It incorporates a high amount of water, resulting in rapid hardening and rapid drying of the mortar as well as excellent shrinkage compensation behavior. [2]

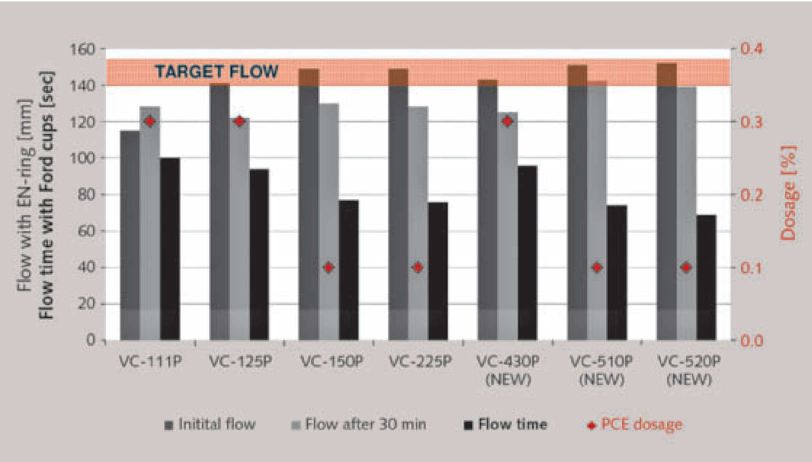
To fulfil the strength requirements of the hardened mortar, the water demand of the dry mortar is limited to 21 %. The most relevant influence of the different PCEs is described by the water reducing power (initial flow), the slump keeping effect and the viscosity (flow time). For the interpretation of the test results it is important to know that both EN rings for the flow tests are filled immediately after mixing. One is pulled right after that, the second after 30 minutes. As shown in Figure 1, different PCE dosage amounts are required to reach the targeted initial flow and workability time. The most effective PCEs (with the lowest dosage amount) tendentially also reach shorter flow times than those polymers which need to be dosed much higher.

Table 1 SLU drymix formulation (%)

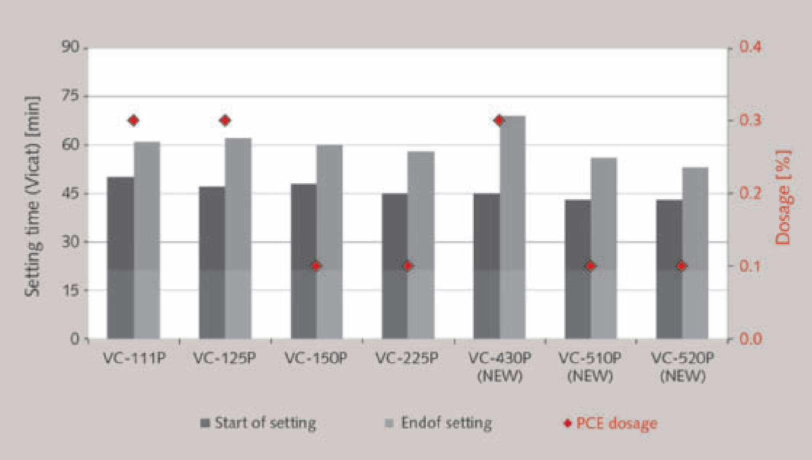
Component	(%)
Portland cement (CEM I 42.5R)	4.00
Calcium aluminate cement	16.00
Alpha hemihydrate	5.00
Sand 0.1–0.4 mm	44.00
Limestone filler	29.xx
Redispersible powder	1.50
Activator lithium carbonate	0.06
Retarder combination	0.12
Stabilizer combination	0.06
Superplasticizer	variable
Defoamer	0.05

Not only do the different polymers have an individual effect on the rheological properties of the fresh mortar, they also have an individual influence on the setting, hardening and strength development (see Figure 2 and Figure 3).

Nevertheless, there is a tendency that the more effective a PCE is (resp. the lower its dosage is), the



1 Slump flow over time and flow time using different PCEs; dosage adjusted to the initial flow requirements

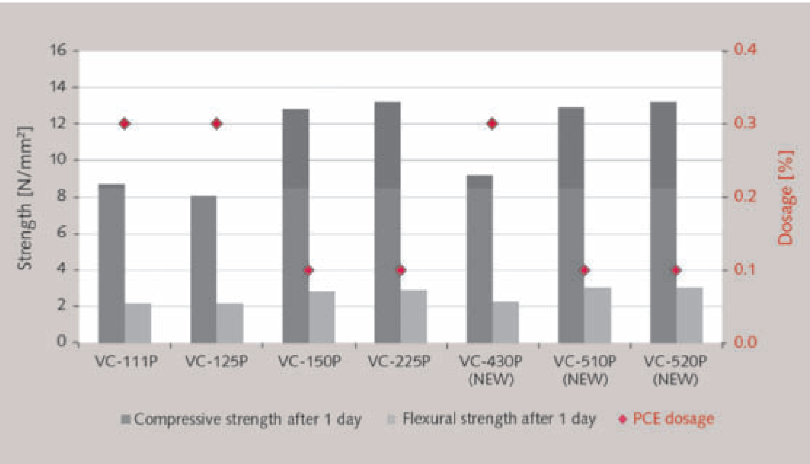


2 Start and end of setting of the mortar using different PCEs (dosage adjusted to the initial flow requirements) less it retards the binder setting. This is accompanied by improved strength development of mortars formulated with the suitable polymers. For the correct interpretation of the results it must be added, that all hardened and dried mortars had a constant raw density of 2.08 ± 0.005 g/cm³ and accordingly a similar air content.

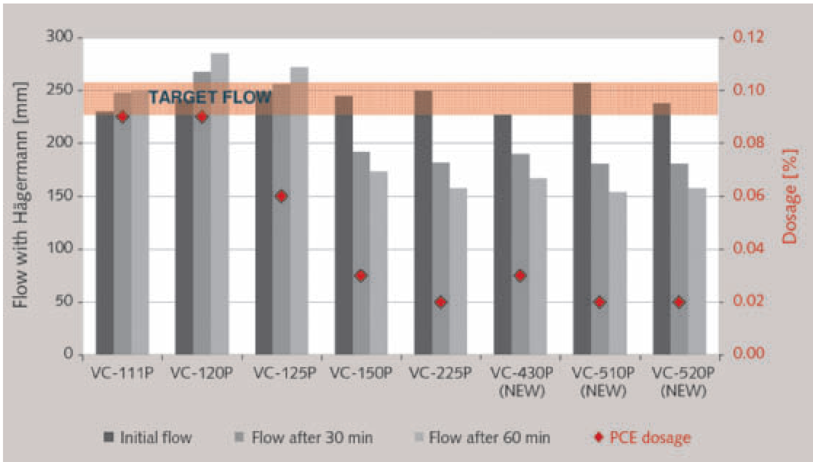
In the given example, a self-levelling underlayment based on a ternary binder system, the new Sika ViscoCrete-510 P fulfills the requirements best: the target slump flow is reached with low dosage, the workability time of 30 minutes is given, the fresh mortar has low viscosity and the mortar is characterized by unaffected setting behavior and excellent strength development.

3.2 SLS based on natural anhydrite

In contrast to calcium sulfate hemihydrate ($CaSO_4 \cdot ½H_2O$, e.g. gypsum plaster), anhydrite ($CaSO_4$) reacts slowly with water and usually turns not fully into gypsum ($CaSO_4 \cdot 2H_2O$). This is due to the relatively low solubility difference of anhydrite and dihydrate. For applications of anhydrite in the construction industry, the reaction rate must therefore be increased significantly; anhydrite must be stimulated. This is possible in principle by a finer milling of the anhydrite raw material and by changing the solution conditions, for example due to the addition of various salts (activator). Since the first option is very energy intensive, various salts are added to anhydrite formulations for the flow screed production. [3, 4]



3 1-day-strength of the mortar using different PCEs (dosage adjusted to the initial flow requirements)



4 Screed flow behavior over time using different PCEs; dosage adjusted to the initial flow requirements

Table 2 SLS drymix formulation (%)

Component	(%)
Natural anhydrite	42.00
Sand 0/4 mm	56.xx
Activator I (CEM I 42.5R)	1.00
Activator II (K_2SO_4)	0.40
Superplasticizer	variable
Defoamer	0.01

In the given case, a mixed activation – including sulfatic (CEM I) and alkaline component (K_2SO_4) – is applied (see Table 2). To fulfil the strength requirements of the hardened mortar, the water demand of the dry mortar is limited to 15 %.

A selected range of PCE-based superplasticizers was evaluated. The most relevant rheological behavior of the SLS is described by the water reducing power (initial flow) and the slump retaining effect of the different PCEs. During flow testing, the mixed material was left in the covered mixing vessel and mixed again shortly with low mixing intensity (15 sec at Hobart mixer level 1) before the next slump flow test was performed (after 30 and 60 minutes). Selected test results are presented in Figure 4. In the case of those PCEs, which are tailor-made for cementitious applications (e.g. Sika ViscoCrete-1XX P series), an inefficiently high dosage is required to reach the targeted initial flow of the anhydrite screed. These mortars show a further increase in flow during the first hour. This effect – known as after-wetting – can lead to undesired sedimentation and bleeding during screed installation causing inhomogeneities and surface film formations. In some formulations, on the other hand, this can help to achieve longer consistency preservation. If combined with a PCE with strong initial flow, both effects can eliminate each other, as exemplary proven e.g. in [1].

In case of some polymers, too high dosage also causes retardation of the binder setting and hardening (see VC-120 P in Figure 5), leading to green strength losses (see VC-120 P in Figure 6). For the screed manufacture that means: If the room climate during screed installation allows drying of the screed – in particular at higher temperatures and/or air flow – even the final strength of the screed can be reduced.

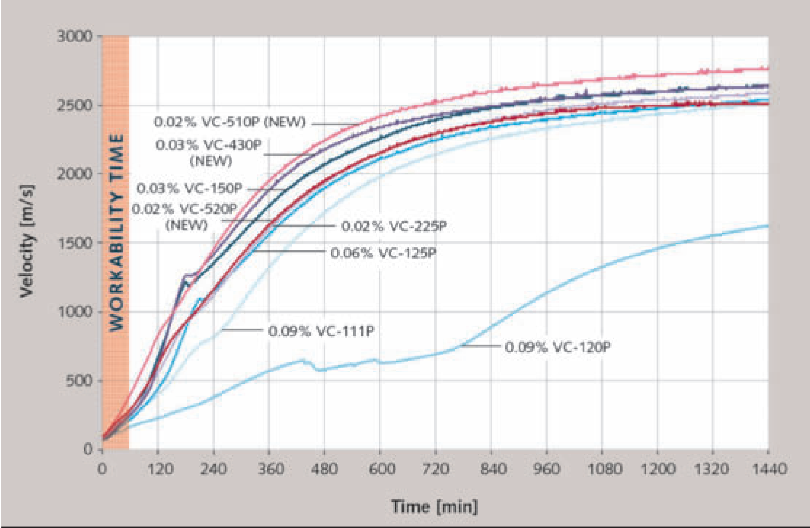
PCEs tailor-made for calcium sulfate based drymixes, on the other hand, reach the initial flow requirements of the anhydrite screed at a lower dosage level (78 % lower dosage in case of VC-510 P, see Figure 4). Assuming equal PCE prices, these solutions result in significantly lower formulation costs. In contrast to the previously described after-wetting and set-retardation, these PCEs liquefy the mortar predominantly in the first few minutes. Already within the first hour, the screed flow is reducing (see e.g. VC-510 P after 30 and 60 min in Figure 4) and its strength starts developing (see Figure 5 and Figure 6). For the screed manufacture that means: Once the mortar is mixed with water, pumped to the place of installation and homogeneously distributed, the unhindered binder setting and hardening starts. This can contribute to quicker construction progress and thus increased construction process efficiency.

In the given example, a self levelling screed based on natural anhydrite, Sika ViscoCrete-510 P fulfills the requirements best: the target slump flow is reached with low dosage, the workability time is sufficient and the mortar is characterized by unaffected setting behavior and excellent strength development. Nevertheless, in cases where the applicator requires longer workability time, the combination of two polymers (e.g. VC-510 P and VC-125 P) has been proven to be a very efficient option (see [1]).

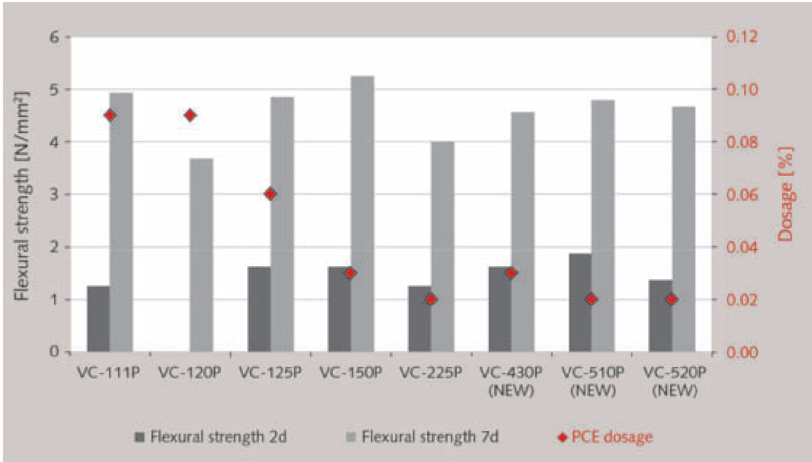
4 Conclusions

Superplasticizers based on PCE-technology can be perfectly tailored to the intended purposes. During drymix mortar formulation development and/or adjustment, the first targeted selection of the appropriate additives according to their intended purpose is crucial. The dosage of other drymix components – in particular other additives such as accelerators, retarders, defoamers or stabilizers – may be necessary to adapt to further optimize technical performance and formulation costs.

From the perspective of the dry mortar manufacturer, additives with a broad spectrum of applications are interesting because often limited raw material storage facilities are available in the individual plants. In subordinated formulations a higher dosage is then tolerated. The screening in 13 different drymix application systems has shown that both high PCE performance and a broad spectrum of applications can be fulfilled (e.g. Sika ViscoCrete-510 P).



5 **Continuous evaluation of the screed structure development process using different PCEs (dosage adjusted to the initial flow requirements) by ultrasonic transmission**



6 **Flexural strength of the screed over time using different PCEs (dosage adjusted to the initial flow requirements**

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Husk rice is the major waste generated in the agricultural production of rice. Despite the fact that many references were found using this waste as raw material for the manufacture of construction products, no references were found analyzing three different formats, whole rice husk, crushed rice husk and rice husk ash. Therefore, this paper analyzes the feasibility of reusing rice husk in three different formats by incorporating them into a plaster matrix, replacing part of the binder by waste.

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Plaster samples with different percentages of added rice husks and formats

UNIVERSIDAD POLITECNICA DE MADRID

Feasibility of plaster composites with rice husk waste

1 Introduction

According to statistics published by the Food and Agriculture Organization of the United Nations (FAOSTAT) in 2014, the total rice produced worldwide in 2012 was around 720 million t [1]. China was the largest producer followed by India. The European Union (EU) was responsible of around 28 % of the total rice produced and Spain is the second largest producer in the EU after Italy.

Each year more than 180 million t of rice husk are generated in the world and their final destination is, at the moment, a problem without a definitive solution, since it is normally incinerated or dumped into waterways, causing negative impacts on the environment [2]. This environmental problem will worsen as rice production fertilizers, herbicides, insecticides and fungicides are frequently used, converting the rice husk into a highly contaminated waste. This is particularly dangerous as uncontrolled incineration releases toxic gases which can cause breathing problems and diseases. Therefore, the concern to establish methods and other alternatives for rice husk waste recycling has increased in recent years.

Several studies were found reusing the waste generated in the production of rice as a substitute for wood [3] or even to produce biogas [4], bioenergy [5] or hydrogen[6].

Other studies analyzed the viability of incorporating rice husk waste as raw material for building construction materials manufacture. These research studies can be classified according to the type of waste used: entire rice husk without treatment (CA), as obtained from the milling process, shredded rice husk (CT), rice husk ash (CE) and rice straw.

Among the works incorporating entire rice husk (CA) the following studies were found: Ahmed et al. used rice husk waste as a reinforcement of building materials [7]. Salas et al. conducted the research project "Materials, Technologies and Very Low-Cost Housing Prototypes" where different proportions of cement and treated rice husk are tested for flexural strength and thermal conductivity behavior [8]. Moreover, Oteiza San Jose incorporates up to 2 % of rice husk and concludes that no significant improvements were achieved with these proportions and without additions [9]. Also, Padhko included rice straw and corn husk for the production of gypsum boards, achieving composites with lower density and less water absorption [10].

According to the studies using shredded rice husk (CT), the following studies can be highlighted. Kim performed plasterboards incorporating shredded rice husk up to 40 % of plaster weight [11]. The findings of this study revealed enhanced reinforcement properties and slightly improved water absorption and humidity. Furthermore, Serrano et al. analyzed lightweight mortars with previously treated rice husk in three different ways: washed with distilled water, bathed in acid solution and basic solution. The mortars obtained can be applied to lightweight and non-bearing construction elements [12].

Moreover, many studies were found dealing with rice husk ash (CE) [13-18]. All these studies incorporate CE in cement or concrete mixtures as an excellent pozzolanic material that improves mechanical strength properties and durability. Also, other scientific studies have incorporated different waste categories in plaster and gypsum composites in order to improve their characteristics [19-22]. However, studies analyzing the behavior of plaster-gypsum composites with rice husk are still scarce [9, 11]. Among these studies, only a maximum of 2 % of CA waste was analyzed compared to 40 % studied with CT in Korea [11]. Also, none of these studies incorporated and analyzed rice husk ash (CE) in the gypsum/plaster matrix despite being widely studied for cement and concrete composites.

Therefore, this paper summarizes the methodology used and the results obtained in a research project that aims to study the feasibility of incorporating CA – exceeding 2 % of addition –, CT and CE in a plaster matrix.

2. Experimental plan

2.1 Materials

To carry out this research work plaster E-35, supplied by the Iberyola Company Placo, was used. This plaster has a purity index ≥ 90 %, grain size ranging from 0 to 0.2 mm and flexural strength ≥ 3 N/mm^2. The setting time is around 13-22 minutes.

The water/plaster (w/p) ratio used is 0.6 and 0.8. Although 0.6 w/p ratio is not recommended by the manufacturer, it was used in this research as used in previous research studies [9-19].

The rice husk was supplied by Herba Rice Mills (located in Seville) in three different formats: entire rice husk (CA), shredded rice husk (CT) and rice husk ash (CE).

Entire rice husk (CA) is the hard protecting covering – short fiber – of the grain rice. CA waste is generated during the milling process and its length varies from 5 mm to 11 mm depending on the type of rice. It has a corrugated structure and irregular surface appearance with highly abrasive properties and 6 value on the Mohs scale [23]. The CA void fraction, i.e. the volume of voids over the total volume they are around 54 %, although voids are normally closed as long as it is not subjected to a combustion process. Other characteristics of CA are: 0.78 g/cm^3 unit weight, 0.108 g/cm^3 bulk density and 0.143 g/cm^3 tap density [12, 24].

1 Three different formats of rice husk that were used in this research

Table 1 Granulometry test for the three formats of rice husk analyzed in this study

	Mesh opening (mm)							
	4.000	2.000	1.000	0.500	0.250	0.125	0.063	Base
Weight of CA at each sieve (gr)	0.0	87.6	37.5	17.8	5.0	0.8	0.2	0.2
Weight of CT at each sieve (gr)	0.0	0.0	71.2	102.8	55.1	11.5	4.1	4.0
Weight of CE at each sieve (gr)	0.0	0.0	0.5	18.2	66.6	47.6	29.5	16.3

Shredded rice husk (CT) is supplied by the same mill and is the result of shredding the entire rice husk (CA). Moreover, the rice husk ash (CE) is obtained from the combustion of the entire rice husk (CA). Rice husk ash reaches high proportions of silicon and it can be used as fuel [25]. Table 1 shows the results corresponding to the granulometry test (particle size distribution) of CA, CT and CE rice husk.

2.2 Methods

Several series of 40 x 40 x 160 mm (three plaster samples per series) were developed with different percentages (6 %, 8 % and 10%) of the three formats of rice husk (CA, CT and CE). These percentages were calculated by total plaster weight following the same methodology used by other researchers [26, 27]. Also, several reference series, i.e. only plaster without rice husk, were produced following the UNE-EN 13279-2 Standard in order to compare the results obtained with the rest of samples produced [28]. Subsequently, a total of 72 samples were prepared following UNE-EN 13279-2 and tested according to the reference, analyzing: workability, density, surface hardness, flexural and compressive strength.

The tests were conducted at the Construction Materials Laboratory of the School of Building Engineering at the Technical University of Madrid (UPM). The environmental conditions in the Construction Materials Laboratory were: 23 °C (296 K) of average temperature and 26.4 % of relative air humidity.

Table 2 Average test results obtained with each mixture

	Rice husk format (w/p ratio)						
	% of added rice husk	CA (0.6)	CA (0.8)	CT (0.6)	CT (0.8)	CE (0.6)	CE (0.8)
Density (g/cm³)	6 %	1.18	0.94	1.16	0.96	1.21	1.02
	8 %	1.18	0.96	1.25	0.98	1.21	1.04
	10 %	1.18	0.97	1.25	1.01	1.21	1.03
	0 %*	1.21	1.00	1.21	1.00	1.21	1.00
Surface hardness Shore C	6 %	99	83	91	80	95	85
	8 %	99	80	93	81	95	87
	10 %	99	81	93	82	95	86
	0 %*	93	78	93	78	93	78
Flexural strength (MPa)	6 %	4.78	2.99	6.11	3.64	6.79	4.84
	8 %	4.35	3.03	6.4	3.22	7.08	4.80
	10 %	3.83	2.79	6.1	3.90	6.63	5.30
	0 %*	7.40	4.50	7.40	4.50	7.40	4.50
Compressive strength (MPa)	6 %	11.46	6.42	14.50	7.32	22.57	12.24
	8 %	10.15	5.07	12.64	5.63	22.15	12.82
	10 %	9.63	5.49	11.74	6.79	22.66	13.25
	0 %*	19.00	10.00	19.00	10.00	19.00	10.00

* Reference series (0% of added waste)

Table 3 Results obtained in the workability test

Rice husk waste format	Slump Ø (mm)					
	w/p ratio = 0.6			w/p ratio = 0.8		
	6 %	8 %	10 %	6 %	8 %	10 %
CA	167	<160		>170		
CT	180	178	170			
CE	162	161	144			
REF	162					

3 Results and discussion

Table 2 shows a summary of the results obtained, on average, for each sample analyzed according to the w/p ratio, the percentages of added waste and the type of rice husk. These results are further discussed in the following sections.

3.1 Workability of the mixture

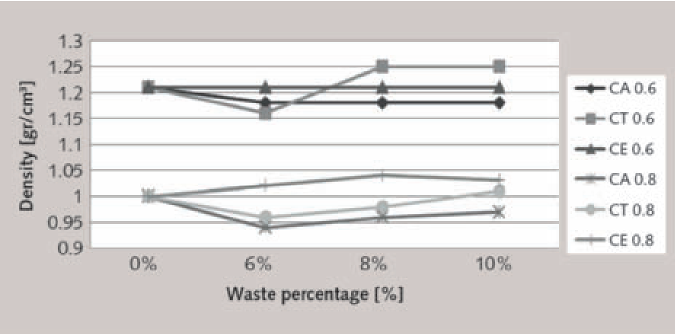
To determine the workability of the mixture the UNE-EN 13279-2 Standard was followed using a vibrating table and measuring de diameter of the slump [28]. Table 3 shows the results obtained.

Results show that mixtures with 0.6 w/p ratio and CA additions above 6 % obtained smaller diameters than the minimum value required by the regulation (160 mm). Also due to the low density of the CA, the entire rice husk volume exceeds the volume of the mixture. Instead, with shredded rice husk (CT) higher percentages can be added in all the samples until the minimum value required by the regulation is reached. Finally, up to 8 % of rice husk ash (CE) can be added, if this percentage is surpassed a bad workability of the mixture is obtained.

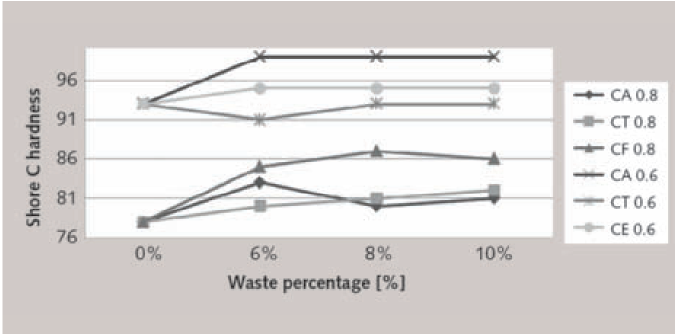
By contrast, mixtures with 0.8 w/p ratio can incorporate higher percentages of rice husk waste, in all the three formats analyzed, as the result is always higher than the minimum value required by the legislation.

3.2 Density

According to 0.6 w/p ratio mixtures (Fig. 2), all CE and CT samples (except those with 6 % of addition) achieve almost the same density as the reference sample (around 1.21 g/cm³). The small variation found in CT samples can be explained by the ex-



2 **Density 0.6 w/p and 0.8 w/p**



3 **Superficial hardness Shore C results**

pansion phenomenon produced during the setting time, as the final volume of CT samples is greater than the reference volume. Results with CA – in the three percentages analyzed – are always below the reference. The behavior of composites with 0.8 w/p ratio is different. In this case, results for CA and CT are below the reference value, reducing up to 6 %. Moreover, for CE samples the density increases, exceeding up to 4 % the reference sample – without rice husk (1.0 g/cm³).

3.3 Superficial hardness Shore C

Figure 3 shows the results for the superficial hardness Shore C test according to UNE-EN 102-039-85 Standard [29].

Results show that, when CE is added, the superficial hardness of the compound increases up to 12 % compared to the reference. Likewise, in general, including CA in a plaster matrix (with both w/p ratios and with different percentages of addition) the superficial hardness is also exceeded, except for the mixture w/p = 0.8 with 8 % of CA. In this case, the hardness remains similar to the reference. According to CT additions with 0.8 w/p ratio, hardness is increased in all cases. For CT samples with 0.6 w/p ratio, results remain the same as the reference except the sample incorporating 6 % which obtained a reduction of 2 %. By contrast, 0.8 w/p ration hardness is increased in all cases. Figures 4 and 5 show the relation between density and hardness for the two w/p ratio mixtures analyzed in this research.

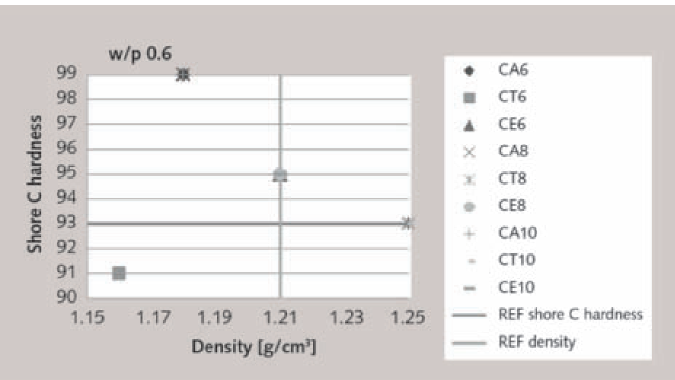
Figure 4 shows the results for samples with 0.6 w/p ratio. It was observed that higher hardness was achieved as the density increased, but the relationship was not linear.

By contrast, Figure 5 shows the results of the samples containing more water (0.8 w/p ratio). In this case, a linear relation was found between density and hardness (except for sample CA6).

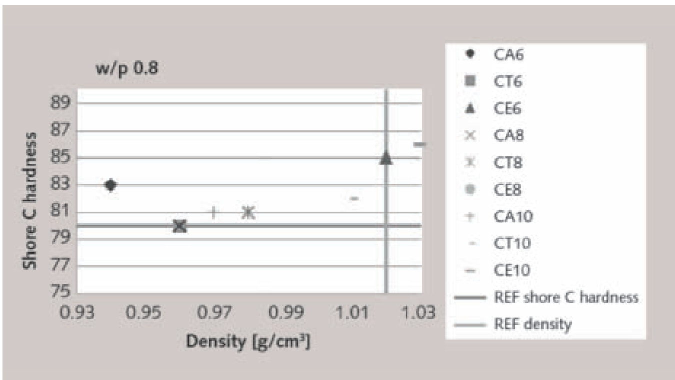
3.4 Flexural strength

Figure 6 shows the results of the flexural test. In general, a strength loss is observed when increasing the rice husk addition. However, all the results were kept over 2.79 MPa, fulfilling the minimum requirements set by UNE-EN 13279-1 Standard (1 MPa) [30].

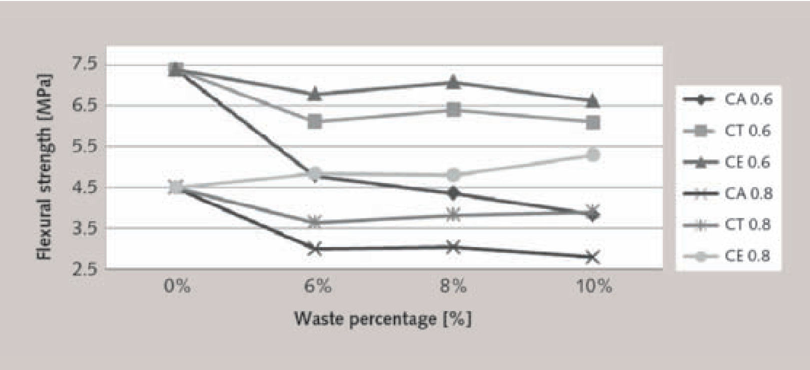
The major reductions – compared to the reference – were reached with CA samples (up to 48 %). With CT additions, the flexural resistance decreased to a maximum of 28 %. Nevertheless, when CE was added, maximum resistance values were obtained (10 % lower than the reference). Mixtures with lower quantities of water have similar behavior to the reference. It can be noted that a flexural



4 **Relation between superficial hardness and density in samples with 0.6 w/p ratio**



5 **Relation between superficial hardness and density in samples with 0.8 w/p ratio**



6 **Flexural strength results**

strength increase of 18 % was achieved with the composite of 10 % of rice husk ash (CE).

As shown in Figures 7 and 8, density and flexural strength are directly related, decreasing both features as the percentage of rice husk waste is increased. For samples with 0.8 w/p ratio a direct linear relation between the density and the flexural strength of the composite was observed, i.e. higher densities provide greater resistances. Although flexural results are lower than the values obtained with the reference, the fracture of the CA and CT series keep both sides of the sample strongly joined (Fig. 9). This is a common phenomenon when reinforcing fibers are incorporated [27].

3.5 Compressive strength

Figure 10 shows the results obtained in the compressive strength test.

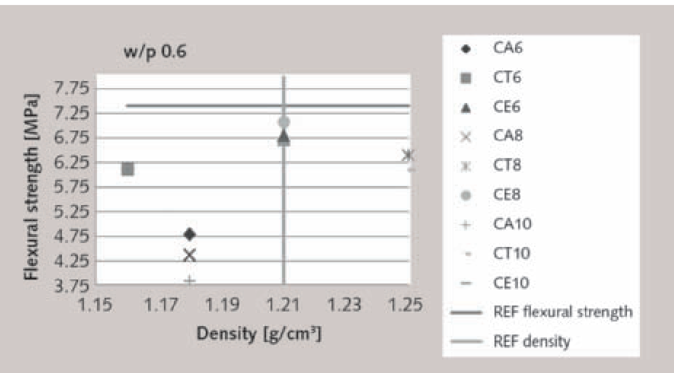
The compressive strength in samples with CA and CT were much smaller than the reference (49 % for CA and 43 % for CT). By contrast, results from the CE series increased in all the cases, achieving the maximum increase (33 %) with CE 0.6.

As shown in Figures 11 and 12, no relation was found between the density and the compressive strength for both the 0.8 and 0.6 w/p series. However, it is seen that low compressive resistances imply low densities.

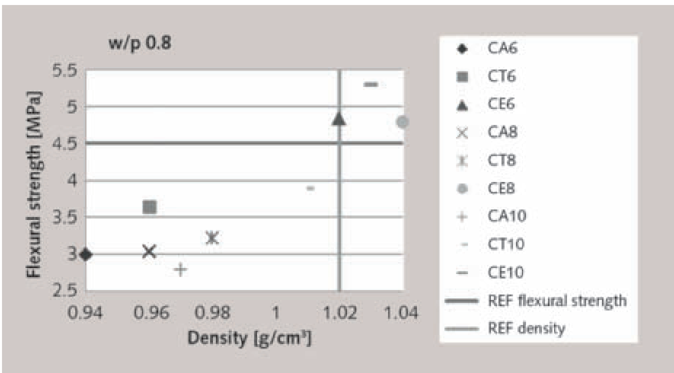
4 Conclusion

From the methodology used and the results obtained the following conclusions can be drawn:

- In composites with 0.6 w/p ratio, the maximum percentage of entire rice husk waste (CA) accepted by the mixture is 6 % – by weight of plaster. A higher content of entire rice husk (CA) exceeds the volume of the plaster and thus the workability of the composite worsens. Samples with rice husk ash (CE) can accept up to 8 %, as the series with 10 % of addition do not meet the minimum workability requirements. Finally, samples using shredded rice husks (CT) can accept larger additions around 10 %. By contrast, more than 10 % of rice husk can be added in composites with greater water proportions (0.8 w/p ratio), as a fluid consistency is achieved with the three types of rice husk (CA, CT and CE) analyzed.
- Incorporating CA into a plaster matrix can reduce up to 6 % the density of the composite compared to the reference sample.
- In general, the surface hardness increases in all the compounds except one (CT 0.6 with 6 % of addition). In particular, CE compounds can be highlighted as they reach the highest increase (up to 12 % compared to the reference)
- For composites with 0.6 w/p ratio, flexural strength decreases as the percentage of added rice husk waste rises – in all three formats (CA, CT and CE). In general, the loss of flexural resistance is related to the decrease in density. However, all CE samples with 0.8 w/p ratio increased around 18 % the flexural strength compared to the reference. All the composites surpassed 1.0 MPa, i.e. the minimum requirement set by the regulation.
- Additions of rice husk ash (CE) – with both w/p ratios – overcome the compressive resistance. This increase is ranged from 17 % to 32 % compared to the reference sample. Samples with



7 **Relation between density and flexural strength (0.6 w/p ratio)**

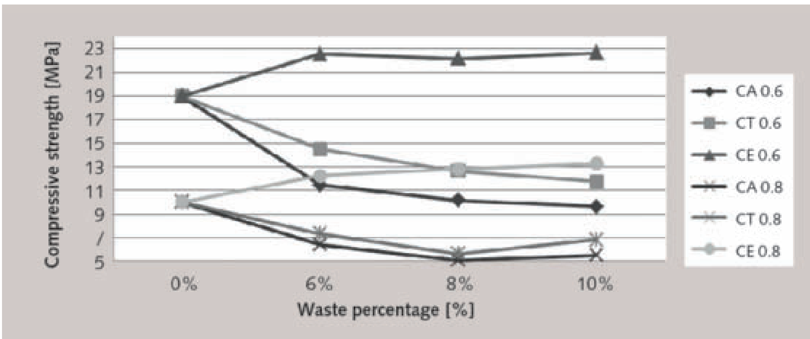


8 **Relation between density and flexural strength (0.8 w/p ratio)**

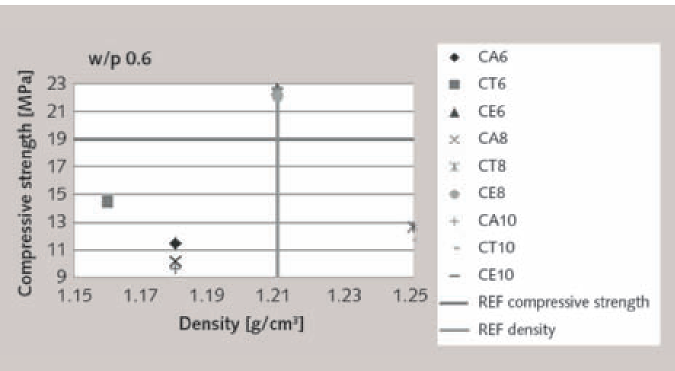
9 CT sample fracture due to flexural strength

CA and CT rice husk decrease the compressive strength between 24 % and 50 % (minimum and maximum values). All the composites reached the minimum compressive strength required by the standard (2 MPa).

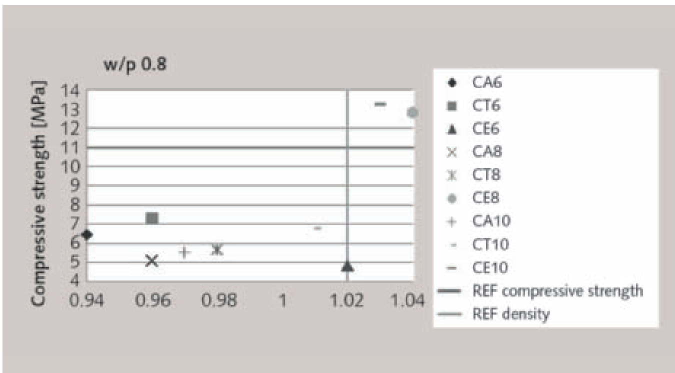
Finally, in view of the results obtained, the plaster compounds studied in this research, incorporating rice husk waste in three different formats (entire, shredded and ash) can be a viable alternative to lighten and reinforce the currently used plaster products and materials.



10 Compressive strength results



11 Relation between density and compressive strength (0.6 w/p ratio)



12 Relation between density and compressive strength (0.8 w/p ratio)

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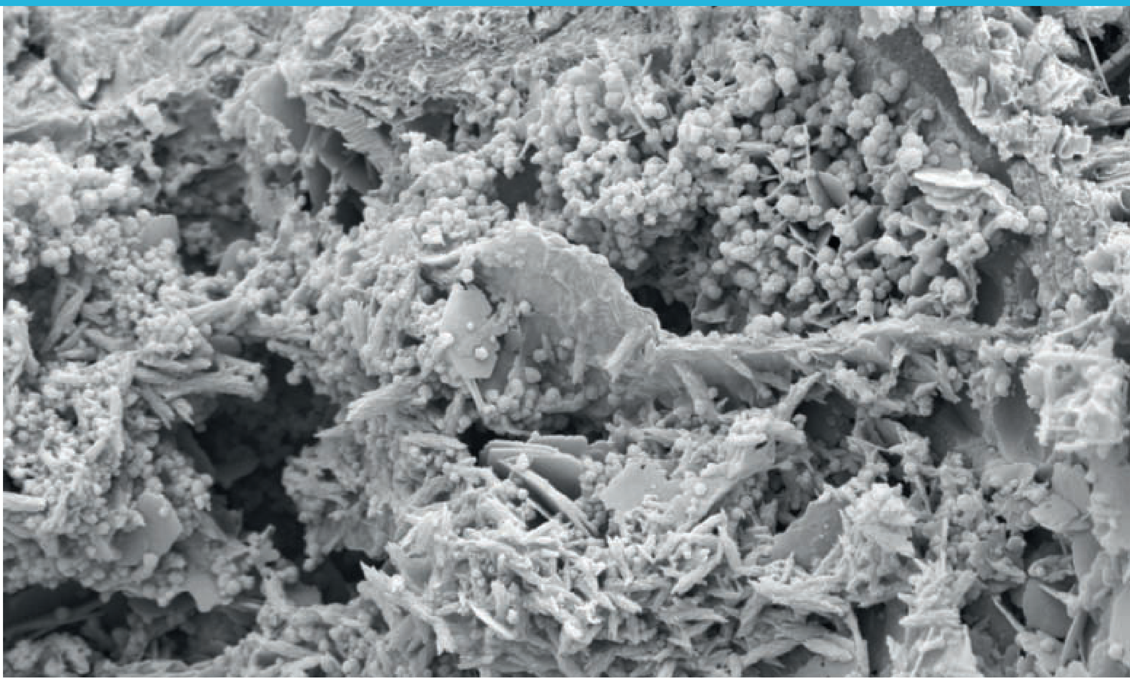

The influence of mechanical and chemical activation on the mechanical properties of high-density concrete and cement mortar has been studied. Portland cement optimum content necessary for apparent increase in the mechanical properties of cement composites has been determined. The size-content study of the mechanically and chemically activated cement has been undertaken. The heat emission development of the mortar based on activated binder has been studied by means of calorimetric measurements. It has been demonstrated that increase in concrete hardening after the activation originates from formation of the cement fine-crystalline structure. According to the elemental analysis data, hydrated calcium silicates (CSH) are developed in spherical globules.

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The influence of binder modification by means of the superplasticizer and mechanical activation on the mechanical properties of the high-density concrete

1 Introduction

The mechanical properties of cement composites are dependent on the application efficiency of the binder's properties [1-3]. A higher level of the efficiency can be achieved by various means of binder activation [4]. The hydration process quickens and the activity of the binder increases due to fine powdering of cement. Qian J. et al. [5] note that strength properties of fine-ground cements with milling fineness more than 5000 cm^2/g do not differ at any age of the hardening period to some significant extent (the 2nd day hardening compressive strength increases by 5 – 10 %, but the 28th day compressive strength is similar despite the increase in milling fineness). In view of economic and technological feasibility the optimum milling fineness is believed to be of 4000 – 5000 cm^2/g.

Nowadays a variety of technologies of cement binding materials dispersion and activation in a liquid medium are being developed. With the appearance of rotary-pulsing apparatus (RPA) we have gained the ability to activate the cement-water suspension directly in RPA [4]. But the technology providing cement-water suspension activation has not become a frequent practice due to under-investigated issues of mechanical activation influence on rheology and structure formation of cement-based systems.

Sajedi [6] notices that mechanical activation of the cement suspension at initial stage of hydration and structure formation leads to an increase in volume of the chemically active coagulation medium and its consolidation which results in 30 % strength increase. In [7], it has been noted that by mechanical activation of the cement suspension by means of RPA, the strength of cement rock at 1 day increases by 70 %. It has also been noted that the activation should be conducted during concrete preparation, since the cement grains with sizes of 40 – 60 µm and bigger remain unhydrated. This worsens due to difficulties in even water distribution between separate particles of binding material. The aggregation of the separate particles in floccules caused by the adsorption and molecular cohesive force takes place and prevents homogenous wetting.

Currently there is a lack of data relating to the optimum content of activated cement and to the influence of mechanical and chemical activation MCA and mechanical activation (MA) parameters on the cement composites strength. Also there are ambiguous data about the influence of MCA of cement suspension on cement mortar heat emission development and the grain size composition of the activated cement. The impact of highly active superplasticizers on the properties mentioned above has not been studied sufficiently.

2 Experimental procedure and results

In relation to these facts, the author have undertaken a study to estimate the MCA basic parameters for cement suspension to obtain high-strength cement mortars and high quality concrete by means of RPA 0.8-55A-2.2УЗ manufactured according to ТУ 5132-001-70447062.

The experiment was conducted in the following manner: in preparation estimated amounts of cement and water were mixed and then loaded into an RPA hopper for activation.

The influence of the partial replacement of activated Portland cement on the mechanical properties of cement mortar with content 1:3 has been defined. Portland cement CEM III/A32.5 N satisfying the requirements of GOST 31108-2003 (EN 197-1), enriched sand with fineness modulus 2.7, naphthalene formaldehyde superplasticizer “Реламикс Т-2”, manufactured according to ТУ 5870-002-14153664-04 at a rate of 1 % were used for the experiment. Water-to-cement ratio for each composition is equal to 0.355. The composition with the additive being investigated without mechanical activation was taken as a control sample. The bending strength test has been undertaken according to GOST 30744-2001 “Methods of testing using polyfraction standard sand”. The experiment results are shown in Table 1.

As seen from Table 1 with increase in the activated cement content, strength properties rise at an early stage of hardening and at 28 days as well. The highest growth in bending strength is observed in composites where all cement was exposed to activation. The strength growth accounts for 98 % at 1 day, 24 % at 3 days and at 28 days it does not differ significantly from the control sample. The highest growth in compressive strength has been observed in compositions where 100 % of Portland cement was exposed to activation and it accounts for 82 % at the 1st day of hardening, 24 % at the 3rd day and it shows no significant difference at the 28th day in comparison with composition with non-activated cement. Despite this it has been accepted to activate 50 % of cement in further investigation due to the fact of the increased equipment wear rate and decreased cement activation efficiency. The efficiency of cement dispersion by means of rotary-pulsing apparatus rises significantly in the presence of surfactants: the concrete density grows and strength rises sharply, especially at the 1st day of moist curing.

Table 1 The influence of a part of activated portland-cement on the mechanical properties of cement mortar

Activated cement content (%)	Bending strength (MPa) at the period of:			Compressive strength (MPa) at the period of:		
	1 day	3 days	28 days	1 day	3 days	28 days
–	1.47* / 100%	4.2* / 100%	5.93* / 100%	6.04* / 100%	19.67* / 100%	40.32* / 100%
25	1.88 / 128%	4.56 / 109%	6.05 / 102%	8.21 / 136%	21.82 / 111%	42.15 / 104%
50	2.52 / 171%	4.81 / 120%	6.17 / 104%	9.91 / 164%	23.44 / 119%	43.47 / 108%
75	2.74 / 186%	5.13 / 122%	6.23 / 105%	10.2 / 169%	24.21 / 123%	43.94 / 109%
100	2.92 / 198%	5.24 / 124%	6.25 / 105%	11.02 / 182%	24.57 / 125%	44.33 / 110%

*: the average rate is shown above the line; relative rate is show under the line (relating to the control sample in %)

№	Additive content (%)	Flow-test spread (mm)	MA period (min)	Water to cement ratio	Average density of concrete (kg/m³)	Compressive strength (MPa) at the period of:		
						1st day	3rd day	28st day
1	–	108	–	0.42	2420	8.13* / 100%	23.2* / 100%	42.8* / 100%
2	1	108	–	0.31	2472	15.0 / 185%	39.2 / 169%	59.8 / 140%
3	1	108	2	0.31	2492	28.4 / 349%	59.4 / 256%	71.2 / 166%

*: the average rate is shown above the line; relative rate is show under the line (relating to the control sample in %)

Table 2 The influence of MA of cement suspension on hardening development of high-density concrete

In order to prove the achieved results, the influence of MCA of cement suspension in the presence of additive “Реламикс Т-2” on the mechanical properties of high-density concrete has been studied.

The experiment was conducted in the following manner: in preparation 50% of the cement was mixed with water containing the superplasticizer “Реламикс Т-2” on amount of 1% by cement weight and then the cement suspension was exposed to MA by means of RPA during two minutes. Then coarse and fine aggregates and the rest of the cement were added to the obtained suspension and mixed by means of a concrete-mixer during 5 minutes. The following concrete composition was taken for the study: cement 490 kg, sand 555 kg, aggregates 1315 kg. Water content was being corrected to achieve a similar consistency for the concrete mixtures (with slump of concrete cone 7 – 9 cm) in all compositions. Cubical shaped samples with a side length of 10 cm were exposed to tests according to GOST “Concretes. Methods for strength determination using reference specimens”. The flow-test spread has been estimated according to GOST 310.4-81 “Cements. Methods of bending and compression strength determination”. The experiment results are shown in Table 2.

As seen from the results in Table 2, the insertion “Реламикс Т-2” (composition 2) leads to increase in concrete strength by 85% at the 1st day of hardening (from 8.1 MPa to 15 MPa), by 69% at the 3rd day (from 23.2 MPa to 39.2 MPa), and by 40% at the 28th day (from 42.8 MPa to 59.8 MPa) in comparison with the control sample. The strength increase accompanies concrete density growth (by 2%) in each period of hardening.

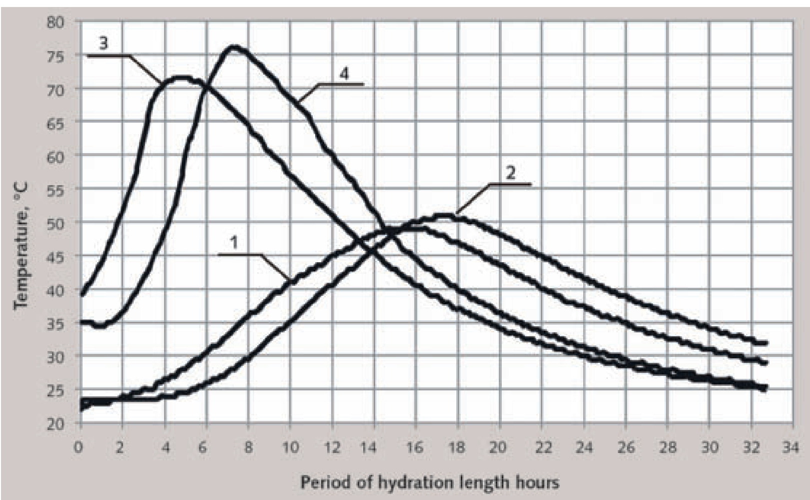
The more considerable increase in compressive strength of concrete is reached by means of MCA of cement suspension in the presence of “Реламикс Т-2” (composition 3). In this case the increase in concrete strength accounts for 249% at the 1st day of hardening (from 8.1 MPa to 28.4 MPa), 156% at the 3rd day (from 23.2 MPa to 59.4 MPa), and 66% at the 28th day (from 42.8 MPa to 71.2 MPa). The strength increase accompanies concrete density growth (by 3%) in comparison with the control sample.

Thus, efficiency of cement dispersion by means of rotary-pulsing apparatus in the presence of superplasticizer increases considerably: the concrete density grows and strength rises sharply, especially at the 1st day of moist curing which is probably connected with the specific character of cement microstructure formation. The cement mortar heat emission development has been studied by means of calorimetric methods. Water-to-cement ratio of each composition accounts for 0.42. The experiment results are given in Figure1.

It is seen from Figure 1 that MA of cement suspension leads to an increase in hydration temperature by 20-25 C^0 while a sharp left-side motion of the temperature peak occurs which indicates intensification of cement mortar hydration.

In the presence of “Реламикс Т-2” without mechanical activation some hydration retardation occurs at early periods of hardening, but in the composition exposed to MA sharp growth in hydration and increase of temperature peak by 25 C^0 also takes place.

The particle size distribution in cement was estimated on samples obtained after hydration without MCA of cement mortar and after MCA. The estimation was undertaken by means of particle size laser analyzer “Horriba La-950V2”.



All Ibragimov

1 Cement mortar heat emission development:
1- control sample;
2- composition modified with “Реламикс Т-2”;
3- composition with no additive exposed to MA; 4- composition modified with “Реламикс Т-2” exposed to MCA

№	Cement size-content	Average particle size (μm)	Specific surface area (cm²/g)	Fractional yield (%), with size of (μm)				
				<20	20-40	40-60	60-80	>80
1	cement	43.87	3783.34	40.27	18.43	13.95	7.21	20.14
2	control	49.47	3246.62	40.79	18.31	14.06	7.6	19.24
3	control activated	40.35	3563.56	54.01	21.12	10.41	8.74	5.72
4	T-2	47.25	3316.21	42.28	19.28	12.86	7.76	17.82
5	T-2 activated	17.10	4278.4	73.68	24.45	1.87	–	–

Table 3 The specific surface area and particle size distribution

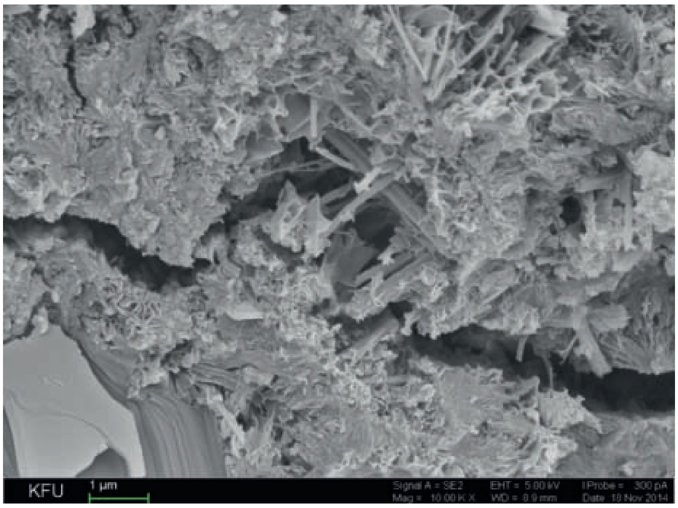
Removal of water from cement minerals and cement, which is active in a liquid medium, and was done by means of a Buchner filter jointed with a water jet pump. Immediately after separation of liquid phase, samples on the filter were filled with pure alcohol and then were preserved in acetone given that the amount of acetone was at least in 5 times bigger in comparison to the weight of the cement sample. After that material was dried in a cabinet dryer at a temperature of 105 C⁰. The cement specific surface area was estimated on preparatory dehydrated and dried cement samples according to the method described above by means of the Cozini-Karman method (ПСХ-9 device). The experimental results are given in Table 3.

Particle size distribution in samples: 1- pure Portland cement; 2- composition with no additive exposed to MCA; 3- composition with no additive, 4- composition with "Реламикс Т-2" exposed to MA; 5- composition with "Реламикс Т-2".

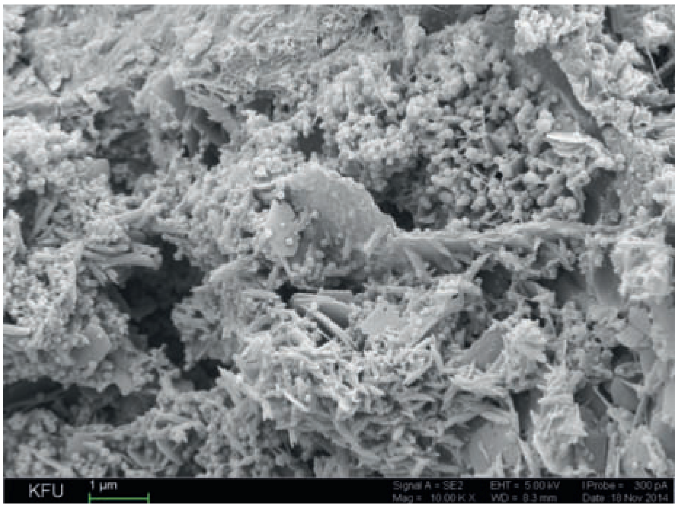
As seen from the data provided above the specific surface area of cement exposed to MA increases by 10 % in comparison to the control sample. With insertion of "Реламикс Т-2" in the cement suspension exposed to MA the cement specific surface area grows by 29 % in comparison to the composition modified with "Реламикс Т-2" without MA.

The structure of cement rock has been studied by means of an electron microscope equipped with an energy dispersic spectrometer AZtec X-MAX.

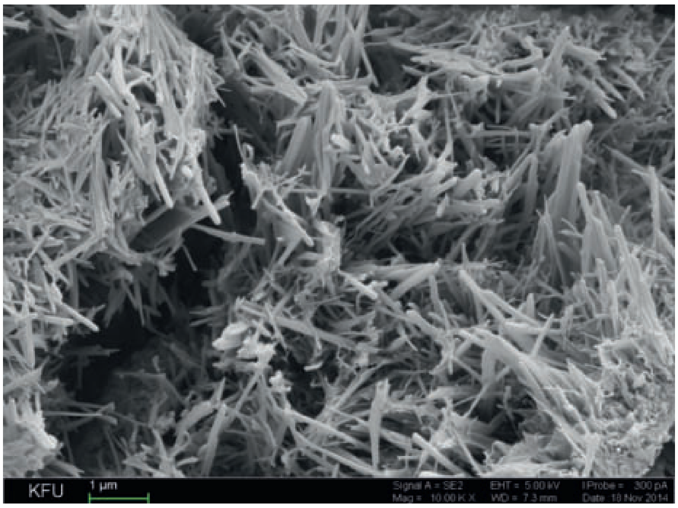
2 Electron microscopy photography of samples under study, magnification 10000x



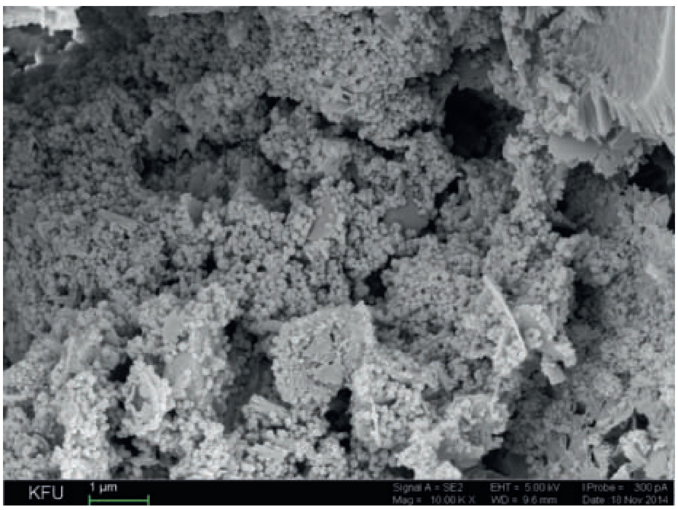
a) control sample



b) control sample exposed to MA



c) composition with "Реламикс Т-2"



d) composition with "Реламикс Т-2" exposed to MCA

Spectrometer resolution is equal to 127 eV. Surface morphology photography was taken at accelerating voltage of 5 keV. Elemental analysis was done at accelerating voltage of 20 keV with focal length of 9 mm, penetration depth less than 1 mm. The cement rock split sample was taken and covered by means of high-vacuum unit Quorum T150 ES with Au/Pd alloy coating provided on the sample in ratio 80/20. The electron microscopy photography is given in Figure2.

As seen from Figure 2 the control sample is represented with a microfissured coarse crystalline structure. With MA of cement suspension, formation of microcrystalline structure is observed. According to elemental analysis data, hydrated calcium silicates (CSH) are formed in spherical globules. Insertion of platicizing additive leads to formation of hydrated calcium aluminate sulfate in cement rock pores which accelerates concrete strength development at an early stage of hardening (composition C). MCA of modified cement suspension (composition with “Реламикс T-2” exposed to MCA) leads to the formation of a highly microcrystalline structure of cement rock and spherical globules of hydrated calcium silicates in bigger amount and smaller in size in comparison to the composition B which causes higher mechanical properties of cement composites.

3 Conclusions

» Positive influence of MCA of cement suspension in the presence of superplasticizer on the mechanical properties of the high-density concrete has been proven. The increase in concrete strength accounts for 249 % at the 1st day of hardening and 66 % at the 28th day in comparison with the control sample

» Under condition of MCA of cement suspension with insertion of superplasticizer and without it, sharp acceleration of heat emission development occurs and growth of temperature by 20-25 C⁰ takes places in comparison to the control sample

» Particle size distribution of cement samples hardened in standard conditions and after MCA exposure has been estimated. The specific surface area of cement suspension exposed to MCA increases by 10-29 % in comparison to the control sample

» MCA of modified cement suspension leads to formation of highly microcrystalline structure of cement rock and spherical globules of hydrated calcium silicates in bigger amount and smaller in size in comparison to the control sample exposed to MCA with no “Реламикс T-2”. This causes higher mechanical properties of cement composites

» MCA of cement suspension leads to sharp growth of strength of cement mortars and concretes, especially at an early stage of hardening which is relevant to cast-in-place construction and also enables the achievement of higher final strength of concrete. Formation of microcrystalline structure of cement rock makes conditions for increase in the durability of obtained composites

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Rapid water loss is one of the important characteristics of thin layer mortar. The testing methods, such as the velocity of water migration, the strength of interfacial bonding, XRD, SEM, FTIR and TG-DSC-DTG were used to research the interface and microstructure of thin layer mortar with continuous moisture migration from the thin layer mortar to aerated concrete. The results show that the rate and the amount of water migration on the interface from mortar to substrate dropped significantly with the increase of viscosity of mortar. There was also a good corresponding relation on the tensile bond strength of the interface and mortar viscosity, which means that the interface bonding strength increased with the increase of the viscosity of mortar.

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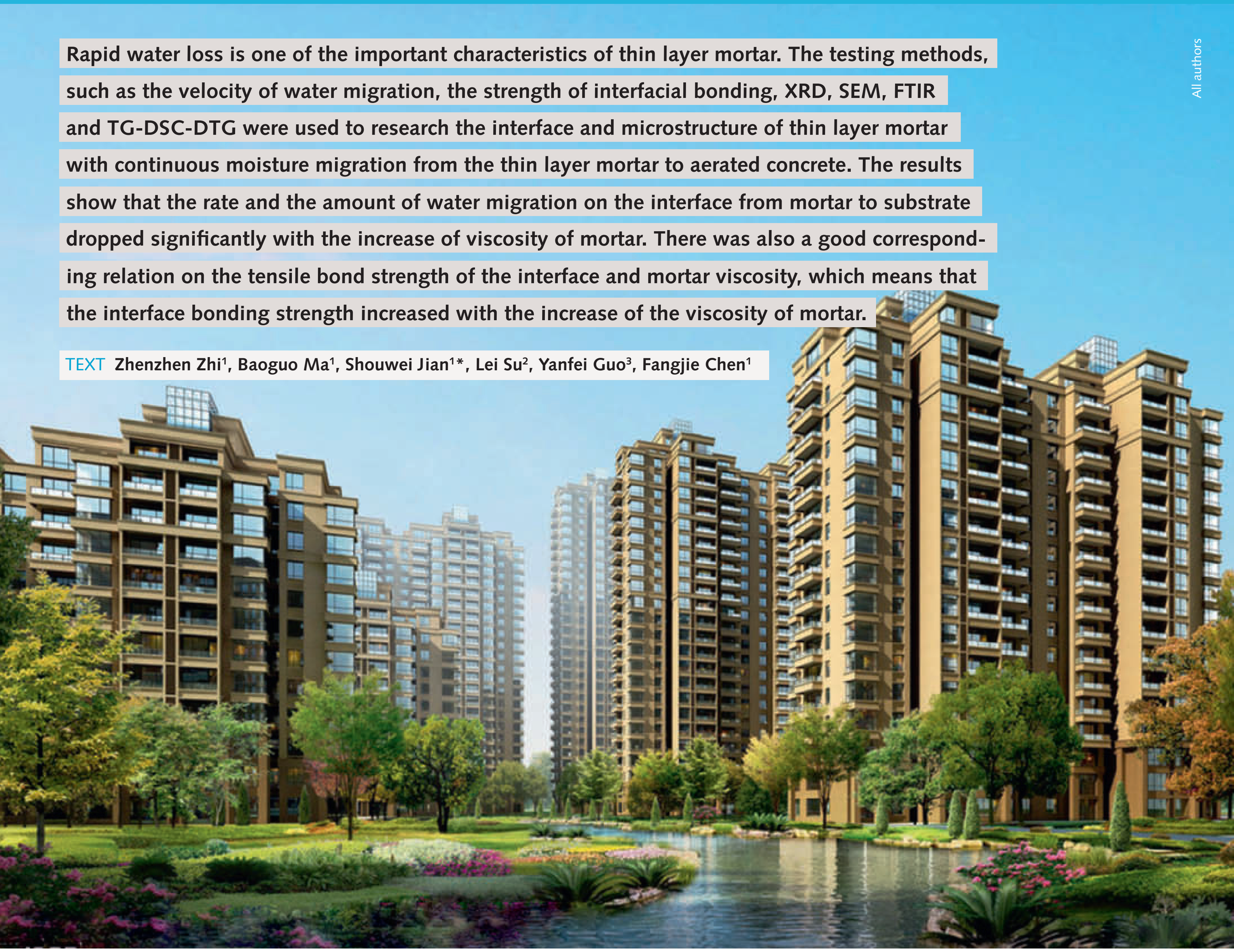

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Research on the interface and microstructure of thin layer mortar

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1 Introduction

Thin layer mortar has been mostly considered as a special mortar, which possesses high water-cement ratio and high area/volume ratio [1].The common problem of the thin layer mortar system is that the a high proportion of water in thin layer mortar will be absorbed by the super absorbent matrix materials [2], then the thin mortar hardens rapidly in a short time due to the rapid loss of water, so the hydration degree is less, even less than 30 %; this has serious effect on the use and service life of construction.

Cellulose ethers (CE), with properties of water retention, thickening and so on, are widespread admixtures introduced into mortar formulations to improve the workability, the process of cement hydration, harden microstructure and other aspects [3-4]. The viscosity of thin layer mortar modified with cellulose ether is increased, which contributes to good flowability of paste and enhanced mechanical strength of the final hardened paste. The well-known cellulose ethers applied in practice are hydroxyethyl methyl cellulose (HEMC) and hydroxypropyl methyl cellulose (HPMC) [5-6]. Many researchers studied the effect of cellulose ethers on mortars from different aspects. Pourchez [7] et al analysed the influence of HPMC and HEMC on cement hydration by adding different dosages of admixtures. Wyrzykowski [8] et al investigated the microstructure of porosity variety of the cementitious matrix with addition of cellulose ethers through mercury intrusion porosimetry.

The previous work showed different results on the hydration process. Ma [9–11] et al researched the early stage hydration process of cellulose ether modified mortar mainly through analyzing the hydration heat, the content of $Ca(OH)_2$ and XRD of the mortar with different dosages and kinds of CE. Based on the above views, this article deals with the study of the properties of interface thin layer mortar modified with cellulose ether with different viscosities, which are rarely reported in the early researches, by dehydrating velocity, FTIR, DTG and SEM.

2 Experimental

2.1 Raw materials

The cement used in this work was Portland cement produced by the HuaXin Cement Company of Hubei province, in accordance with the Chinese standard GB 175 Type II (PII42.5). It has a mean grain size of 16.17 µm and mass density of 3.15 g/cm^3. The physical properties and chemical composition of cement are given in Table 1 and Table 2.

The HPMC was an America Hercules Group Company product. The viscosity of HPMC is 1 000 000 m Pa•s in a concentration of 2 % at 25 °C. Aerated concrete was used as the super absorbent matrix material. The physical properties are given in Table 3.

2.2 Experimental process

The samples for the experiments were modified cement paste material to add different dosages of HPMC with a water-cement ratio of 0.4. Samples were formed with self-made mould. The size of mould are 40 mm x 40 mm x 6 mm. Preservative films were put on the surface of samples to prevent water evaporation. The curing temperature of cement ingredient was (20±5) °C and humidity 65 % R.H. Samples were maintained for 3, 7 and 28 days respectively before being tested. The structural sketch is given in Figure 1.

2.2.1 Tensile strength

Tensile adhesive strength between interface and modified thin layer cement mortar was measured at 3, 7 and 28 days according to standard JCT985-2005 “Cementitious self-leveling floor mortar” by a testing machine.

2.2.2 Dehydrating velocity

Dehydration velocity of interface thin layer mortar is based on Equation 1:

$$P=(Mt_1-Mt_2)/(t_2-t_1)\cdot S \qquad (1)$$

P: dehydration rate (g min^{-1} m^{-2})
Mt_1: sample quality of t_1 (g)
Mt_2: sample quality of t_2 (g)
S: sample area (m^2)

2.2.3 Slurry viscosity

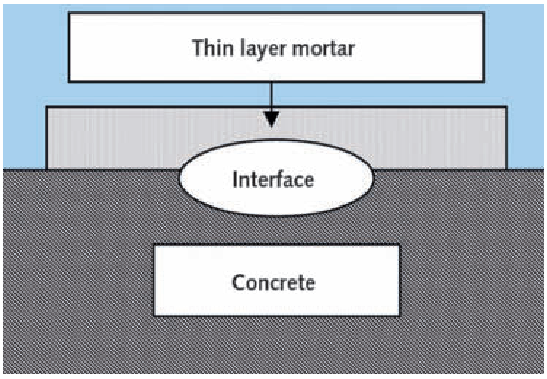
The viscosity of thin layer mortar was tested by the R/S.SST paddle rheometer. Shear stress ranged from 6 to 200 Pa, the test date processing used Rhe02000 software.

2.2.4 Chemical combined water content

Configured cement paste samples were sealed in plastic bags and maintained in a temperature and humidity conservation box for a defined period. Next, the samples were hydrated in ethanol. The paste block was then comminuted to particles of less than 1mm in diameter, after which 5 g samples were dried for 2 hours at 105°C to eliminate the physically bonded water. Finally, the samples were fired to constant weight at 1050°C. Chemical combined water content based on Equation 2:

$$W = \left[\frac{M_1 - M_2 - \omega_s M_1}{M_1} (100-\omega_1) - \omega_1 \right] x\,100\,\% \qquad (2)$$

W: chemically combined water content (%)
M_1: hardened cement paste quality before ignition (g)
M_2: hardened cement paste quality after ignition (g)
ω_1: loss on ignition of cement paste (%)
ω_s: dosage of admixture (%)



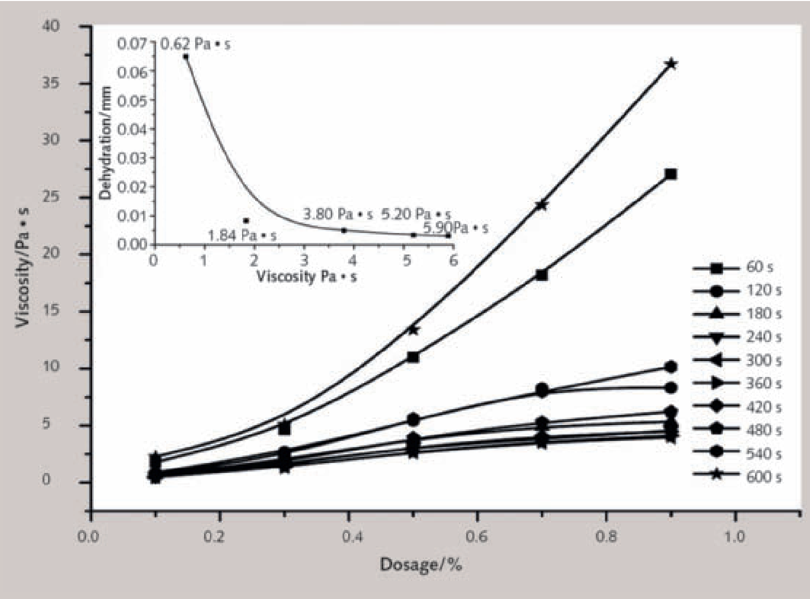
1 Structural sketch

Table 1 Physical properties of cement

Fineness 80 µm (%)	Water content for standard consistency (%)	Time of setting (h)		Compressive strength (MPa)		Flexural strength (MPa)	
		Initial	Final	7 d	28 d	7 d	28 d
2.80	25.80.	3.26	4.55	25.46	42.58	6.3	9.4

Table 2 Chemical composition of cement

Composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	TiO_2	SO_3	LOI
Mass fraction (%)	21.04	6.94	2.36	61.27	1.32	0.19	1.94	3.76



2 Curves of thin layer cement paste modified with cellulose ether viscosity between dehydration and dosage of cellulose ether

2.2.5 Micro measurements

Qualitative analysis of phases was carried out by a Japan D/Max-RB X-ray diffractometer. FTIR spectra were taken in a Perkin Elmer Nexus spectrometer. Powdered samples were mixed with KBr and pressed into pellets. The analyses were carried out in the frequency range of 400–4000 cm^{-1}, using 4.0 resolution and 128 scans. For the thermal analyses, a Netzsch STA 449PC, a simultaneous Thermogravimetry (TGA) and Differential Scanning Calorimetry (DSC) system, was used. The samples were heated from room temperature to 1000 °C with a heating rate of 10 °C/min in a N_2 atmosphere (60 ml/min). The microstructure of the cement pastes was investigated with a Japan D/Max-RB Scanning Electron Microscope (SEM).

3 Results and discussion

3.1 Viscosity and dehydration of interface

The relationship of thin layer cement paste viscosity, dehydration and cellulose ether dosage are shown in Figure 2. It can be seen that the viscosity of thin layer modified mortar gradually increased and the dehydration decreased with increase of cellulose ether dosage.

The thin layer cement paste modified with cellulose ether between dehydration velocity and hydration time is shown in Figure 3. With the hydration continuing, the dehydration velocity of thin layer cement paste modified with cellulose ether at the interface gradually slows down. During the first six minutes after mixing, the dehydration velocity is decreased linearly and the latter flattens. The viscosity of thin layer cement paste decreased to the bottom at six minutes after mixing, and then increased rapidly. Because the water retention of cellulose ether did not completely work in early hydration, after six minutes, on the one hand, the matrix absorbed lots of water from the thin layer cement paste; on the other hand the cellulose ether function enhanced the viscosity of the thin layer cement paste to retain the water. Studying the relationship between viscosities and dehydration velocity can find that the variation trend of the dehydration velocity of thin layer cement paste modified with cellulose ether at the interface decreased first and then increased.

3.2 Viscosity and tensile bond strength

The dependence of tensile bond strength on viscosity and ages is given in Figure 4. The tensile adhesive strength between the aerated concrete matrix and the thin layer mortar increased with both viscosities and times increased. According to analyzing curve of 3 days, the tensile adhesive strength linearly increased with the increasing of the viscosity, while after 7 days and 28 days, the trend stabilized to 2.62 MPa.

3.3 Micro-analysis

3.3.1 XRD analysis

Figure 5 shows the XRD analysis of thin layer cement paste with different viscosities and times. It can be seen that the main minerals in hardened cement paste include $Ca(OH)_2$ and C_3S; the diffraction peak of $Ca(OH)_2$ in 18°and the diffraction peak of C_3S appear in 34° and 29° respectively. Compared to the XRD diffraction of the same period and different viscosities, the diffraction peak intensity of $Ca(OH)_2$ decrease with the increase in viscosity. Due to the dosages of HPMC increased, which delayed the hydration process, the viscosity of the thin layer mortar increase, but the production of $Ca(OH)_2$ and C_3S decrease.

However, compared to XRD diffraction of 3 d, 7 d and 28 d, with the extension of age, the thin layer cement paste hydration could fully, thus the intensity of the diffraction peaks of ettringite, $Ca(OH)_2$ and C_3S all increase.

3.3.2 FTIR analysis

Figure 6 presents FTIR analysis of thin layer cement paste. The most remarkable feature of the FTIR spectrum is its peak changes. With the extension of age, the characteristic peak of Si-O shifted from a high wavenumber to a low wavenumber(874 cm^{-1} to 978 cm^{-1}), due to the polymerization of SO_4^{2-} units during C-S-H formation. The characteristic peak of OH^- which are associated with the formation of $Ca(OH)_2$ appeared at 3640 cm^{-1}. Because of the Si-O stretching vibrations in Q1 sites, all cement paste samples had a characteristic peak around 850 cm^{-1} and the intensity of the characteristic peak increased gradually. The position of S-O band appeared at 1150 cm^{-1}, due to early formation of ettringite. The characteristic peak of CO_3^{2-} was at 1450 cm^{-1}.

Compared to the same age and different viscosities of samples, with the viscosity increased, the positions of $Ca(OH)_2$ and Si-O characteristic bands shifted to higher wavenumbers and the intensity of these peak decreased, then these peaks gradually decreased. When the viscosity is 5.90 Pa•s, the vibration peaks of OH at 3640 cm^{-1} and (Si-O)Q1 at 850 cm^{-1} were not obvious. This showed that thin layer cement paste modified with cellulose ether not only delayed the process of cement paste hydration, but also changed the structure of C-S-H during cement hydration. The larger the viscosity, the more it decreases obviously.

3.3.3 Differential thermal analysis

The thermal analysis results of thin layer cement paste are given in Figure 7. Applying thermal analyses for the assessment of the Portland cement hydration processes has proved very useful [12-13]. It is known that tricalcium silicate (C_3S) and dicalcium silicate (C_2S) are the main mineralogical components of Portland cement [14]. With the mortar hydration, endothermic effects with the maximum at 462.9 °C correspond to portlandite decomposition which was generated by $Ca(OH)_2$ heating. Endothermic effects accompanied by the mass loss which occurs with the maximum at 737.9 °C correspond to the decarbonation of $CaCO_3$ [15-16].

By comparing DTG curves of samples with different viscosities, it can be seen that the trend is similar. There was only a small difference in the intensity of the endothermic peaks, this decreased with the increase of the viscosity of mortar. The addition of cellulose ether showed an effect of slower hydration processes and lesser $Ca(OH)_2$ content compared with the control sample. According to the mass variation of TG curves between 420 ~ 460 °C and 105 ~ 1000 °C, the proportions of $Ca(OH)_2$ and chemically combined water are shown in Table 4.

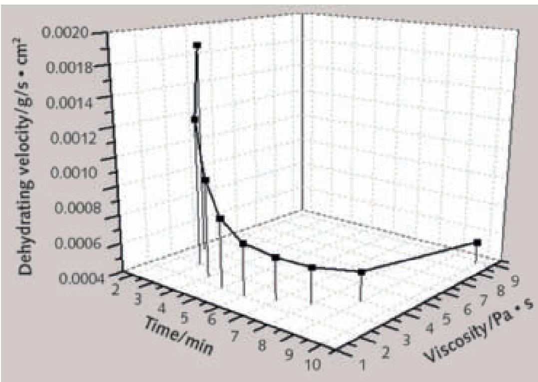
The results of the measurements of content of $Ca(OH)_2$ and chemically combined water of thin layer cement paste are shown in Table 4. With the viscosity increasing, the content of $Ca(OH)_2$ in cement pastes and chemically combined water gradually decreased. The higher the viscosity of the cement paste, the greater its impact on the setting time and initial hardening rate. After 3 days of hydration, the cement paste viscosity of 5.90 Pa•s, in which 4.83 % $Ca(OH)_2$ was 60 % less than the 7.78 % $Ca(OH)_2$ in the con-

Table 3 Physical properties of matrix material

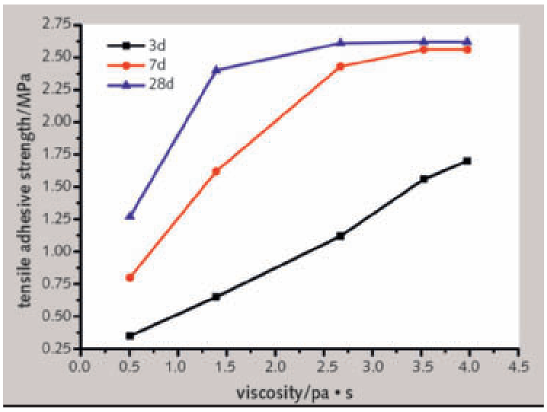
Matrix material	Water absorption of 24h (%)	Porosity (%)	Volume weight (kg/m^3)
Aerated concrete	35	60	615

Table 4 Content of $Ca(OH)_2$ and chemical combined water of thin layer cement paste modified with cellulose ether

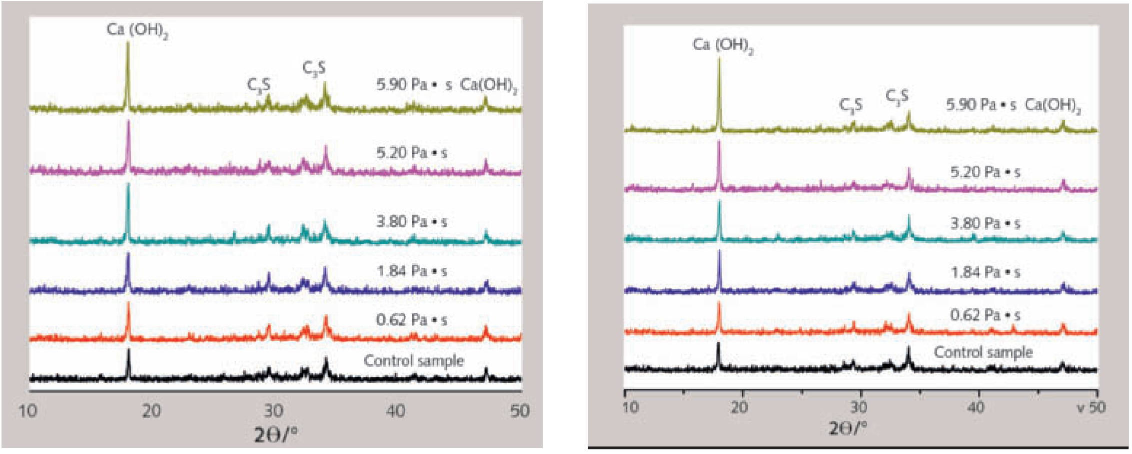
Viscosity (Pa•s)	Content of $Ca(OH)_2$ (%)			Content of chemical combined water (%)		
	3d	7d	28d	3d	7d	28d
Control sample	7.78	8.05	8.71	11.30	13.55	15.40
0.62	7.48	7.81	8.35	11.26	13.42	14.99
1.84	6.43	6.83	8,04	11.25	13.28	14.81
3.80	5.94	6.57	7.74	11.12	13.19	14.80
5.20	5.04	6.41	6.88	10.97	13.12	13.93
5.90	4.83	5.61	5.71	10.58	13.08	13.74



3 Curves of thin layer cement paste modified with cellulose ether between dehydrating velocity and hydration time

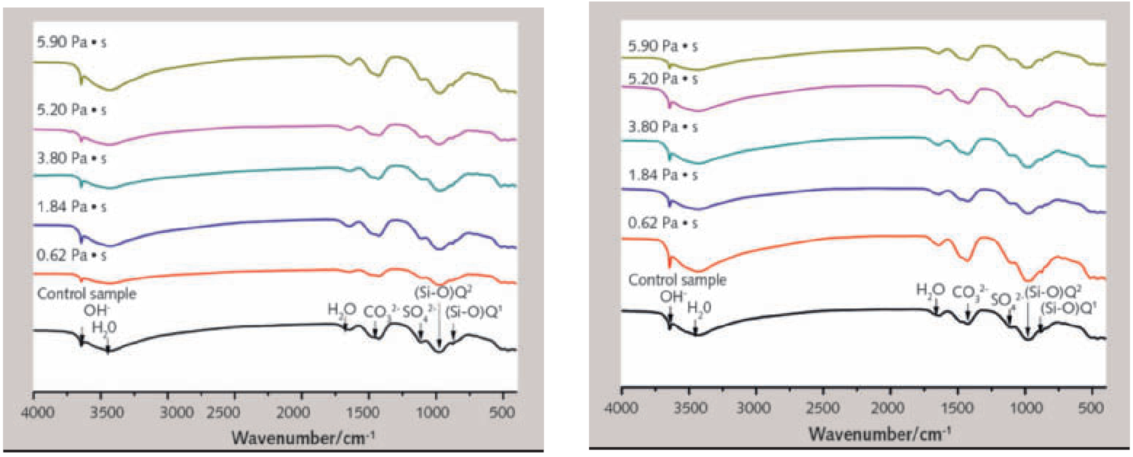


4 Curve between tensile bond strength and viscosity of thin layer cement paste modified with cellulose ether



3d 7d

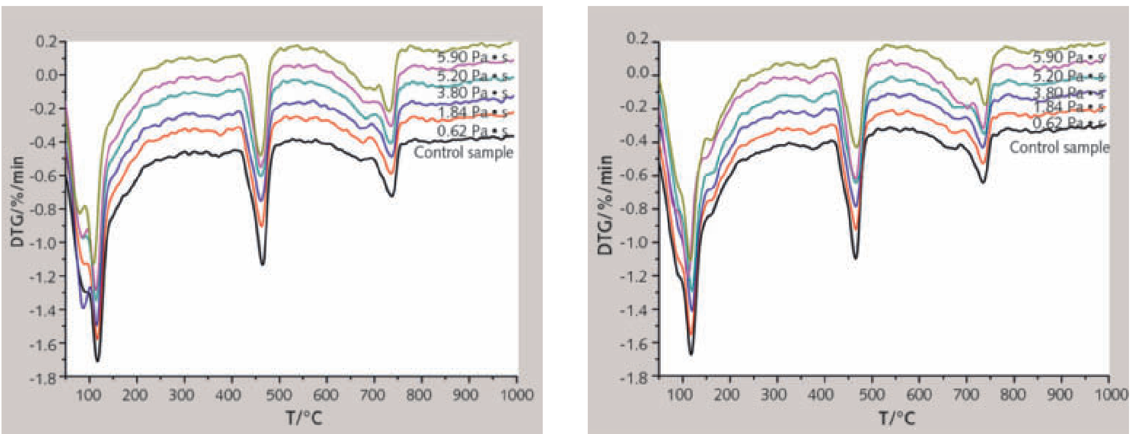
5 **XRD spectrum of interfacial transition zone between thin layer cement paste modified with cellulose ether and aerated concrete**



3d 7d

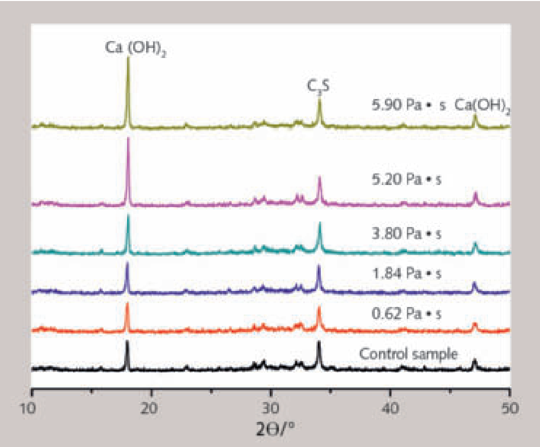
6 **FTIR spectrum of thin layer cement paste modified with cellulose ether**

trol sample and the content of chemically combined water was 10.58 % in the viscosity of cement paste which was 5.90 Pa•s less than that in the control sample with 11.30 %. After 7 days of hydration, the $Ca(OH)_2$ content had decreased by 43 % (control samples) to a viscosity of 5.90 Pa•s. After 28 days of hydration, the decrease amounted to 46 %. It can also be seen that the content of $Ca(OH)_2$ and chemically combined water obviously increased as the mortar hydration continues. Compared to the 3 days ,7 days and 28 days of hydration, there are big differences of content of $Ca(OH)_2$ and chemically combined water. The contents of $Ca(OH)_2$ of the control sample are 7.78 %, 8.05 % and 8.35 % respectively and the contents of chemically combined water

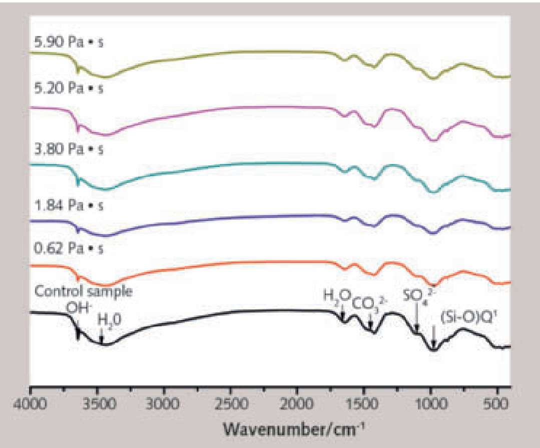


3d 7d

7 **DTG spectrum of thin layer cement paste modified with cellulose ether at different ages**

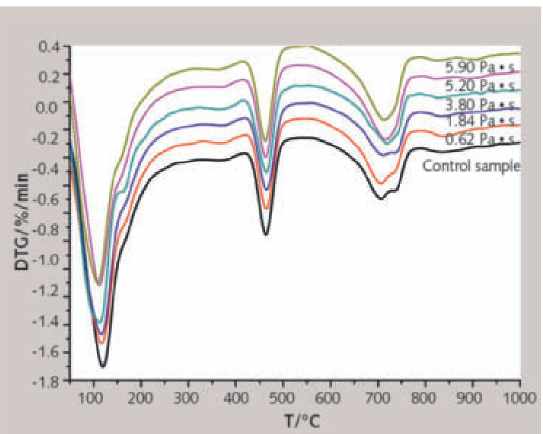


28d



28d

are 11.30 %, 13.55 % and 15.40 %. Moreover, the increasing range diminished gradually as the viscosity of mortar increased, which can be explained by the fact that increasing viscosities can retain more water and the processes of hydration can be prolonged. Therefore, the change of content of $Ca(OH)_2$ and chemically combined water decrease.



28d

3.3.4 SEM investigation

The above results are in good qualitative agreement with the results of the SEM measurements in Figure 8, where substantial changes in the crystalline structure can be observed as the samples gradually hydrate. There are quite a few holes in all thin layer mortar samples due to the air-entraining function of cellulose ethers. The density of the sample structure increased along with the viscosity of the thin-layer mortar [17]. When aerated concrete which was a high water-absorbing matrix contacted with thin layer cement paste, it would absorb lots of water from cement paste rapidly and block the hydration process. The mortar viscosity modified with cellulose ether can be hydrated fully at the interface of aerated concrete [18]. On the other hand, the effect of cellulose ether on thin layer cement paste seems to be a significant advantage to the strength of hardened cement paste which could generate a greater amount of C-S-H gel, $Ca(OH)_2$ and ettringite. These hydration products formed a network for improving the compactness of structure.

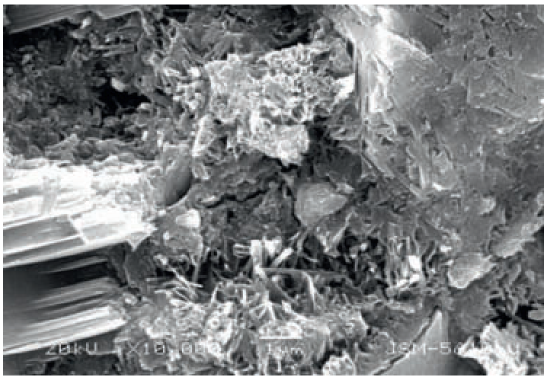
4 Discussions and conclusions

Based on related analysis, the microstructure model of the interfacial transition zone is shown in Figure 9 [19]. Previous research has shown that the water and ions of hydration products concentrated in interface between thin layer mortar and high absorbed matrix (aerated concrete), at the same time, the water and ions (Ca^{2+}, OH^-, SO_4^{2-} and Al^{3+}) have strong migration behavior and penetrated into the pores of the matrix materials surface, which hydrated first and formed hydration of $Ca(OH)_2$ and C-S-H [20-21].

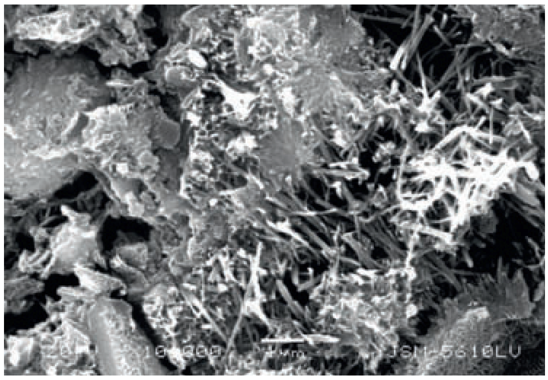
The stacking density of cement particles in the interface transition region is increased. Porosity and crystals decreased from modified cement paste to aerated concrete interface and formed interface enhancement region due to crystal preferential [22-24]. The contents of C-S-H gel of modified mortar interface are more than control samples. A continuous film of cellulose ether formed at the interface of the transition region due to hydration-induced interaction between mechanical force, hydrogen bonding and van der Waals force [25].

Based on this research, it can be concluded that gradual effects of viscosity on thin layer cement paste dehydrating was clearly observed. The results demonstrated that the viscosity of mortar is crucial to the tensile adhesive strength and dehydrating velocity. It was noted that, as the viscosity of thin layer cement paste modified with cellulose ether increased, the adhesive strength of the interface was

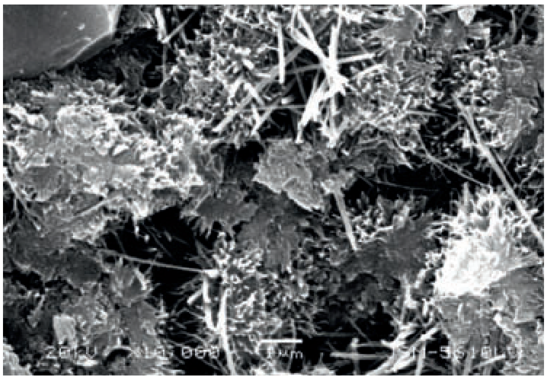
8 **SEM spectrum of interfacial transition zone and different ages between thin layer cement paste modified with cellulose ether and aerated concrete**



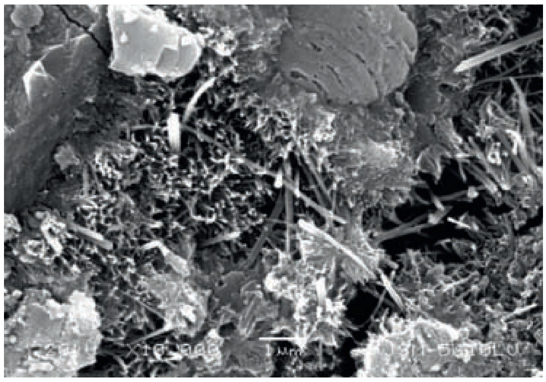
3 d **Control sample**



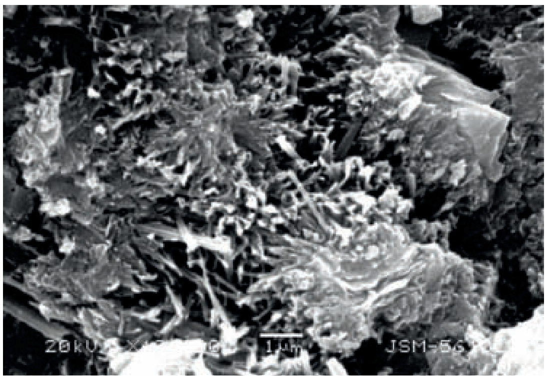
5.20 Pa • s



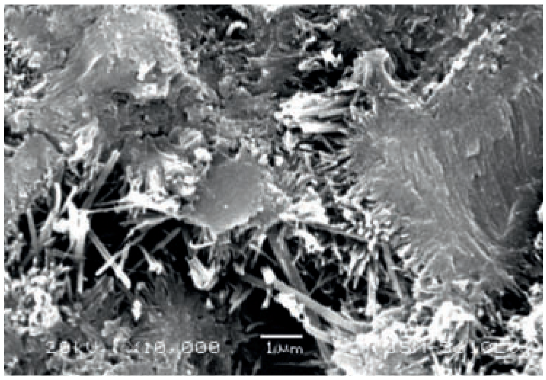
7 d **Control sample**



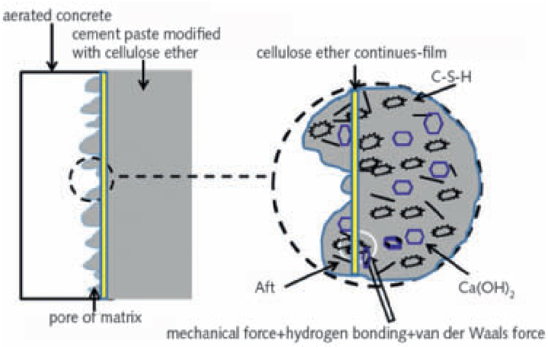
5.20 Pa • s



28 d **Control sample**



5.20 Pa • s



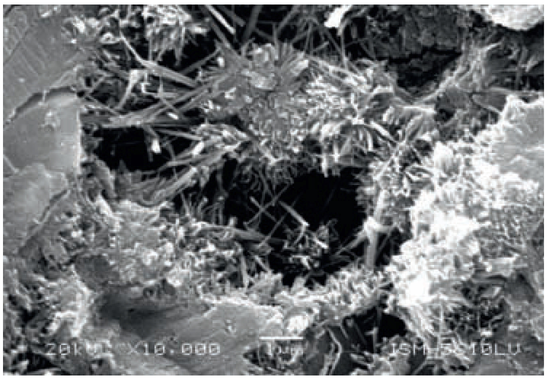
9 **Microstructure model of interfacial transition region of thin layer cement paste modified with cellulose ether**

increased, the dehydration was diminished and the microstructure of harden was densification.

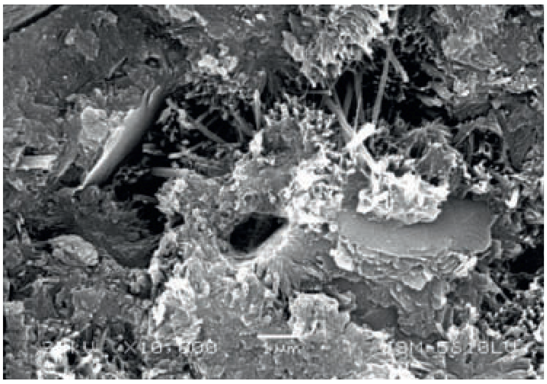
In summary, cellulose ether modified the viscosity of the cement paste as a tool to control flow properties and hydration processes. Therefore, higher viscosity of thin layer mortar can be optimized by using the production process.

Acknowledgements

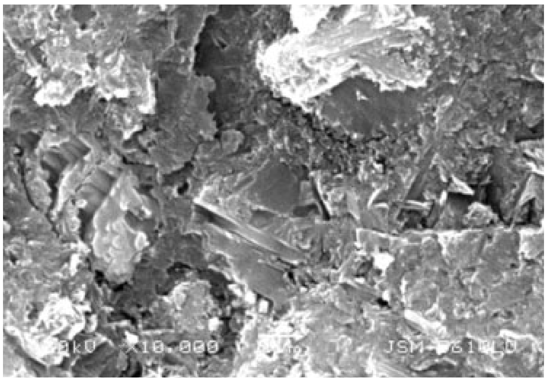
The program was funded by the Youth Fund of the National Natural Science Foundation of China (No.50902107) and the National Science and Technology Supporting Program (No. 2012BA-J20B04-02).



1.84 Pa•s



1.84 Pa•s



1.84 Pa•s

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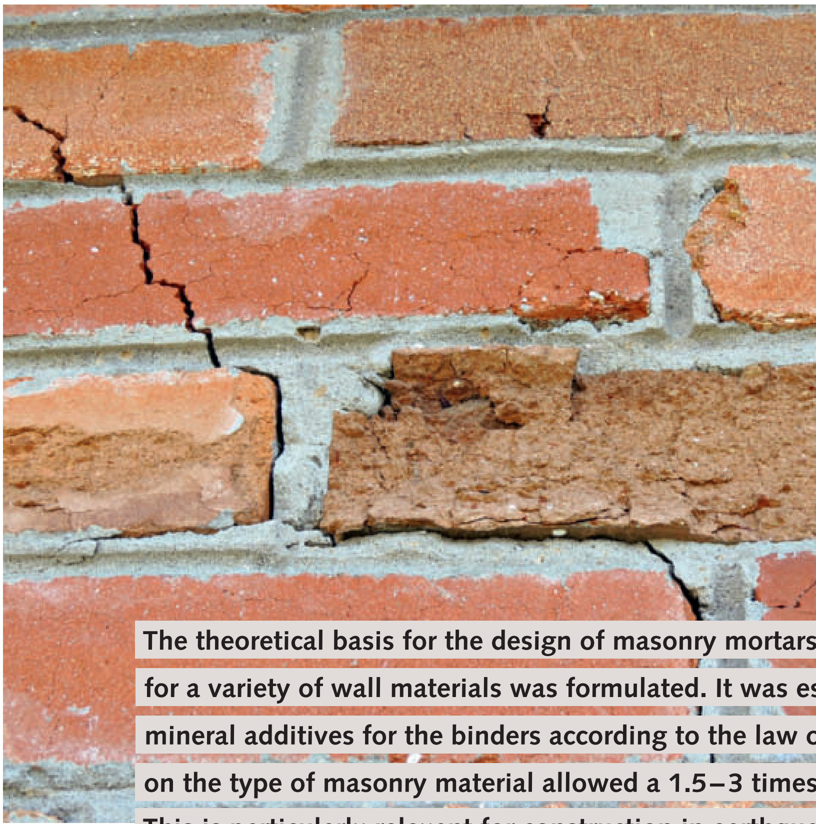

The theoretical basis for the design of masonry mortars based on composite binders for a variety of wall materials was formulated. It was established that selection of mineral additives for the binders according to the law of affinity of structures depending on the type of masonry material allowed a 1.5–3 times increase of the adhesion strength. This is particularly relevant for construction in earthquake zones.

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BELGOROD STATE TECHNOLOGICAL UNIVERSITY

Theory and practice of designing and production of masonry mortars

1 Introduction

The succession of natural cataclysms and armed conflicts all over the world has escalated the issue of increasing the safety of buildings. One of the aspects has become tightening of standards for earthquake resistance in some countries. This is associated with natural and technogenic impacts, significant changes in the environment by using construction materials and environmental protection. Most modern construction materials and structures based on them are initially created taking into account the increase of requirements.

However, an important goal of construction materials technology is not only the development of new knowledge-intensive materials, technologies and solutions, but also revision, improvement and updating of existing ones based on the most advanced theoretical framework. It would be a mistake to select research subjects through their scale and significance for the construction industry. Conventional technologies that are very popular in low-rise private and agricultural construction should not be simply forgotten. One of them is certainly clip joint bricklaying, the improvement of which is possible only through a revision of the provisions of mortar synthesis.

More importance regarding this issue is added by the fact that one of the criteria for assessing the level of development of the industry as a whole is not only the introduction of advanced technologies, but also the reduction in the gap between them and their application in everyday life.

2 Methods and materials

Geonics (Geomimetics), a transdisciplinary direction based on the limitless information resource of geological processes [1–4] may become the basis of the theoretical foundation for research. The evolving of construction materials over time and the results of their interaction with the environment was reflected in the theoretical provisions of technogenic metasomatosis [5–6]. The design of durable materials not taking this into account is unsafe and not feasible.

However, the use of the law of affinity of structures allows determination of the right direction for the search in the case of the need to combine materials varying in functional purposes [7–9] which is experienced in masonry [8–10].

It is known that in view of the specific conditions of application and the use in the form of thin interlayers between porous materials, the requirements for mortar mixtures are significantly different from their “next of kin” – concretes. Strength indicators having priority for heavy concrete give way to the water-holding capacity, establishing prerequisites for the possibility of easy application of a thin layer and good adhesion to the core masonry material. The mortar often has to harden under adversely lowered humidity. In most cases mortars are prepared on site, often by low-skilled workers, which also impacts the final result.

Speaking about the existing practice of preparation and application of masonry mortars, they can be conditionally divided into “conventional” and “modern”.

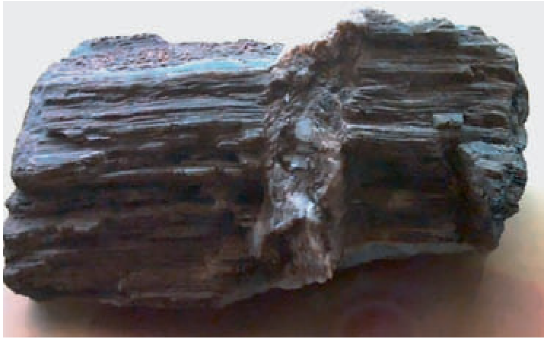
3 Results and discussion

“Conventional” are the materials with the basic technological properties achieved mainly through the use of mineral constituents. An example of such mortars is cement-lime-sand, cement-clay-sand, etc., used for the emergence of Portland cement to make clip joints and forming 15-20 % of the masonry volume. The advantages of such mortars include availability and low cost of the materials used, as well as acceptable performance of the mixtures. However, the value of adhesion to the material is often insufficient to make use of the potential of the core masonry material. Structures have low durability under dynamic effects (vibrations, earthquakes, explosions), and complex kinds of operation (the occurrence of bending and twisting moments, shear stress).

“Modern” mortars are the materials with special properties mainly present due to the use of chemical additives-modifiers, such as cellulose ethers, redispersible powders and others. This approach underlies the overwhelming majority of commercial dry construction mixtures (DCM). The use of effective modifiers makes it easy to provide virtually all properties of mortars that are difficult to achieve or unachievable using mineral raw materials only. A significant drawback is the high price, justified in their minimal consumption as an adhesive (not more than 2–3 % of the masonry volume) and for special tasks (repair work, installation of elements on vertical surfaces, etc.).

These two approaches may also be combined. For example, highly dispersed mineral constituents (e.g. lime) are introduced to reduce the cost and improve the performance of individual DCM indicators. And for the “conventional” masonry mortars, specialized complex modifiers are available, intended for use at construction sites. Nevertheless, due to the desire to maximize savings, low-quality mortars are used very often, that create a potential hazard to life and health, and cause economic damage.

At the same time, nature shows the ability to create advanced layered structures based solely on mineral constituents, which is analogous to ma-



1 Artificial material and its natural counterpart: a) old stonework; b) faulting crack in the layered sandstone cemented by feldspar

Table 1 Strength of rocks taking into account texture characteristics and artificial stoneworks

Rock name	Compression resistance [MPa]	
	Perpendicular to banding	Parallel to banding
Magmatic rocks		
Gabbro banded	237	125.5
Granite-porphyres	310	278
Sedimentary rocks		
Marmorized limestones, banded	171.4	88.9
Organogenic limestones	95	65
Metamorphic rocks		
Micaceous banded granites	97.5	63
Metamorphic slates	216.7	120
Banded quartzite sandstones	258.2	190.6
Brickwork on brick M150 and mortar M100	4.5	1.3
Large-block: blocks of heavy concrete B12,5, mortar M100	6.7	2

sonry (Figure 1). The mechanical characteristics of the layered rocks are given in Table 1.

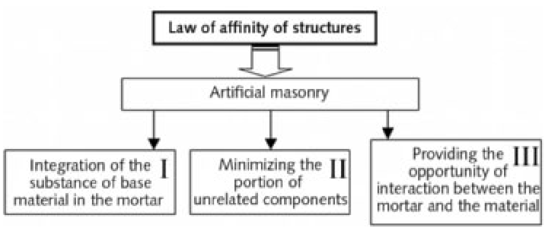
As shown in the table, the strength of the artificial masonry is 20 or more times inferior to natural counterparts, and such a backlog increases with loading along the horizontal mortar joints.

As already mentioned, systematization of geological information and reversible engineering are the basic tools of Geonics [11-14]. In accordance with its terms, identification of the causes of the high strength values of layered rocks and the application of these data in the design of mortars for masonry allows bringing together their characteristics.

The peculiarity of buildup of layered natural formations is the low speed of the processes providing maximum uniformity of natural mortar layers due to diffusion interpenetration and intergrowth. Unfortunately, this peculiarity cannot be fully reproduced in vitro.

Another peculiarity is the composition of the natural concreted mortar. The "adhesive" basis is of aqueous salt mortars filling the remaining free space with microscopic particles of bedrock and new formation crystals. A high degree of homogeneity of the natural mortar with bedrock is provided due to this.

The improvement in the efficiency of masonry mortars can be implemented through the use of the law of affinity of structures that imposes the number of technological measures provided in Figure 2.



2 Basic principles of the use of the law of affinity of structures

In accordance with the proposed principles, when making the artificial masonry, it is required to:

» Provide affinity of materials of the mortar and the base material due to the introduction of the latter in the form of filler in the composition of the mortar.
» Reduce the amount of clinker component because before formation of the final structure of cement stone, its properties change and are different from the base material, which can be a cause of micro-defects.
» Provide an opportunity to fill surface defects of the base material with a cementing substance and increase its homogeneity. This is possible by increasing the dispersity of components, replacement of cement stone with microconcrete in sufficient quantities.

Due to its properties, traditional Portland cement does not fully meet the task set, so a favorable solution would be the synthesis of specialized composite binders (КВ) with properties initially optimized for preparation of masonry mortars (Figure 3).

Straight Portland cement ЦЕМ I 42,5Н was used as a binding base. Its portion in all the composite binders was 40 %.

To test the above assumption on a higher favorable level of interactions between affined structures, the following materials were used as mineral additives in the composite binders: the breakage of ceramic bricks (Кк), keramsit concrete (Кб), sand-lime brick (Ск), gas silicate (Гс) and heavy concrete (Тб). The original Portland cement and composite binder with quartz sand as a mineral additive (Кп) were used as control compositions. Before co-milling all materials – mineral additives were crushed to a maximum particle size of 2.5–2 mm.

Composite binders were obtained by co-milling of Portland cement and mineral additive.

Due to significant differences in grindability of the additives, the common grinding time was a common parameter, i.e. the same amount of energy was transferred to all compositions during mechanical activation. This approach allows evaluation of the effectiveness of the implementation of additional energy consumption which is important for their practical implementation (Table 2).

To reduce the negative impact of the increased dispersity of the binders on mortar properties, the Muraplast FK88 water reducing agent was used. Rational dosage of the additive defined using a minicone for each of the composite binders is given in Table 2. The type of mineral additive has a significant impact on the value of rational dosage and the water demand of the resulting binders, except that direct correlation with the value of the specific surface area is not observed.

All КВ compositions have naturally higher normal dough consistency (up to 35 %), going beyond the permissible level for Portland cement. The plasticizing agent allows a significant improvement of this indicator, by limiting it to an acceptable range of 21-27 %. It should be noted that there was no aim to significantly reduce the water demand of the compositions, as for masonry mortars it is not necessary to provide a branded strength of more than 20 MPa, and more than 10-15 MPa in practice.

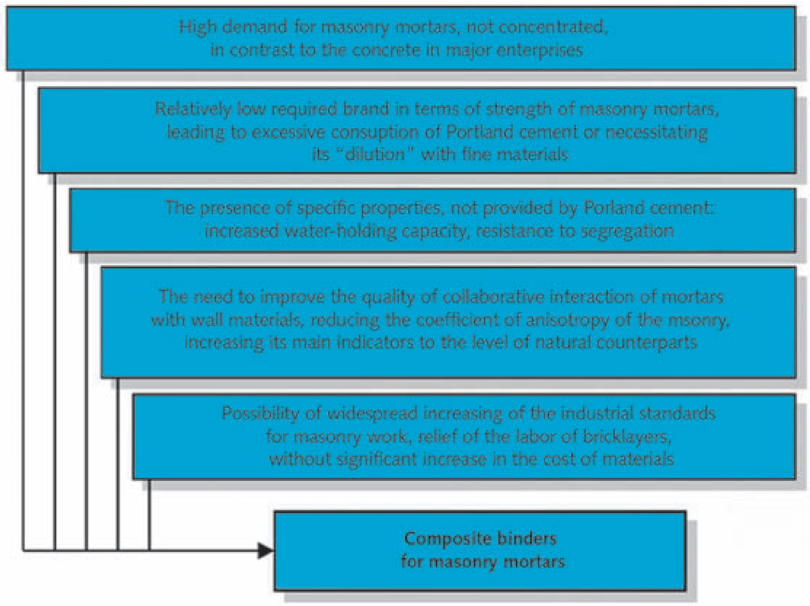
The type of mineral additive has a significant impact on the strength indicators of the binders. Activity was determined by the addition of a plasticizing agent of a rational dosage. Portland cement shows characteristically the greatest value of this indicator. A slight increase in the strength of plasticized mortar for cement of the ЦЕМ I 42,5 Н grade, is probably due to the low fineness modulus of the sand used of 1.2-1.4.

The composite binders compared to the original Portland cement have 30-45 % less strength, which is a rather good indicator, given the fact that the content of the clinker portion in them is 60 % reduced. Activity of the composite binders increases depending on the type of mineral additive in the following sequence:

Gas silicate → quartz sand → ceramic brick → Haydite concrete → heavy concrete → lime brick

A different situation emerges in the case of curing of cement-sand mortar on different binders under conditions close to real: cement : sand = 1 : 3, water : cement = 0.5, the mixture was compacted by pinning and smoothing with a spatula; in curing, the samples were isolated from the environment with polyethylene film that reduces moisture evaporation. In this case, 2–3 times less material strength indicators were obtained. The reasons for this are the higher water content of the mixtures, the absence of vibration compaction and the lack of moisture.

The best absolute and relative results were shown by the compositions containing ceramic materials as mineral additive (КВ40К6, КВ40Кк) and gas silicate (КВ40Гс). The unifying factor in



3 Prerequisites for the use of composite binders for masonry mortars

Table 2 Main characteristics of composite binders

Composition	Cement	КВ40К6	КВ40Кк	КВ40Гс	КВ40Ск	КВ40Т6	КВ40Кп
$S_{specific}$ [m²/kg]	350	756	814	894	626	677	699
Rational dosage of Muraplast plasticizing agent (% of binder)	1	0.7	0.5	1	0.5	0.7	0.5
Normal dough consistency [%]							
– without superplasticizing agent	26	34	34.5	34	30.3	30	34.7
– with superplasticizing agent	19.5	27	26	23	21.5	23.5	25
Activity [R_A] [MPa] (forming according to GOST 310.4-81, vibration compaction, water curing)*	54.6	34.6	32.9	29.7	38.7	36.1	32.3
Mortar strength [R1] [MPa] (at Cement:Sand = 1:3, Water : Cement = 0,5, pinning, curing in air humid condition, 28 days)*	17.9	17.6	17.3	14.9	12	12.4	10.6
Relative strength: R1/RA	0.33	0.51	0.53	0.5	0.31	0.34	0.33

* All compositions are prepared with a plasticizing agent of a rational dosage

Table 3 Properties of mortars and the masonry on different wall materials

Masonry material	Type of binder	Mortar strength in the masonry [MPa]	Mortar adhesion to the base [MPa]
Ceramic brick	КВ40Кк	11.5	0.61
	КВ40Кб	13.8	0.77
	КВ40Ск	10.7	0.49
	КВ40Гс	10.4	0.55
	DMM	5.7	0.53
	CLS	3.4	0.33
Lime brick	КВ40Кк	5.8	0.34
	КВ40Кб	4.9	0.34
	КВ40Ск	6.1	0.48
	КВ40Гс	5	0.57
	DMM	1.7	0.38
	CLS	1.3	0.37
Cement-concrete block	КВ40Тб	6.8	0.59
	КВ40П	6.4	0.76
	DMM	6	0.64
	CLS	5	0.48

this case is 10-40 % higher specific surface area than in the other compositions showing a 3-fold reduction in strength.

High dispersion of the particles is the key to a high water-holding capacity, which contributes to the formation of smaller capillary pores, better preserving moisture in the curing concrete. Furthermore, clay materials have a highly developed inner surface. During baking, partial melting of the particles occur, leading to isolation of the part of the surface inside larger structures. When grinding, the glass ceramic shell is destroyed, which again makes the entire surface of baked clay available for interaction with water. This explains the higher normal consistency of the compositions on the composite binders with the addition of ceramic materials. Thus, ground ceramics serve as an accumulator of moisture in the curing concrete.

A similar situation may occur in the composition based on binder КВ40Гс containing gas silicate as mineral additive. In this case, the source of surface to hold water are the products of the interaction of ground sand and lime – hydrous calcium silicates constituting a significant portion of volume of interporous partitions and representing microporous crystalline aggregates of particles of different morphology. The destruction of bonds between the individual crystals is likely to require less energy consumption, which accounts for the highest and specific surface area of the КВ40Гс binder.

A large portion of volume (up to 80 %) of silicate brick and heavy concrete is taken by a filler with solidity and reduced grindability. All other things being equal, this explains the lower specific surface area of the КВ40Тб, КВ40Ск, КВ40П binders containing heavy concrete, lime brick and quartz sand, respectively as mineral additives, as well as their lower water demand and capability to maintain a favorable micro-climate for curing.

Based on the developed binders, masonry mortars were prepared that have been tested on the basic types of wall materials: ceramic and silicate brick, cement heavy concrete blocks. For the purity of the experiment, no chemical and mineral additives (except superplasticizing agent) were introduced.

Mortar composition was accepted as cement : sand = 1 : 3, the plasticizing agent was introduced of a rational dosage, the amount of water was chosen on the basis of condition to ensure the same mortar mobility corresponding to the depth of cone immersion of 9 cm. For comparison, conventional cement-lime-sand (CLS) mortar was used calculated according to a standard technique for the M150 brand, and the P-10 (M150) ready dry masonry mortar mixture (DMM) containing polymer modifiers and having a similar stated strength value.

To determine adhesion, the elements of 120 × 60 × 35 mm were cut from wall materials. The elements were connected crosswise, with a mortar interlayer of 8-10 mm. Samples were cured for 28 days in the laboratory and isolated with polyethylene film. In our opinion, such organization of the experiment to a greater extent than the standard technique simulates the complex conditions under which materials interact in the masonry.

The mortar strength was determined by the non-destructive method after separation of one of the elements of the wall material.

The type of the main wall material and the binder used to prepare masonry mortar, have a significant impact on the system strength. Once again this confirms the fact that lime brick is the most difficult material in terms of making solid and homogeneous masonry. The strength performance of the mortar cured surrounded by it, all other things being equal, is 1.5-3 times lower than in the same mortars, but cured surrounded by ceramic bricks. The reason for this, in our opinion, is the difference in parameters of the pore space structure of the base material and the mortar.

Mortars based on composite binders in all cases exhibit higher strength than the control mortars, which is, to a large extent, related to the features of capillary porosity that may be judged by the dynamics of water absorption and microstructure photographs.

Absorption of the main quantity of water by ceramic brick and cement concrete (Figure 4), despite the great difference in absolute values occurs within the first 10 minutes, and is associated with filling of the system of sufficiently large pores. Over the following day, further only 1/10 of its total quantity is absorbed. This fact is due to the low water/cement ratio of vibration pressed cement blocks and the clogging of fine pores during brick firing.

In the initial period, lime brick absorbs water slower than ceramic brick, however, the process, due to its redistribution within the material is not completed even after a day, and as a result, water absorption of ceramic brick is exceeded.

The solutions themselves have a similar nature of water absorption with silicate brick. High initial water absorption rate water is associated with rather high W/C = 0.5–0.6, contributing to formation of large capillaries, and the process flow during the subsequent time can be explained by the small size of new formations and the genetic characteristics of the mineral additives in the composition of the composite binders. Thus, ground ceramic brick brings to material ceramic particles of partially destroyed cellular structure characteristic for the poorly metamorphized clays formed by sedimentogenesis (Figure 5). A similar pattern is observed in other combinations of affined materials.

In summary, two combinations of the nature of water absorption of the hardened mortar and wall material can be distinguished, differently affecting the redistribution of moisture during curing:

» Favorable: rapid saturtion of wall material and high water absorption of mortar with slow saturation, typical for ceramic brick and mortars on affined binders. In this combination, the solution is able to retain moisture during curing and gain a significant portion of the intended strength during curing under reduced humidity
» Unfavorable: wall material has a high water absorption with slow saturation (lime brick). The lower the “fast” component of water absorption of the mortar, the worse the conditions for its curing in the masonry and the lower is the strength. This relationship can be seen in the example of cement-sand mortar (Table 3 and Figure 4)

An additional factor affecting a micro climate favorable for hydration is the developed inner surface of the cured mortar.

The more important aspect of the interaction between the components of masonry is mortar adhesion to the wall material.

According to data obtained, this figure is insignificantly associated with the actual compressive strength of the mortar. The most striking example is a slight change in cohesion strength and large fluctuations in the strength of cement-lime-sand mortar with different types of wall materials.

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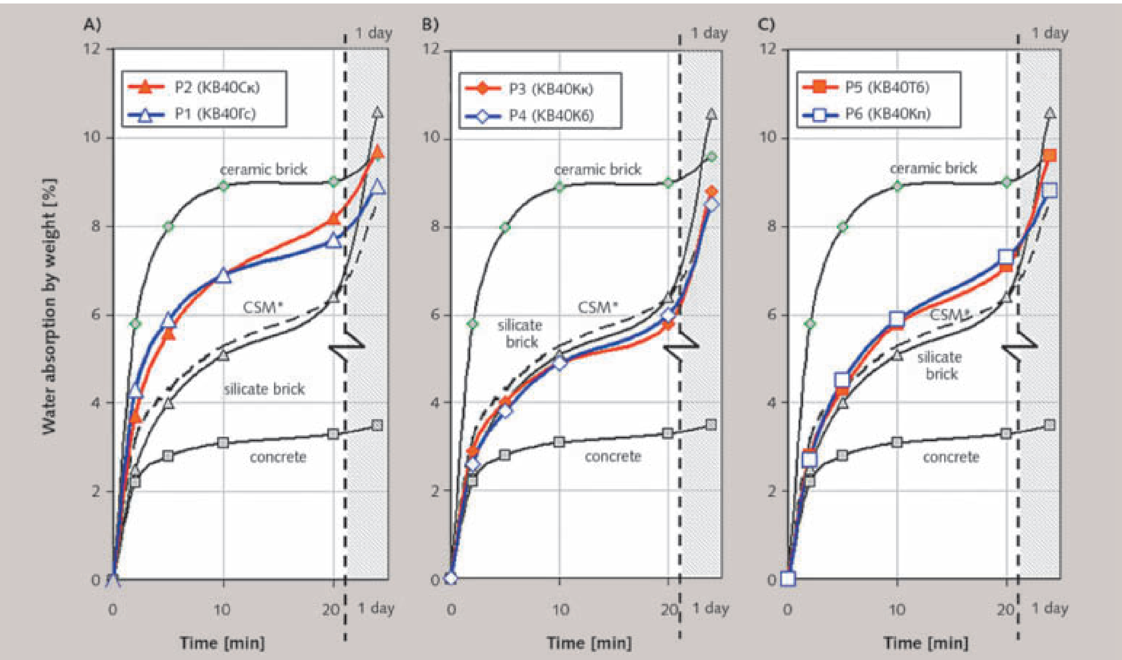
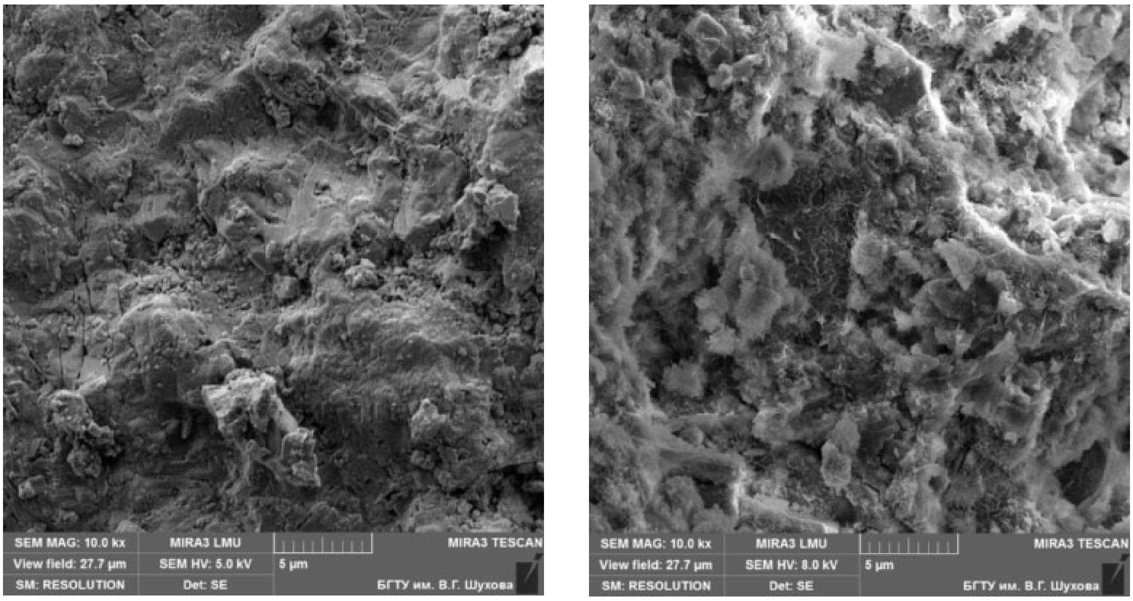
According to data obtained, this figure is insignificantly associated with the actual compressive strength of the mortar. The most striking example is a slight change in cohesion strength and large fluctuations in the strength of cement-lime-sand mortar with different types of wall materials.

The highest relative indicators of adhesion are exhibited by the mixtures on composite binders with mineral additive affined to the applied wall material. Thus, wall material substantially affects the absolute levels of this magnitude.



4 Features of the dynamics of water absorption by wall materials and solutions on various binders (*cement sand solution)



5 Similarity in microstructures of the surface of ceramic brick (left) and fracture of the mortar in the affined composite binder (×10 000)

The use of specialized composite binders containing mineral additives affined to wall materials in masonry mortars, allows reaching an adhesion level of 0.57-0.77 MPa without using a polymer modifier. It should be taken into account that these materials contain a large amount of modifying additives, and use heavy concrete as the base to determine adhesion, with favorable characteristics in the structure of pore space and surface.

All the mortars obtained based on composite binders have a water-holding capacity at the level of 98–99 % (according to GOST 5802-86), high resistance to lamination, low (compared to polymer-modified compositions) adhesiveness to metal tools, enough fixing power and survivability and high operational comfort.

4 Conclusion

Thus, the application of the law of affinity of structures in the design of masonry mortars allowed an increase of the breaking strength of structures by 35–60 %, which is especially important in terms of improving the safety of houses and engineering facilities at higher risks of technogenic and natural dynamic effects.

Acknowledgement

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AU 2015101734 A4

Mortarlite is a premixed, prebagged ready to mix ultra light sandless roof tile bedding mortar for use as a bedding agent for concrete, cement and clay tile roofs

(22) 01.12.2015
(45) 14.01.2016
Abstract or brief summary for reader to quickly identity the key features of the product.
Mortarlite, is a pre-blended, pre-begged roof tile bedding mortar ready to mix on site with addition of water. The key advantages of Mortarlite compared to conventional sand & cement mixtures are:

1. Once mixed with water, the same dry weight mix of Mortarlite produces twice the ready to use wet volume of mortar opposed to conventional sand and cement mixtures.
2. Once mixed with water, Mortarlite's wet weight will be half that compared to the same wet volume of conventional sand & cement mixtures.
3. Mortarlite contains over 3 times the water compared to conventional sand and cement mixture resulting in greater wet adhesion and working time on the roof.
4. Using Mortarlite under half the amount of mortar mix will be needed on site, resulting in a safer roof working environment and greater working productivity by using a product the produces twice the volume at half the weight compared to conventional sand and cement mixtures.

(71) Robert Dixon

US 2014/0171553 A1

Dry mortars with long open time and increased water factor

(22) 06.09.2013
(43) 19.06.2014
(57) The presently disclosed and claimed inventive concept(s) relates to a mixture composition for modifying a dry mortar formulation. The mixture composition comprises at least one redispersible polymer powder, a polyamide, a cellulose ether and a multivalent metal salt. The presently disclosed and claimed inventive concept(s) further relates a modified dry mortar formulation, a method of making the modified dry mortar formulation and a method of increasing the open time and water factor of the dry mortar formulation without deteriorating the mechanical strength of the cured dry mortar formulation.
(71) Hercules Incorporated, Wilmington, DE (US)
(73) Hercules Incorporated, Wilmington, DE (US)

US 2015/0166413 A1

Use of polypropylene oxide or ethylene oxide-propylene oxide copolymers in combination with starch ether derivatives as additive in dry mortar compositions

(22) 05.04.2012
(43) 18.06.2015
(57) The use of an adhesion-promoting additive combination composed of one or more polyalkylenoxides out of the group comprising polypropylene oxides and ethylene oxide-propylene oxide copolymers, and of one or more starch ether derivatives out of the group comprising carboxyalkyl starch ethers and their alkali salts, and hydroxyalkyl starch ethers, in mortar compositions comprising mineral binders and waterredispersible polymer powders.

US 2015/0321957 A1

Additive for hydraulically setting mixtures

(22) 11.12.2013
(43) 12.11.2015
(57) The present invention relates to a hydraulic binder-free composition comprising a water soluble polysaccharide-derived water retention agent for use in the preparation of dry mortar formulations, in particular, cement based tile adhesives (CBTA), adhesive, ETICS base coat or adhesive formulations and/or grouts. The invention further relates to a dry mortar formulation comprising said a hydraulic binder-free composition. Furthermore, the invention is directed to the use of such a hydraulic binder-free compositions for increasing, once cured, the adhesive, flexural and/or compressive strength of a dry mortar formulation.
(71) Dow Global Technologies LLC, Midland, MI (US)

US 2015/0274593 A1

White or colored cementitious mixture for manufacture of concrete, mortar and interactive pastes with photoluminescent properties

(22) 21.10.2013
(43) 01.10.2015
(57) A white or colored cementitious mixture for the manufacture of micro-concrete or normal concrete, mortar or interactive pastes with photoluminescent properties, which respond to an incident luminous stimulus when exposed in a dark environment, decaying after several minutes. The cementitious mixture comprises the following components, in percentage in weight of the components relative to the total weight of the composition: a) 35–80 % of white or gray Portland cement; b) 0.1–30 % of finely ground limestone filler; c) 0.01–3 % of powdered super-plasticizer; d) 0.01–3 % of modified polyvinyl resins; e) 0.01–5 % of dispersant of vinyl acetate and ethylene copolymers; 1) 0.3–20 % of photoluminescent pigment based on strontium aluminate, or other, of various colors; and also one or more components selected from: g) 1–10 % of binding regulator, h) 0.1–4 % of zinc stearate; i) 1–20 % of metakaolins; j) 5–60 % of artificial pozzolans, k) 0.1–15 % of inorganic pigments.
(71) Secil S.A. Companhia Geral de Cal e Cimento, Setubal (Pt)
(73) Secil S.A. Companhia Geral de Cal e Cimento, Setubal (Pt)

US 2015/0203404 A1

Powder mixture and process to make dry mortar

(22) 08.07.2013
(43) 23.07.2015
(57) The present invention provides a powder mixture suitable for hydrophobizing and thickening cementitious mortars, comprising a) 5–90 wt % of one or more water-thickeners i), said thickener i) being in powder form and selected from a specific group, b) 5–90 wt % of one or more component ii), wherein component ii) is in powder form and comprises one or more components iia) selected from the group of fatty acids, fatty acid salts, fatty acid derivatives, alkyltrialkoxysilane and/or a dialkyldialkoxysilane, wherein the alkyl group being a C_6- to C_{12}-alkyl group and the alkoxy group being a methoxy, ethoxy, propoxy and/or a butoxy group, optionally one or more components iib) selected from the group of water-insoluble polymer, water-soluble polymer, carrier and filler, and optionally one or more components iic), and c) 0–70 wt % of adjuvants iii), said adjuvant iii) being in powder form, wherein thickener i), component ii) and adjuvants iii) are different powders and the added components sum up to 100 wt %, based on the total amount of the powder mixture. The invention further provides a process to make a dry mortar comprising a hydraulic and/or latent hydraulic setting binder and the powder mixture according to the invention, wherein the mixture is made first, followed by mixing it with the binder. The powder mixture and the process provide an easy quality control means to ensure the presence of the component in the dry mortar.
(71) Akzo Nobel Chemicals International B.V., Amersfoort (NL)

WO 2015/194958 A1

Dry mortar mixture with grains of expanded glass

(22) 19.06.2015
(43) 23.12.2015
(57) Dry mortar mixture characterized by a glass mixture of expanded glass beads with a grain size d/D 0/8, mixed in a ratio of between 1:1 and 1:3, for example 1:2 with a dust poor or dust free binding mixture of hydraulic binders and stone granules in the weight ratio of 1:2 to 1:4. The glass has a discontinuous grain distribution. For the glass mixture the fractions 0.5/1.0 and 2.0/4.0 are present while the fractions 0.25/0.5 and 1.0/2.0 are absent. For the glass mixture preferably all grain sizes between 1.0 and 2.0 mm are absent and the grain size distribution is around an average, so that an open structure is obtained.
(71) Ceves Vergeer BV, Teugseweg 23, NL-7418AM Deventer (NL)
(84) ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)

ZKG PATENT RESEARCH

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E-Mail: ralf.giskow@aol.com

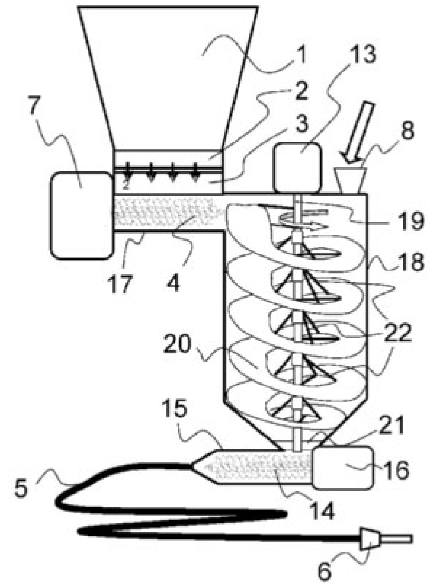
PATENT CODING SCHEME

(22) Date (dates) of application
(43) Date of publication of the patent application
(45) Date of publication of a patent document
(57) Summary or claim
(71) Name applicant(s)
(73) Name(s) of holder
(84) Contracting states named in accordance with regional patent agreement

WO 2015/087214 A1

Mixing and conveying system for dry mortar materials from a storage silo

(22) 04.12.2014
(43) 18.06.2015
(57) The invention relates to a mixing and conveying system for dry mortar materials. The dry mortar materials can be obtained from a storage silo (1) through an openable closure panel (3). A pipe (17), in which a drivable screw conveyor (4) is mounted, is arranged under the closure panel (3). The pipe (17) leads into a mixing and buffer container (18), in which a coil (20) is rotatably mounted on a central axis (19). The mixing and buffer container (18) has a volume which equals at least 1.5-times the 2 minute capacity of the pump-screw conveyor (14). It is thus ensured that the dry mortar material is mixed therein with the added water for at least 90 seconds or longer. The mixing and buffer container (18) leads into a pipe (15) at the bottom having a pump-screw conveyor (14) which conveys the mixed mortar into a hose (5). The pump-screw conveyor (14) can be allowed to run backward. The coil (20) runs continually such that the mortar is constantly agitated to prevent setting.
(71) S&P Clever Reinforcement Company AG, Seewernstrasse 127, CH-6423 Seewen (CH)
(84) ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)



WO 2015/124313 A1

Dry mortar, mortar slurry and method for producing semi-rigid coatings

(22) 20.02.2015
(43) 27.08.2015
(57) The present invention relates to a dry mortar and a mortar slurry, and a method for producing semi-rigid coatings. In one embodiment, the dry mortar and/or mortar slurry comprises a cement, a very fine component, and a superplasticizer and is free of silica fume, wherein the mortar slurry can be applied at an asphalt framework temperature between 55 and 80°C, and a compressive strength of at least 100 N/mm² is reached after 28 days. In a further embodiment, the dry mortar and/or mortar slurry additionally contains a gelling agent to reduce the propensity of the mortar slurry to flow out.
(71) HeidelbergCement AG, Berliner St. 6, 69120 Heidelberg (DE)
(84) ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)

WO 2015/181479 A1

Method for manufacturing a composition of lightweight concrete or mortar

(22) 22.05.2015
(43) 03.12.2015
(57) The invention relates to a method for manufacturing a composition of lightweight concrete or mortar having a dry density of 200 to 1400 kg/m³ into which are mixed components comprising at least light aggregates with a particle density of 50 to 1000 kg/m³, at least one mineral binder selected among the hydraulic binders, the sources of calcium sulphates and lime, at least one foaming agent and water, and optionally one or more additives, said foaming agent being a polyvinyl alcohol and the foaming thereof occurring in place during the mixing thereof with water and at least one of the components selected from among the aggregates and/or the mineral binder.
(71) Saint-Gobain Weber, Rue de Brie, 77177 Servon (FR)
(84) ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)

EVENT PREVIEW

Date Place	Event Contact
11.04.–17.04.2016 Munich/Germany	**bauma 2016** www.bauma.de
13.04.2016 Munich/Germany	**Casual drymix.info Meeting on bauma 2016** www.drymix.info
19.04.–21.04.2016 Nuremberg/Germany	**Powtech 2016** www.powtech.de
19.04.–25.04.2016 Hanover/Germany	**Hannover Messe 2016** www.hannovermesse.de
27.04.–30.04.2016 Aachen/Germany	**Feuerfeste Werkstoffe In Theorie und Praxis** www.feuerfest.info
03.05.2016 Philadelphia, PA/USA	**Fifth American Drymix Mortar Conference admmc five** www.drymix.info
15.05.–19.05.2016 Dallas, Texas/USA	**58th IEEE-IAS/PCA Cement Industry Technical Conference** www.cementconference.org
30.05.–03.06.2016 Munich/Germany	**IFAT 2016** www.ifat.de
15.06.–16.06.2016 Lund/Sweden	**3rd Workshop on Cement Calorimetry** www.cementcalorimetry.org
16.06.–17.06.2016 Bremen/Germany	**Jahrestagung des Bundesverbandes der Deutschen Kalkindustrie (BVK)** www.kalk.de
30.06.2016 Buenos Aires/Argentina	**Argentina Drymix Mortar Meeting** www.drymix.info
27.09.–28.09.2016 Düsseldorf/Germany	**VDZ-Jahrestagung** www.vdz-online.de
10.10.–12.10.2016 Munich/Germany	**2nd International Conference on the Chemistry of Construction Materials** www.gdch.de/icccm2016
12.10.–14.10.2016 Washington, D.C./USA	**ILA General Assembly** www.internationallime.org
25.10.2016 Tehran/Iran	**Iran Drymix Mortar Meeting** www.drymix.info
16.11.–18.11.2016 Abu Dhabi/UAE	**21st Arab International Cement Conference and Exhibition (AICCE21)** www.aucbm.org
22.11.–25.11.2016 Shanghai/China	**bauma China 2016** www.bauma-china.com
07.03.–11.03.2016 Las Vegas, NV/USA	**Conexpo-Con/AGG** www.conexpoconagg.com
03.04.–04.04.2017 Nuremberg/Germany	**idmmc six** www.drymix.info
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