Putzmeister Concrete Pumps GmbH, 72631 Aichtal, Germany

The new Storstrøm bridge created from precast concrete elements – Quality, costs and construction time speak for themselves!

■ Bernd Rottmann, Process Engineering, Putzmeister Concrete Pumps GmbH, Germany

Denmark and Germany are moving closer together thanks to the new prefabricated bridge over the Storstrøm. When completed, the bridge will connect the Danish islands of Zealand and Falster via the island of Masnedø. With a total length of 4 km, it becomes Denmark's third longest bridge and thus ranks behind the Øresunds Bridge and the bridge over the Great Belt. In the future, both trains (up to 200 km/h) and cars (up to 80 km/h) will travel over the Storstrøm Bridge. The structure is an integral part of the rail link between the Danish capital Copenhagen and Germany. Future commercial and passenger transport between Scandinavia and Germany will be much more efficient.

In 2018, the Danish Ministry of Transport, as both client and future operator of the Storstrøm Bridge, awarded the contract for the bridge construction to the Italian consortium SBJV under the leadership of Itinera S.p.A. following an international bidding process. In addition to the architectural appearance, the main criteria for awarding the contract included the superior quality assurance and guaranteed timeframes provided by precast concrete technology, compared to in-situ construction, especially under adverse weather conditions.

Fig. 1: Illustration of the Storstrøm Bridge as integral component of the rail connection between the Danish capital Copenhagen and Germany. (copyright: Vejdirektoratet)

The impressive architectural design as well as the concept for assembling the bridge from prefabricated elements were developed by the renowned architectural firm De Miranda from Milan, which has over 50 years of international experience in bridge construction. With the exception of the central pylons and the associated bridge deck, as well as the ramp structures located on both abutments of the bridge, the structure is entirely constructed with prefabricated concrete elements.

Key project data

Length of bridge	3,832 m
Ship passage clearance	26 m
Construction costs	560 million Euros
Use	2 rail lanes, 2 road lanes, 1 combined cycling / pedestrian path
Connection of the islands of	Masnedø and Falster
Establishing the precast plant	March 2019 to June 2020
Installation of the concrete pump system	September 2019 to February 2020
First concrete pumping	October 2019 (floors, production halls)
Commencement of precast production	June 2020

Concept of the production plant

The precast elements are classified into three basic types:

1. Foundations
2. Bridge pillars
3. Deck structure

Fig. 2: The three production halls for manufacturing the precast elements for the Storstøm Bridge. (copyright: Vejdirektoratet)

For each type of precast concrete element, separate production halls were created according to the respective space requirements. The three production halls are shown in Figure 2. With a length of 400 m and a width of 50 m, the production hall for the bridge decks is the largest. The second largest hall is used to produce the bridge pillar elements and the prefabricated foundations are produced in the smallest hall.

Due to the high weight of the precast elements, it was necessary to locate the production plant at a port facility so that the elements can be transported to the quay by means of heavy-duty vehicles or sliding rails, from where they are towed to the installation site by means of pontoons.

The operator must ensure the highest quality of the precast elements. Therefore, in the basic concept of concrete production and conveying, the decision was made to install two production lines with continuous concrete supply via pumps, plus an additional redundant third line. Pumping is the best method to avoid segregation and cold joint connections. In order for the concrete to be filled into the formwork in the required quality, the operator relies on a concrete pump solution from Putzmeister. For this purpose, an electric stationary drum mixer (P8E) as a buffer storage and a stationary electric concrete pump (BSA 2109 H E) were installed under each concrete mixing plant.

The stationary mixer is equipped with load cells and integrated into the mixing plant in terms of control technology, so that the buffer volume can be precisely displayed to compensate for the batch operation of the upstream mixing plant and refilled as required. The downstream concrete pumps are equipped with level measuring facilities in the pump funnel, which automatically activate the filling through the buffer tanks.

Fig. 3: Two mixing plants with the 8 m³ buffer tanks and stationary concrete pumps BSA2109 H E.

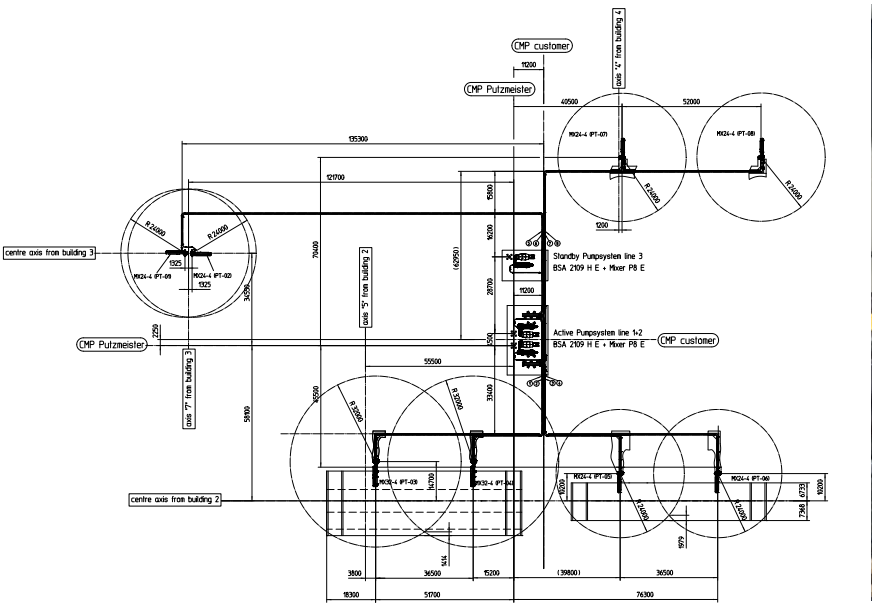

Fig. 4: The drawing shows the working areas of the distribution masts (circles) and the pipeline paths. The concrete pump lines (2 + 1) can be seen in the centre.

At any time, only two concrete pump lines are operated in parallel. The third line serves as a substitute in order to be able to replace an unavailable supply line in the event of a fault at a mixing plant or a pump line. In addition, the piping system is also designed in such a way that maximum operational safety is ensured during the concreting process.

These measures ensure that the continuous filling of the formwork for the large-volume precast components is always guaranteed. In addition to the high demands on the quality of the prefabricated elements produced, the cost-efficient concrete supply is of course another important aspect for the operator. Thanks to the selected concrete pump solution, the concrete can be supplied directly from the mixing plant to the formwork, which is located at a distance of 200-300 m.

As shown in Figure 4, a total of eight stationary masts are located in three production halls for formwork filling, which are fed with the concrete pumps. The two smaller halls each contain two distribution masts with a reach of 24 m (MXR24). In the large production hall for bridge deck production, a total of four distribution masts are installed. In addition to two additional distribution masts with a reach of 24 m (MXR-24), two distribution masts with a reach of up to 32 m each (MXR-32) are also used in this production hall. Each stationary distributor mast is located on a 6 m tubular column (RS850) and is connected to the base of the column with a main conveyer and a reserve conveyor line. The centre of the drawing (Fig. 4) shows the three buffer storage facilities and the concrete pumps, which are installed under the mixing plants. The concrete is transported directly from the mixing plant into the formwork, which is up to 300 m away. For this purpose, the pipelines are laid in a ditch and do therefore not obstruct any traffic in the plant.

The precast members are produced from self-compacting and conventional concrete. In addition to the basic constituent materials cement, gravel, sand and water, all mix compositions also contain micro silica, fly ash and air entraining admixtures. In order to produce high-performance concretes of consistent quality with a low water/cement ratio and sufficient workability retention without delaying the development of early strength, two different plasticizing agents are used, depending on the requirements.

Due to the robust concrete mix formulations, an excellent surface quality, as well as good pumpability and full compaction can be achieved despite closely spaced reinforcing bars.

The first foundation element with integrated bridge pillars

June 2020 marked the commencement of precast element production. It started with the foundations in Hall 3, where foundation elements can be manufactured at two production sites.

The operation of the stationary masts (Fig. 5 and 6) is carried out by means of radio remote control in order to be able to precisely insert the hose endings into the reinforcement cage. The two stationary masts (MXR-24) ensure simple, uniform and safe formwork filling assisted by 3-dimensional operational capacity and the 24 m range. Under normal conditions, concrete placement in times of high demand is done with two pumps simultaneously in order to achieve an average flow rate of 45 to 50 m³/h per formwork. The maximum flow rate for the self-compacting concrete is 50 m³/h per pump.

Fig. 5 and 6: Reinforcement cage of the first foundation element (left) and the two MX24 distribution masts on the tubular column system (right).

On December 18, 2020, the first prefabricated foundation with two pillar segments was transported to the assembly site, using pontoons as discussed earlier. The total weight of the component is approx. 1,800 t. At the assembly site, a heavy-duty crane (28 m high and 60 m wide), which was brought into the assembly position in advance, was used to place the first foundation element (including the pillar segments) on the prepared seabed.

Fig. 7: Completed foundation, ready for transport (copyright: Vejdirektoratet)

Fig. 8: The first prefabricated foundation with two pillar segments is transported to the assembly site and installed with a crane catamaran (copyright: Vejdirektoratet)

Get your own impression of the remarkable prefabricated Storstrøm Bridge and discover additional interesting information at https://precast.putzmeister.com.

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Deliveries and services by Putzmeister Concrete Pumps GmbH

- Process consulting for concrete conveying and plant installation
- Concept development incl. support of detailed engineering solutions for concrete transport and installation
- 3 no. of stationary mixers P8E with 8 m³ buffer volume
- 3 no. of stationary concrete pumps BSA 2109 HE (electric motor)
- 1 no. stationary concrete pump BSA 2109 HD (Diesel-operated) as stand-by; can also be used as cleaning pump
- 6 no. stationary masts MXR 24-4 with 6 m RS850 tubular column
- 2 no. stationary masts MXR 32-4 with 6 m RS850 tubular column
- 1400 m conveyer line SK125-5,5" / 130 bar
- 2 no. MXR 35-4 with 9+3 m RS850 tubular column (installation on ponton for concrete placement for the central pylons)
- Supervision for assembly and commissioning
- Service, supply of wear and spare parts by the locally responsible Putzmeister branch in Hamburg, Germany ■

FURTHER INFORMATION

Putzmeister Concrete Pumps GmbH
Max-Eyth-Str. 10
72631 Aichtal, Germany
T +49 7127 599-0
pmh@putzmeister.com
www.putzmeister.com