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Opening of a plant for UHPC machine frames in China

Modern ultra-high performance concrete (UHPC) now has a permanent place in mechanical engineering. Apart from the low costs, concrete offers advantages in both the vibration and thermal behaviour of machine tools and is increasingly replacing conventional materials such as grey cast iron or welded steel constructions. One of the market leaders in cement-based cast minerals for machine frames is a UHPC with the binding agent Nanodur Compound from Dyckerhoff GmbH. Now the Chinese manufacturer Kle-Rause is also introducing this future technology into China and has built a new plant for it.

Machine frames are normally manufactured from grey cast iron or welded steel constructions. Apart from that, epoxy resin bonded cast minerals also established themselves about 25 years ago and currently have an (estimated) market share of about 15 %. Modern ultra high performance concrete has

joined them in recent years. The consequence of this development is that cement-based concrete is now of a high enough quality to replace synthetic resin-bound polymer concrete. Hence, several precast plants across Europe have already been successfully producing machine parts from cement-based concrete for some years now. A UHPC with the binding agent Nanodur Compound 5941 from Dyckerhoff GmbH is frequently used for this. This has nothing to do with machine foundations, but rather with the machine beds placed on the foundations and integrated into the machines. The moving bearings and drives are fastened to these base frames. Machine beds of this kind can be lighter than a tonne and can also reach very large dimensions. For instance, Shandong Yonghua Machinery in China recently manufactured a portal milling machine that stands on six (black) supports measuring 4 m x 1.8 m x 1 m, each of which was cast with 7.5 cbm Nanodur concrete. They were manufactured in Germany and shipped to China in containers.



Fan Lei, Managing Director of Kle-Rause, and Dr Bernhard Sagmeister, Managing Director of durcrete GmbH, at the commissioning of the mixing plant for machine components made of Nanodur concrete.



Concrete mixing plant from Teka



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Banking on future technology

Following intensive market research the Kle-Rause company, which is based in Yanzhou near Jining in China, decided to bank on this future technology and erect its own production facility in China for machine components made of Nanodur concrete. One of the main factors in this decision was the fact that the Chinese environmental regulations governing the production of grey cast iron are constantly being tightened. The binding agent for the UHPC is imported from Germany, while the aggregates and admixtures are procured locally. "The reliably high quality and above all the simple processing were instrumental in this decision", explains Fan Lei, Managing Director of Kle-Rause. The main reason for this is that it is not necessary to add silica dust to Nanodur concrete, because when silica dust is added to UHPC the mixture becomes very viscous and sticky, so that apart from the expensive mixing technology due to the high input of energy, nitrogen cooling would also be required. In contrast, Nanodur UHPC can theoretically even be manufactured in a rotary drum mixer from the DIY store and consequently requires only a pan mixer for its fabrication. Not only that, silica dust is an industrial by-product that is available only in strongly fluctuating quality. Defined quartz flours are difficult to come by in China. Nanodur compound, conversely, contains all fines in high quality and they are homogenised using specialised mixing tools so that manufacturers can work uncomplicatedly. The suitability test of the concrete recipe with the Chinese aggregates was conducted in the laboratory at Dyckerhoff GmbH and the results made available to the Chinese production plant.

Application advice and engineering from Germany

Kle-Rause cooperated with durcrete GmbH from Germany for the planning and erection of the plant in an already existing factory hall. This engineering company provides application advice for Nanodur concrete on behalf of Dyckerhoff AG and

also develops, distributes and manufactures products made of Nanodur concrete in its own name. Together with Prillhofer Consulting, a plant concept was elaborated and the invitation to tender and award of the contract took place. The absolute output quantity of approx. 3,000 tonnes per year is small for a precast plant. In theory, only one binding agent silo and two silos for coarse aggregates and sand are necessary. Therefore, the planned delivery cycles were decisive for the size of the silos. The design of the mixer was determined by the largest planned component, which weighs 20 tonnes and must be cast fresh-in-fresh with a maximum of 6 batches. The batch mixing time lies between 7 and 10 minutes, depending on the temperature. In the case of Nanodur concrete with its pre-mixed compound, only the superplasticiser needs this time in order to liquefy effectively and the batch mixing time is thus primarily dependent on the chosen superplasticiser and less on the input of energy into the mixture.

The contract for the complete mixing plant, including silos, big bag unloading station, transport equipment, sensors, control systems, concrete distribution and recycling, was awarded to Teka. An important factor in this decision was that the selected turbine mixer can mix both large and very small batches with a high quality. Therefore, no second mixer had to be purchased for the many smaller components. The disposal of the residual concrete and the washing water also required some thinking about. The environmental laws are very strict in China. However, no recycling water may be added to the UHPC and the residual quantities are too small for use in a conventional concrete recycling plant. The components for the mixing plant were all manufactured in Germany, shipped to China and assembled by Teka at Kle-Rause. Acceptance took place eight months after the signing of the contract. Dr Bernhard Sagmeister, managing director of durcrete GmbH, is delighted by the smooth completion. "At Teka professionals are at work who are well-versed in international business. From the technology to the assembly, the employees take care of everything and drive the project forwards, so that the



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Construction of a portal milling machine

acceptance actually took place three weeks before the contractually agreed date. Several components were successfully cast during the trial casting as part of the acceptance testing, as a result of which the plant was able to start production without delay.

Quality control according to German standards

The procurement of conditioned, high-quality raw materials in more difficult in China than in Europe. For that reason, extensive equipment was acquired for incoming goods inspection on gravel and sand. The buyers of the products also demand extensive in-plant production controls. Hence, a test specimen of each cast component is manufactured and subjected after seven days to a pressure test in a testing machine. Not only the quality of the component itself, but also the erroneous trend of the production as a whole can thus be comprehended quickly. The decisive test variable is not the compressive strength, which is completely meaningless in mechanical engineering. The decisive material parameter is the bending tensile strength of the concrete. The test of the modulus of elasticity is also important, because one can distinguish oneself positively from competitors in the field of synthetic resin-based cast minerals with a high modulus of elasticity, and the end customer always expects the smallest possible and, above all else, constant deformation of the concrete. Durcrete drew up a QM plan according to German standards as well as the invitation to tender for the testing and inspection devices. The contract for these was awarded in a package to the Testing company. Decisive for the client was the comprehensive service on offer in China.

Defined production sequences provide for absolutely crack-free products

The plant is still not complete with the mixing plant. It is just the necessary prerequisite; the true know-how lies in the mould construction and the production sequence. The customer expects absolutely crack-free products, which are located exclusively in the elastic area. The usual building industry aids are no help in mechanical engineering, since fibres or conventional reinforcements only start to have a real effect after the concrete has cracked. These aids are denied the producers of machine components. Through low-shrinkage recipes, moulds without constraints and clever production sequences, even large and craggy components up to 12 m in length can be manufactured without cracks. Kle-rause cooperates here with the German concrete plant Sudholt-Wasemann GmbH, which has built up extensive know-how in this field over the last five years. A large part of Kle-Rause's products is initially being supplied to its own parent company, Shandong Yonghua Machinery Ltd, which is a manufacturer of large, high-quality milling machines on the Asian market. Moreover, employees have already been taken on who have begun with

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sales to other Chinese manufacturers of precision machines. Kle-Rause will thus succeed in conquering the Chinese market for solid machine beds, since the subsidiaries of German cast mineral companies based there manage only to supply other German subsidiaries and not original Chinese companies. ■

FURTHER INFORMATION



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