New steel silo for Irish Cement

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Irish Cement's Limerick works is located on the west coast of Ireland near the River Shannon. The original plant was built in 1938 and in 1981 a 40,000t steel silo was erected by the German manufacture, Salzgitter Maschinen und Anlagen AG to store the clinker.

Work on foundations at Irish Cement's, Limerick plant

Since then, the production capacity of the plant has been increased and the additional clinker was stored in other places. To fulfil new environmental standards and various other reasons, Irish Cement Ltd recently invested in a new large clinker storage, amalgamating several stockyards into one silo resulting in greater economic and operational benefits.

Cement production and environmental control

Cement production in Limerick involves the fusing, at high temperature, of a precisely-controlled blend of very finely ground limestone and shale. The resultant clinker is then further ground with the addition of approximately five per cent of gypsum.

The Limerick Works utilises the modern dry production process. The consequent elimination of large quantities of mixing and blending water, which characterised the older wet process, enables savings to be made in the fuel traditionally used to drive off moisture. Irish Cement recognises the environmental responsibilities associated with all aspects of its operations and as a matter of policy seeks to avoid, reduce and mitigate any potentially adverse effects on the environment.

It is company policy to comply with all legal requirements imposed on its operations and in particular to operate its production facility at Limerick in accordance with the requirements of the environmental protection agency.

All capital expenditure projects, including the new storage silos, at the Limerick works include a significant investment in environmental control. The

Welding equipment


Roof platform assembled in the workshop

plant seeks to exist as a good neighbour within the local community and has adopted a policy of open communication on environmental performance.

Major issues for new project

The new clinker silo should have a live 60,000t plus capacity and should have two discharge tunnels which can be used separately to feed different cement mills.

Because of the hot clinker, coming sometimes from the kiln at about 300°C, the new silo cannot be made of concrete. The existing steel silo was also designed for the same temperature, so the new silo should be designed in the same way only with 50 per cent more storage capacity. To clean the silo a wall access (gate) has to be assigned.

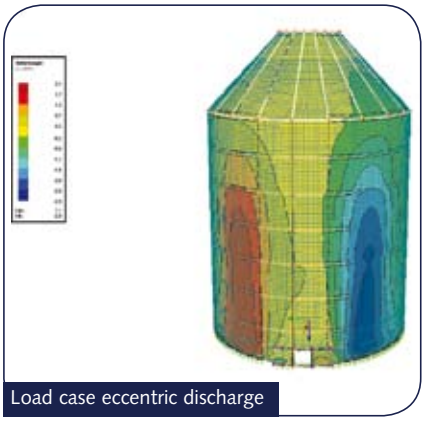
The silo should be made of corten steel (S355J2W, Material No 1.8965). In this way, no corrosion protection like coatings are required. Corten steel is more expensive than common S355J2 but the cost calculation for sand blasting the silo structure including painting and maintenance of the painting (destroyed from time to time by hot clinker) shows, that this is the more efficient way.

The supplier of the first silo, Salzgitter Maschinen und Anlagen AG does not operate in this business any longer. Therefore, Irish Cement decided to contract Wuerth Consulting Engineers for the design and consulting services for the steel parts of this project.

Silo design

The basis for the design was the silo loading code DIN 1055/6 (2005) which handles the load case 'eccentric discharge' much more carefully than the earlier one.

The silo measures □37m and is 40m high with the roof at an 45° angle. The structure is based on limestone rock, so a


Load case eccentric discharge

flat foundation can easily take the loads from the silo. The two discharge tunnels have an axis distance of 11m. Each tunnel has four discharge openings, the two in the centre are motorised and remote controlled and the other two openings are manual operated and locked.

Extraction stages

Stage 1 **51,000t**
(tunnel 1 with 2 motorised openings)
Stage 2 **5000t**
(tunnel 1 with 4 openings)
Stage 3 **3000t**
(both tunnels with 2 x 2 motorised openings)
Stage 4 **1000t**
(both tunnels with 2 x 4 openings)
Stage 5 **10,000t**
(bob cat through wall gate)
Total **70,000t**

The maximum available sheet thickness for the used steel quality is 50mm. This gives the design the limit. Operation rules are required to keep the eccentricity so small, that the wished capacity could be reached with the available sheets.

Operation rules for the silo are only to use the motorised openings before using the manual operated openings. With this restriction it was possible to design such a


Uplift of last wall sheet

large silo with a relatively small eccentricity and a high live/dead load ration of 0.86.

Other main load cases which had a significant impact on the design:

- temperature of the clinker: 300°C
- wind: 54m/s
- dead load (conveyor, penthouse, dust load).

In the end, for the design of a steel silo, only one point is really determining: the vertical loads on the wall (including friction) want to buckle the wall sheets and the safety factor against this buckling must be calculated greater than 1.5. The total steel consumption of the clinker silo is around 1400t.

To insure that everything which took into consideration of the design will be executed a quality assurance programme for fabrication and erection and a quality assurance programme for operation and safety was worked out.

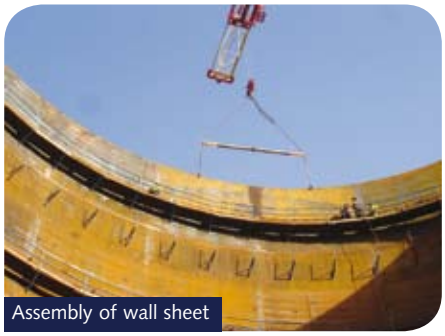
Fabrication and erection

To fabricate and erect such a structure a contractor qualification H2=D according to the EN 729-3 is required.

During fabrication the most difficult tasks are to curve the heavy and thick wall plates. The required deviation tolerances are quite hard to reach. A very experienced contractor has to be chosen for such a project.

After a tender evaluation Gronemeyer & Banck from Germany was chosen for the supply and erection of the steel silo. This company has been producing large capacity storage tanks since its foundation


Sheets lifted into position


Assembly of wall sheet


Roof on ground ready for lifting

in 1881. Next to its excellent reputation in building large storage tanks the offered price was the lowest. It was remarkable that the German contractors made lower offers than the contractors from the east and southern part of Europe.

Erection procedure

After erection of the base rings, the wall sheet of the first layer has to be placed with a crane. The vertical and horizontal welding edges will be first temporarily fixed. When the whole ring of the first layer is placed, the geometry of the silo must be checked and the given tolerances must be kept. After that, the vertical welding should be carried out first, followed by the horizontal welding. The roof structure is to be erected (and stabilised by some temporary wind bracings) outside the silo at the floor. The up-lift weight of the roof is limited to 50t because the maximum capacity of the crane available on the island is 50t for a hook height of approximately 70m. When the roof has reached its final position on top of the silo, the roof cover sheets can be finished.

The horizontal welding utilise is around 60 per cent and the vertical welding utilise is around 75 per cent. Weldings are made with equipment which can also carry out the 50mm sheet welding in one processing step! For this procedure the equipment must be equipped with a water cooling system. The required quality for the vertical welding is level B (ultrasonic checks are required) and for the horizontal welding it is level C (ultrasonic checks are not required). Time to order the material was approximately three months, time allowed for fabrication was about one month and time for erection is scheduled for nine months.

Conclusion

Today it is rare to have the opportunity to realise such large steel silos. Under specific circumstances it is still worthwhile building large silos with structural steel. Know how about these kind of silos is not widespread, either in the design nor in the supply.

To get a satisfactory result for such a project it is important that the client chooses the designer and contractor carefully so that his project ideas can be realised.


Roof in position


Roof been lifted into place


Stairway to silo heaven