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Bridge Beam Manufacturing for HS2: A Behind-the-Scenes Look

■ April Kraft, Kraft Curing Systems GmbH, Germany

In the town of Melton Mowbray, a joint venture is taking place at the FTB facility. This venture, comprised of industry giants Freyssinet, Tierra Armada, and Roger Bullivant, has set its sights on producing prestressed bridge beams for Balfour Beatty VINCI's (BBV) section of the HS2 line, England's zero-carbon high-speed railway. HS2, the groundbreaking high-speed rail project, is currently in development to connect London to the North-West of Britain. Its trains will seamlessly link major cities in Scotland with Manchester, Birmingham, and London. This undertaking stands as the largest infrastructure project in Europe. The upcoming high-speed rail line is designed to span from the North West to the South East, making stops at key cities such as Manchester, Birmingham, and London, while extending its reach to Scotland and other destinations via the existing rail network. Anticipated to commence operations between 2029 and 2033 upon the completion of Phase One, HS2 services will progressively expand as additional sections of the network are developed.

Project Scope

The heart of this venture is a state-of-the-art, custom-built 365-meter-long facility designed exclusively for manufacturing prestressed bridge beams for HS2. The scope of the project is immense, and the facility itself is a testament to the scale of the project.

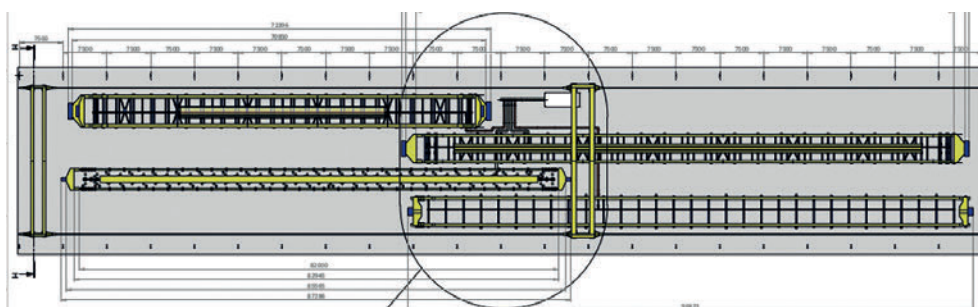
The project there includes designing and producing more than 3,600 precast pre-stressed concrete bridge beams and



The 365 m long FTB production facility located in Melton Mowbray

supplying beams measuring up to 33m long and weighing a maximum of 100 tons to 78 structures.

The facility uses a total of four (4) benches to produce up to ten (10) bridge beams each day (a max. daily production of about 160 m³). Kraft Curing's role in the endeavor to consistently produce the intended quantity was pivotal. Rapid curing for the prestressed concrete beams was necessary to allow for demolding from the stationary forms after 12 hours and keep production running smoothly.



Production hall design with a total of 4 benches.



The decision was made by the FTB venture to invest in the Kraft containerized Vapor Generator

The decision was made by the FTB venture to invest in the Kraft containerized Vapor Generator with water stabilization system and water softener, as well as automatic vapor control valves, and distribution pipe system to each of the four benches. The AutoCure® curing control system with data graphing capabilities and temperature sensors will allow for full automatic control of the entire curing process. To achieve perfection in demolding, four Match-Cure ovens, one for

each bench, are employed. These ovens play a critical role in determining the optimal moment to release the prestress elements, guaranteeing their structural integrity. These components work in synergy to ensure the quality and efficiency of the curing process. During the curing process, the elements are covered by a Kraft® tarp roller attached to large moving cranes for stabilization. This device drapes the tarp over the moulds with precision, ensuring coverage and providing an optimal curing environment.

The Critical Role of Careful Control in Concrete Curing

The Kraft Curing Systems containerized Vapor Generator 50-2S offers a multitude of benefits for concrete curing producers producing large precast or prestress elements. First and foremost, its innovative design allows for unparalleled mobility and convenience. Additionally, the vapor generator boasts exceptional energy efficiency, optimizing the curing process and reducing operational costs. The direct-fired Vapor Generator supplies vapor varied from 100°C, with high moisture content, to 350°C, with low moisture content. This unit carries the designation HP for the use of a high-pressure (1 bar) gas supply.

The combustion chamber is manufactured with a double-wall stainless steel water-cooled structure, providing a protective environment for air and gas combustion, ensuring the

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The fully kitted containerized Vapor Curing Unit.



The Vapor Controls touchpanel (top-right) along with the AutoCure touchpanel (bottom-right) on the control cabinet in the containerized unit.

desired moisture content in vapor. The 304 L stainless steel combustion chamber undergoes rigorous testing, guaranteeing safety, quality, and durability at pressures four times the maximum rated limit. This water-cooled design not only facilitates combustion of 1500 °C gases but also ensures a "safe-to-the-touch" outer wall. Kraft's confidence in the chamber's design is reinforced by a lifetime guarantee.

A crucial aspect is the water flow safety mechanism positioned in the water supply line between the water-cooled mixer-burner and the stainless-steel combustion chamber. This safety feature verifies the continuous flow of water during operation, preventing any chance of combustion without water and potential damage to the combustion chamber.

The containerized unit located at the Melton Mowbray production site is equipped with a water pressure stabilization system, designed to prevent water pressure fluctuations from reaching the vapor generator and causing changes in vapor temperature and moisture content. It provides constant water pressure, especially when water demand for concrete batching is at its highest. The built-in water softener prevents lime build-up in the vapor distribution system. The containerized unit is insulated and fitted with lighting and safety equipment, as well as equipped with an electric space heater to keep inside temperatures above freezing.

The precise control and uniform distribution of the vapor produced by the Vapor Generator results in accelerated and high-quality curing of concrete, leading to improved strength and durability of the final product.

The AutoCure Controls, powered by the Kraft designed software, revolutionize the concrete curing process by offering

precise measurement, control, and recording capabilities throughout all four phases of the curing cycle. The Pre-Set Controller allows users to input duration and temperature parameters, ensuring control during the initial phase. The ramp function ensures linear control of the rate of increase of concrete temperature, preventing issues like shocking, cracking, or crazing in fresh concrete. The soak function manages the maximum curing temperature and duration, while the cool-down function prevents rapid concrete cooling to eliminate the risk of thermal shock.

Utilizing a user-friendly touchscreen interface, Kraft recreates the curing area graphically on screen, allowing supervisory users to effortlessly make necessary adjustments to temperature and time parameters. A graphic curing curve is generated with user-inputted data, and the curing process is initiated with a simple touch to the start button. AutoCure then compares signals from various temperature and humidity sensors to programmed set-points, enabling the PLC to control one or more vapor generators and/or vapor control valves, creating the optimal curing environment for concrete. The separate Vapor Controls touchscreen panel of Kraft Curing's Vapor Generator gives users comprehensive control over essential functions such as Auto/ Manual, On/Off, Water Prime, Reset, and Emergency Stop. These are visible and accessible via the touch panel's main screen, while automatic vapor and pressure control and digital indications give real-time feedback on possible operating faults, covering aspects like Low Water Pressure, Low Gas Pressure, Vapor Over-Temperature, and Mixer/Burner Over-Temperature, ensuring efficient and trouble-free operation. The digital display even offers on-screen solutions with photos and descriptions, allowing for accessible and simple maintenance. The vapor controls touch panel may be connected via LAN connection



The Containerized Vapor Curing Unit along with 4 automatic vapor valves.



The four Match-Cure ovens located next to the containerized Vapor Generator

to a remote service router, allowing Kraft technicians to connect to the vapor generator and remotely monitor the operating parameters- extremely useful for remote fault finding and performance tuning.

The vapor is distributed to the four curing zones via the vapor distribution pipe system. The main header consists of an 8-inch carbon steel pipe while the secondary header consists of a 5-inch and 4-inch carbon steel pipe.

A 5-inch stainless steel control valve - a total of four each for four curing areas - provides for the controlled distribution of vapor to independent concrete curing areas. It operates together with the aforementioned AutoCure Curing Control System. The vapor control valve is constructed of stainless steel with a high CV (Flow Coefficient) to reduce pressure loss.

Ensuring Quality: The Match-Cure Quality Control System

Kraft Curing takes the guesswork out of determining the strength of prestress concrete elements with the Match-Cure Quality Control System. The four provided Match-Cure insulated enclosures have space for three each 4x8 inch test cylinders or 6x6x6 inch cubes containing the same mix design as prestressed concrete elements in the production area. Each match-cure enclosure includes an independent heating system, air circulation ventilator, and temperature sensor.

The Type K Thermocouple temperature sensors installed in the Match-Cure enclosures and the production area, transmit concrete temperatures to the central AutoCure automatic concrete curing control system, which "matches" the temper-

ature in the test cylinders with that of the prestress elements (up to 70°C/160°F).

The quality control that match-curing prestress elements enables, includes the prevention of premature detensioning which could result in a damaged product, or delayed detensioning which can result in lost production time. Another advantage of the Match-Cure System is the reduction of higher curing (energy) costs by preventing unnecessary over-curing. The rugged and durable German-engineered design of the Match-Cure ovens allow them to be placed in the production area with other manufacturing equipment.

Combined with the VaporWare V2 industrial PC, which measures, records, stores, and prints all climatic curing data independently of a computer, the system provides optimal control.

The interplay of remote service access by way of the service router module providing remote connection between a user and the Siemens PLC.

The Access Anywhere® interface connects operators of concrete curing facilities to the AutoCure screen in the factory with up-to-date communication devices including PCs, tablets or smartphones. Parameters can be reviewed and altered on the go giving assurance that everything is running satisfactorily.

Reliable and Effective Coverage for Long Line Casting Forms

The motorized tarp roller provided by Kraft Curing provides a reliable and effective method of covering for long-line concrete casting forms.



The motorized tarp roller moves along the form by way of the overhead crane, evenly unrolling the curing tarp.

The motorized unit is supported via an adjustable spreader beam with two connections for suspension by an overhead crane. While the crane moves over the length of the form, the hydraulic drive powers the payout/take-up reel to easily cover or uncover the form for accelerated curing purposes. A powerful gasoline engine drives the hydraulic unit, while a hand-held remote allows for quick and very simple operation by an operator. The roller drive unit of the crane-operated tarp roller is designed for the 7m wide heavy-duty spindle. The spindle is supplied with a 650 gram/m² heavy-duty nylon reinforced curing cover with dimensions equal to 7 m wide and 70m, 80m, and 90m long.

The motorized tarp ensures a consistent and uniform placement over the form, which reduces wear and tear caused by uneven stress or tension that can occur with manually placed tarps. The enclosed curing environment provided by the tarp



The tarp covered long line form

retains the heat and moisture of the vapor and accelerates the concrete hardening process while preventing dry-shrinkage cracking.

Results and Conclusions

Throughout the unfolding of the joint venture at Melton Mowbray's FTB facility for HS2, the incorporation of advanced technologies such as the containerized Vapor Generator, AutoCure Controls, Match-Cure Quality Control System, and the motorized Tarp Roller has underscored Kraft's commitment to precision, innovation, and efficiency. Kraft's role in ensuring optimal curing conditions, coupled with remote access capabilities, not only contributes to the success of the FTB joint venture in the HS2 project but sets a new standard for concrete curing in large-scale infrastructure development.



The facility uses a total of four benches to produce up to ten bridge beams each day.



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