Measuring Viscosity Of Fresh Concrete By Sensing Torque

Background

Torque Measurement is a very simple mechanical process; in essence, it is a measure of the 'force' used in turning (or attempting to turn) something. When a force or 'torque' is applied to a shaft, the shaft twists (by a very small amount). This twisting produces a 'stretch' in the material of the shaft, and it is this process that allows a measurement of force in the mixing process. The input torque applied to a mixer is directly related to the measuring viscosity of the mixture.

Our client needed to apply these principles to a large-scale concrete production at Terminal 5 Heathrow. The existing system used the measurement of the electrical input power (KW) to determine the viscosity of the mix. Large fluctuations in the input voltage and the inherent inaccuracies of measuring power on large motors, in this way, made control of the process difficult. The ability to control and monitor the quality of concrete produced was being disrupted due to the inconsistency of power being supplied. Therefore, a more reliable measurement of the mix viscosity was required.

Torque measurement is an ideal principle for controlling mix consistency, not just in concrete production, but other forms of mixers and associated applications.

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The Torque monitoring solution provided highly accurate data relating the consistency and performance of the concrete mix. Data supplied from the shaft provided raw data, indicating how the mix was performing, as it was being mixed.

The Client

Concrete production for the T5 Heathrow project was identified as cost inefficient, hence a more affordable alternative was required.

Normally, measuring the supply current during the mixing process controls the concrete viscosity and provides an indication when the correct mix consistency has been achieved. If the power, supplied to the motor, is fluctuating and not at a consistent level, it can be difficult to keep costs at a controllable level and waste concrete was becoming a huge issue.

One way of controlling the power fluctuations was to switch to a more reliable power supply in order to control mix quality. In the first instance, the company made the decision to supply a generator for the concrete production facility. Although it could potentially resolve the issue, it proved to be an expensive option, so they continued looking for a more cost-efficient alternative to control and monitor concrete production.

Solution

Firstly, Datum identified a suitable coupling in the driveline for measurement. The motor, which drives a spindle shaft within the mixing drum to mix the concrete, powers the concrete mixer. The motor is connected to the shaft via this large coupling. By measuring the torque on this coupling, one can get insight into the force being applied to the concrete mix. Understanding this applied force within the mixing process would provide key information of mixture viscosity, allowing accurate assessment of concrete quality and control, without the need to control the input power.

As long as the coupling controlling the shaft could be monitored, data could be provided on the viscosity of the mix, thus controlling quality and efficiency of production, as well as saving money and eliminating waste.

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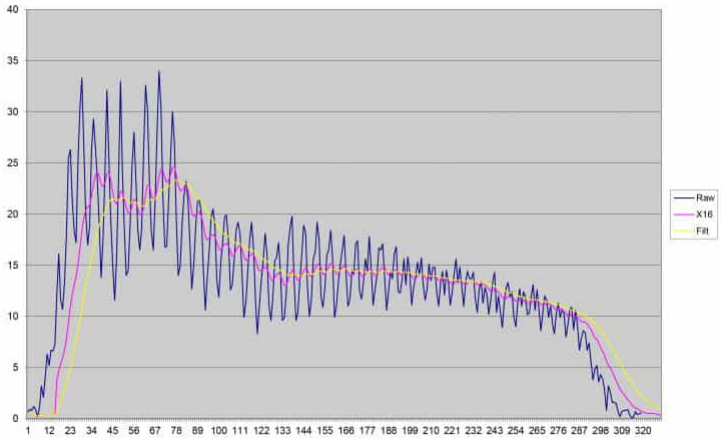

Custom torque transducer

Impact

Because of the nature of the environment, it was more efficient instrumenting the coupling and assembling the torque measuring equipment at Datum Electronics, converting the coupling into a custom torque transducer.

The Datum Torque Measurement System was installed onto the shaft along with an inductive power coupling. A stator unit was engineered to fit the envelope around the coupling, which provides power for the shaft unit and acts as a receiver for the torque signal. This design is completely non-contact. Torque and Shaft speed signals are transmitted from the stator, as RS485 data to the control room. The data is displayed and recorded in the control room as either torque or power.

Datum utilised a spare coupling spacer to replace the existing one in line as an exact fit replacement.

The Torque monitoring solution provided highly accurate data relating the consistency and performance of the concrete mix.

Data supplied from the shaft provided raw data, indicating how the mix was performing, as it was being mixed. The data transmitted from the shaft showed the sharp rise in torque, as the load is added to the mixer and the drop off in torque (viscosity) as the mix becomes more consistent. Operating staff are able to “tune” the mix by the addition of fluid to attain the desired consistency in the shortest time. The repeatability of the data from the torque signal has allowed a reduction in the time required to achieve this.

Analysis of the logged data shows that not only does the data revealed the change of viscosity, but it also shows the consistency of the mix in term of the lumps within it. Once the mixture was at the right consistency as indicated by the data, it could be dropped and the next load made ready. The display of data for the operator was optimised to show the exact performance of the mixing process.

Due to the fluctuations in the mixing process, the data was smoothed in a software programme, giving an averaged torque level, allowing the user to know the exact performance of the mix.

Following successful proving trials on the first mixer, a second system was ordered and installed. Once the first unit was installed, a second Torque measuring system was installed on the second batcher, due to the successes of the first.

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