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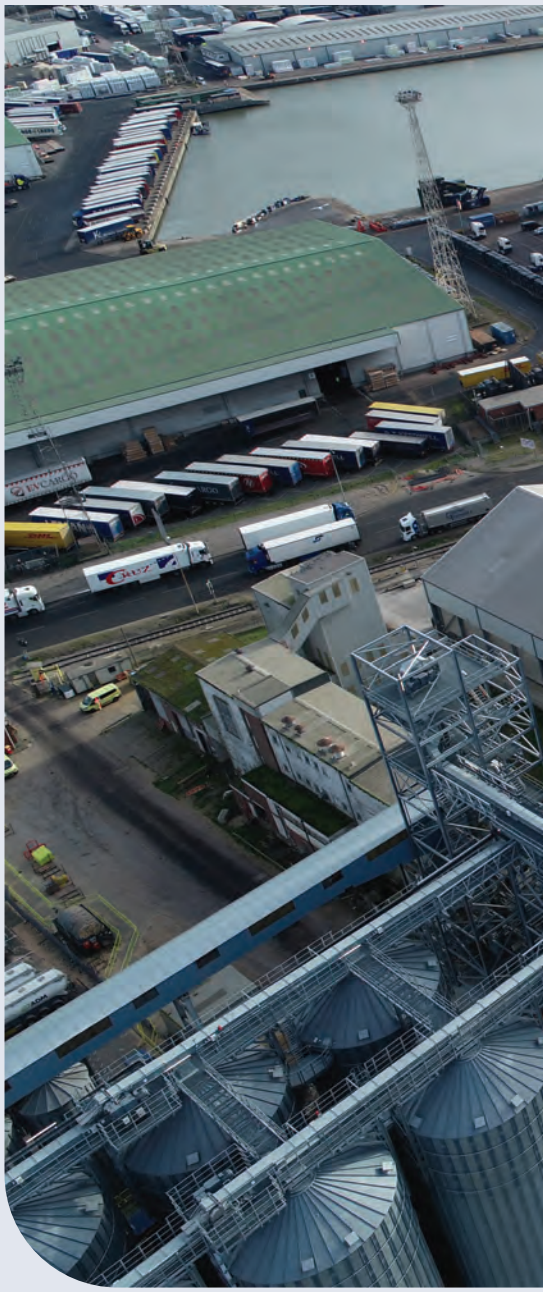
PORT OF TILBURY GRAIN SILOS

Martin Arnold of **Careys** looks at how slipforming was combined with conventional formwork and precast elements to create the first major concrete grain silo facility built in the UK for half a century.



The conflict in Ukraine, one of the world's biggest producers of wheat, has highlighted the importance of not only our own arable farming, but also efficiently managing the produce we buy from elsewhere. Currently, the Port of Tilbury on the Thames is at an advanced stage in updating and expanding its own capacity, with the highly experienced civils and concrete specialist Careys filling the role of principal contractor.

The construction of the 30-silo facility, which commenced in February 2022, represents a major redevelopment within the confines of the capital's primary port, as well as being a logistically challenging brownfield site. Meticulous planning was required throughout to ensure the slipformed and precast concrete structure was built without causing interruption to the constant transhipment of goods through the port.

SCOPE OF RESPONSIBILITIES

While a demolition contract had razed the original storage structure prior to Careys taking possession of the site, the scheduling of the works still involved dismantling sections of the steel frame attached to the closely adjoining Centre House, along with its complex conveyor systems that date back to the 1960s.

Careys was appointed as the principal contractor and its management of the project team has included employing the tender design team to benefit from their first-hand knowledge of the grain complex in completing the detailed work. The team also includes the architect, structural engineer and Dangerous Substances & Explosive Atmosphere Regulations (DSEAR) consultant, while TH White was chosen as the M&E/conveyors specialist.

The Thames alluvial deposits provide a notoriously difficult geology for those working around the capital, so it is little surprise to hear Matthew Kirsop, project manager, describe the ground conditions for piling operations, in particular the band of alluvium, as being "like toothpaste". Keller Geotechnique was awarded the subcontract to install 409 fully cased, bored concrete piles, which went down an average of 28m to found in the underlying chalk and gravel.

Rather than installing conventional pile-caps, Careys in-house design team opted to construct lines of 'elephant foot' columns, which harness together the load-bearing capacity of half a dozen or more of the new piles, as well as the 'legacy' support of the older foundations left beneath the retained ground floor. Each of the elephant foot columns has a base measuring 4.4 × 2.0m, while the upper section reduces to 2.1 × 0.92m.

Rising to a height of 4.5m above formation, the 72 columns effectively create an undercroft at which level operatives cast the 750mm-thick bin slab in heavily reinforced concrete, before preparing to switch to slipform.

TWO-DECK SLIPFORM SYSTEM

Kurt Sartorius is responsible for evaluating all the slipform proposals across Careys ahead of construction, from contract award to completion. He says, "Careys considers five slip providers on every opportunity. Every project is sent out for proposals and evaluated back to overall method, detail and cost in the first round at tender stage, against cost to the company. Once we've gained the contract and assessed it together with the site team, a supplier is chosen at the earliest opportunity. With all information, dates and requirements reconfirmed, the scheme is then officially awarded to our slipform supplier for design to be closed out."

In the case of the Port of Tilbury project, it was the Austrian specialist Gleitbau that came in with the best package, being contracted to supply a modified version of its well-proven, two-level slipform rig, initially being launched from the south side of the bin slab to begin constructing the first bank of 15 grain silos.

The double-decker design not only provides safe access and a degree of weather protection for the dozens of operatives involved, but it also facilitates the execution of very distinct operations that are separated by just a few feet in space but by many hours in time.

The entire slipform frame is continuously supported and raised up off vertical rods cast into the core walls, using hydraulic jacks spaced at 2m intervals, while lasers help the electronic control system keep

MAIN IMAGE: The new silo facility for the Port of Tilbury measures 79 × 22m with its construction consuming 1000m³ of concrete.

everything vertically aligned and moving in unison.

All of the predominantly 25–30mm diameter, high-tensile steel reinforcement cages are assembled in-situ, along with any necessary box-outs by those working on the upper level, ready for the concrete to be placed using either of two gantry-mounted booms, which are fed from a static pump at the base. While conventional vibrating pokers are used to ensure correct compaction, any necessary 'rubbing up' or other finishing work is carried out at the lower level as the rapidly curing concrete emerges from the 2.5m-tall, steadily transitioning shutter.

Kirsop says that the amounts of retarders and superplasticisers used varied considerably throughout the two-week duration of both slipforming exercises. He explains:

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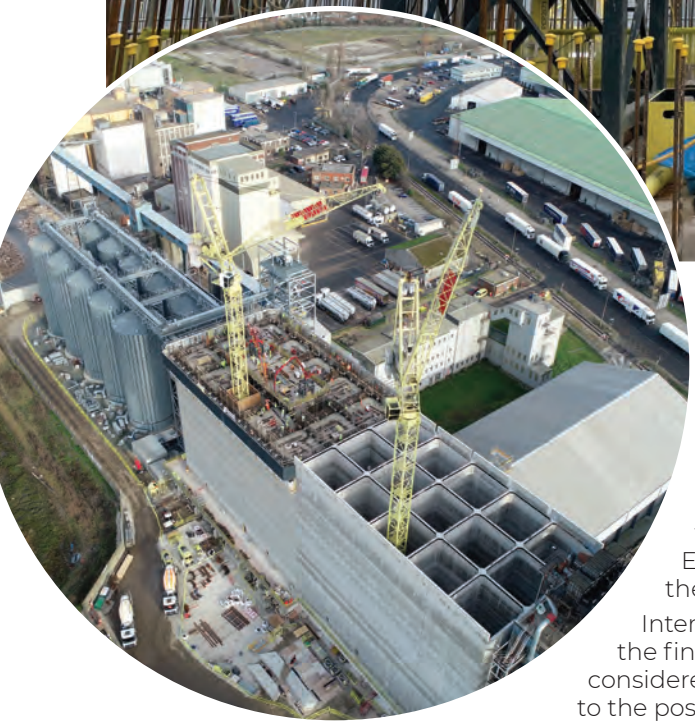

TOP:
The density of reinforcing steel remains constant for the entire 37m height of the 300mm-thick slipform structure, to ensure it would withstand an explosion.

INSET:
Once complete, the terminal will be restored to its full storage capacity of 135,000 m/t.

"There were ten different mixes trialled ahead of work commencing – all C32/40 or C40/50 strength class – tailored to accommodate different speeds of rise for the slipform, depending on ambient temperature as well as to facilitate creating box-outs, of which there were multiple ones as we neared the top. Also, a ridge-type feature had to be formed along the centre line to carry the precast planks, which make up the sloping roof structure.

"Quality control is paramount for slipforming, with the temperature of the placed concrete being monitored, while cube testing was carried out for every delivery from Euromix, which supplied all the concrete at Tilbury."

Interestingly, while the finished concrete is considered to be inert in regard to the possibility of the stored grain suffering contamination, throughout the design of the silo complex, great care was taken to avoid creating ledges or other features where dust might collect; and the density of reinforcing steel remains constant for the entire 37m height of the 300mm-thick slipform structure to ensure it would withstand an explosion.

Some ten months after work began, Bank One of the new silos was finished prior to Christmas 2022, enabling the slipform to be dismantled and re-erected ready to begin casting the second bank early in the New Year.

Sartorius observes, "It's reasonable to say that the way the slipform was set up and managed on the Tilbury contract offered a much more organised and calmer environment than is the norm for such operations. That calmness is definitely down to the site management. They put a lot of time in ahead of the game, planning all the operations, so that when you went to site, everything was in the right place – methodical – which promotes good productivity and safety. The slipform was specifically designed for the task and the platforms were continuous. This created a safe environment and one that offered ample space for fixing the steel reinforcement."

EXACTING TOLERANCES

Throughout the redevelopment, Careys and the company's subcontractors were required to work to extremely tight tolerances, both to avoid any irregularities that could present a risk, and to guarantee perfect alignment of all the new chain conveyors where they interface with the reconfigured steel frame and existing mechanical handling equipment in Centre House, which still feeds 1960s-era silos. This was in part achieved by making use of 'cloud point' laser scanning technology to obtain millimetre-precise 3D images of the existing installations.

Kirsop concludes, "While we had a designated logistics route into our site, Tilbury is an active industrial setting with lots of vehicle deliveries, container cranes and even trains moving around it. We are proud, then, to have maintained good relationships with the Port of Tilbury throughout."