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CONSTRUCTION PLANNING FOR THE RENEWAL OF THE MANIPULATOR CRANE TRACK IN THE MAW SCRAPPING FACILITY OF KERNTECHNISCHE ENTSORGUNG KARLSRUHE GMBH

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ABSTRACT

At the KTE GmbH reprocessing plant, the crane system in the MAW (Middle Activated Waste) disposal cells is currently being modernized. In the process, the manipulators are being renewed and the load capacity increased, which will significantly expand the processing possibilities in MAW scrapping.

The crane runway rails and girders are being updated and the consoles and their anchorages are being redesigned. In addition to the relevant nuclear and construction engineering regulations, demanding technical boundary conditions from the existing building as well as occupational safety and radiation protection for the personnel performing the construction work must also be taken into account.

The design of the steel structure was particularly complicated by the following boundary conditions:

- Design of the steel structure for two crane systems traveling directly behind each other (drum manipulator and heavy-duty manipulator),
- Construction in existing buildings with limited knowledge of the on-site situation due to poor as-built drawings and limited access because of radiation exposure,
- Significant number of special solutions required during and after completion of detailed design to adapt the structure to existing conditions,
- Interruption of the crane runway girders in the area of the lifting bulkheads and revolving gates,
- Adjustment of the brackets and the anchorages to the crane system, and
- Adjustment of the brackets and the anchorages to the wall openings and interfering edges.

INTRODUCTION

The crane system in Building 536 of the KTE GmbH reprocessing plant is currently being renewed. The aim of the measure is to design the structure and anchorages for larger loads and to ensure fatigue strength requirements are met for the planned operating life of the plant.

Two manipulators operate the crane system:

Drum manipulator H03:	lifting capacity 5 t
Heavy-duty manipulator H32:	lifting capacity 10.5 t

The two crane rails along the sidewalls (east and west wall) connect the cells 129, 130 and 131 (loading/unloading cell, airlock cell, and work cell, respectively) which are located one behind the other.

The cells are approx. 8.0 m wide, 5.4 m high and are separated from each other by 1.3 m thick reinforced concrete walls. In the partition walls between cells 129 and 130 and cells 130 and 131, there is a swing gate and a lifting bulkhead. The lifting bulkheads can be raised hydraulically to ensure that the walls can be driven over with the manipulators. The side walls in cell 131 are clad with a stainless steel liner up to a height of approx. 4.0 m. A plan view of the crane runway rooms is shown in Figure 1.

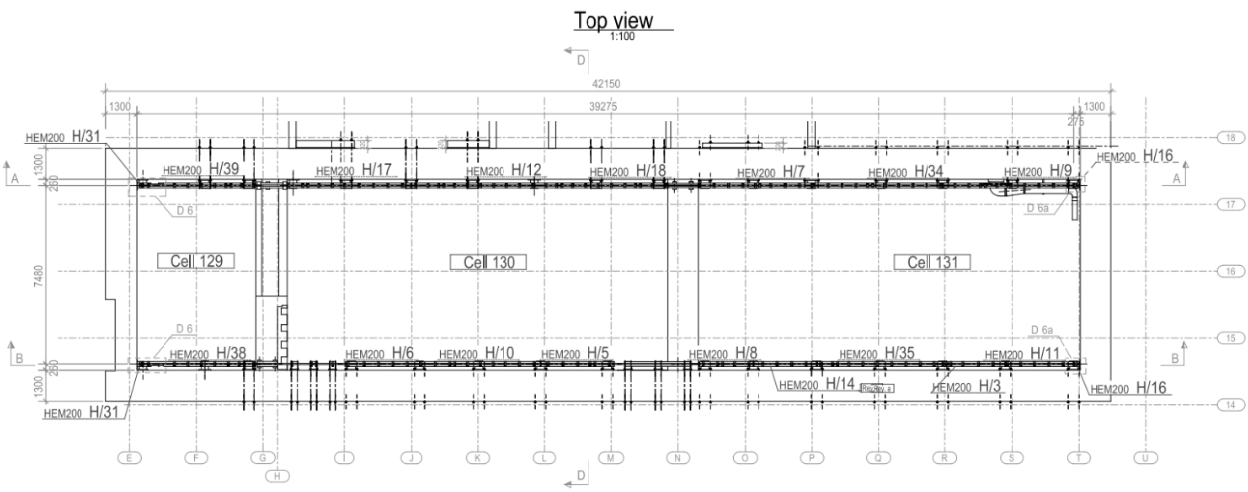

Figure 1. Top view of the crane runway in cells 129, 130 and 131

The crane rails are placed on HEM 200 crane runway girders (as shown in Figure 1) and bolted to the upper flange by means of steel angles. The crane runway girders rest on steel brackets that are anchored to the side walls with through-wall-anchors and dowels approved for earthquakes. In the area of the partition walls between the cells, the crane runway girders must be interrupted for reasons of space. This area is bridged by the crane rail. In this area the crane rail is supported by steel structures anchored to the lifting bulkhead walls and sliding bearings were used.

When planning or selecting the anchoring methods, radiation protection is an important aspect in order to minimize the exposure of the installation personnel. For this reason, a large number of through-wall-anchors were used in order to minimize the time spent in the rooms during assembly.

COMPLICATIONS OF THE STRUCTURAL ENGINEERING DESIGN

The simultaneous consideration of the various boundary conditions required elaborate and detailed planning. The following pages describe the special structural engineering features.

Limited mounting area of the brackets on the side-walls

The anchoring area of the anchor plates is limited at the bottom by the +4.0 m high stainless steel liner (cell 131 only). Towards the top of the wall, the through-wall-anchors were not allowed above the crane runway girder to avoid a conflict with the crane system. A detail of the through-wall-anchors is shown in Figure 2.

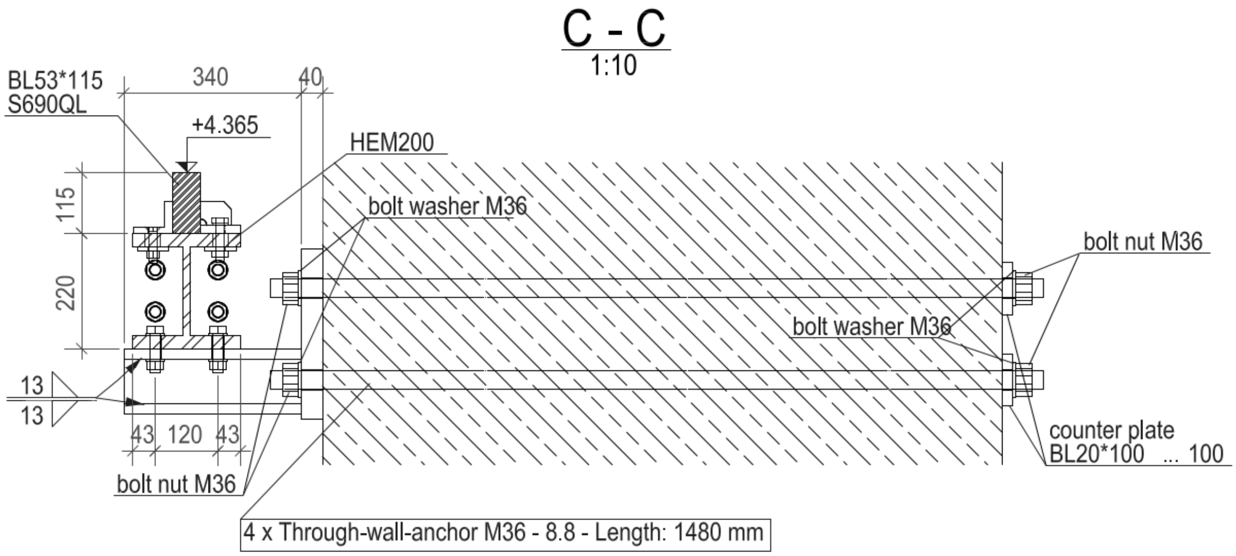

Figure 2. Through-wall-anchors of the details D2 and D3

Another constraint for the design of the anchorages, in addition to maintaining the edge distances to the numerous interfering edges and wall openings, was the lack of space on the partition walls between the cells.

Dismountable anchors with shear keys

Maintenance of the crane system with its manipulators requires demountability from the construction sections in cell 129. For this purpose, demountable dowel plates with double shear keys were provided as shown in Figure 3.

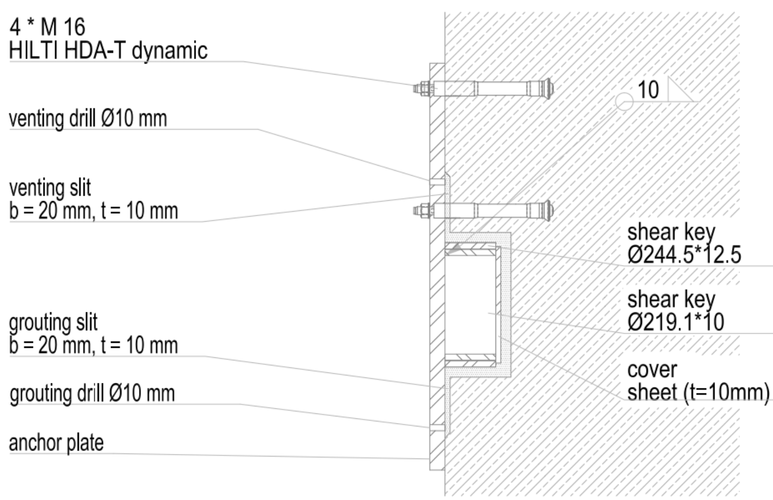

Figure 3. Dismountable shear key design of the D4 detail

Requirements for operational stability

When the crane is in operation, high loads will be transported and on- and offloaded, resulting in alternating stresses and fatigue was also considered in the design for the crane runway, the crane girder and the anchorages. In particular, due to the simultaneous use of the two manipulators, various different load positions and the resulting interactions had to be investigated and the fatigue behavior assessed.

In parallel, the use of high-strength S690 steel for the crane rail and anchoring means suitable for dynamic loading is intended to ensure the planned long service life of the MAW scrapping plant and the required operational strength.

Difficult working conditions due to limited accessibility because of radiation

Due to the existing local dose rate and contamination in the various work areas as well as incomplete as-built documents, it was not possible to prepare an accurate record of the existing conditions as a basis for design. Modifications to components already manufactured and supplied can only be carried out on site in the cells. As a result, the possible solutions were limited in terms of planning.

In addition, radiation protection was an important aspect for the choice of anchoring means. A large number of the brackets were fastened with through-wall-anchors. This allowed part of the work to be shifted to the neighboring rooms behind the side walls. Working under full protection with external air supply (Mururoa protective suits) became necessary. Very tight tolerances had to be maintained.

Crane runway transition in the area of the lifting bulkheads and the revolving gates

The limited free transition height between the upper edge of the lifting bulkhead and the lower edge of the ceiling meant that the crane runway girder had to be interrupted in this area. These sections were bridged exclusively with the rail. The crane rail is supported on steel structures anchored to the lifting bulkhead walls. Figure 4 shows the transition area of the lifting bulkheads.

The limited bending capacity of the rail and the existing interfering edges and wall openings above and next to the lifting bulkhead, as well as the space remaining after the lifting bulkhead was lowered, required elaborate preliminary and construction planning.

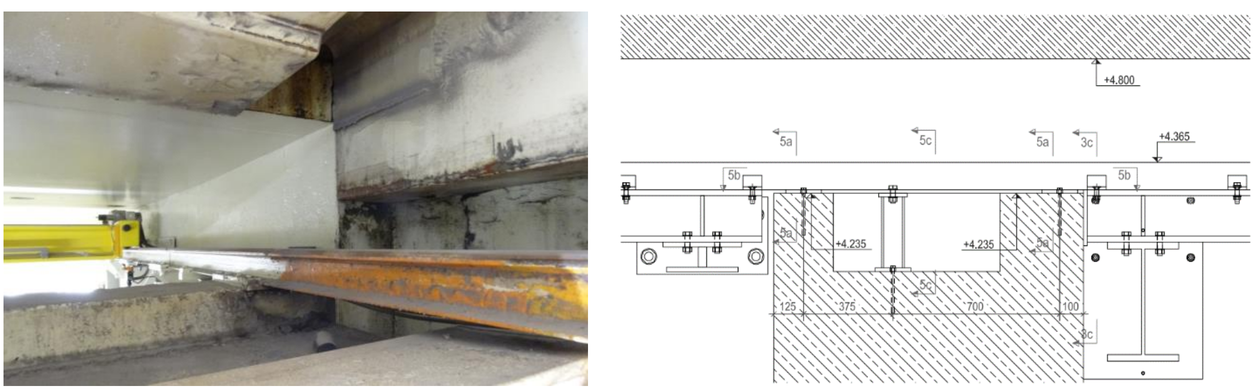

Figure 4. Transition in the area of the lifting bulkheads

Collision of the new consoles with the rotary gates of cell 130

As a result of the greater loads of the new crane system, additional brackets with reinforced vertical stiffeners were required next to the swing gates. When open, the swing gates could have interfered with the stiffeners, prohibiting the swing gates from opening fully. To eliminate the conflict, vertical slots were planned in the swing gates and adapted to the geometry of the stiffeners as shown in Figure 5.

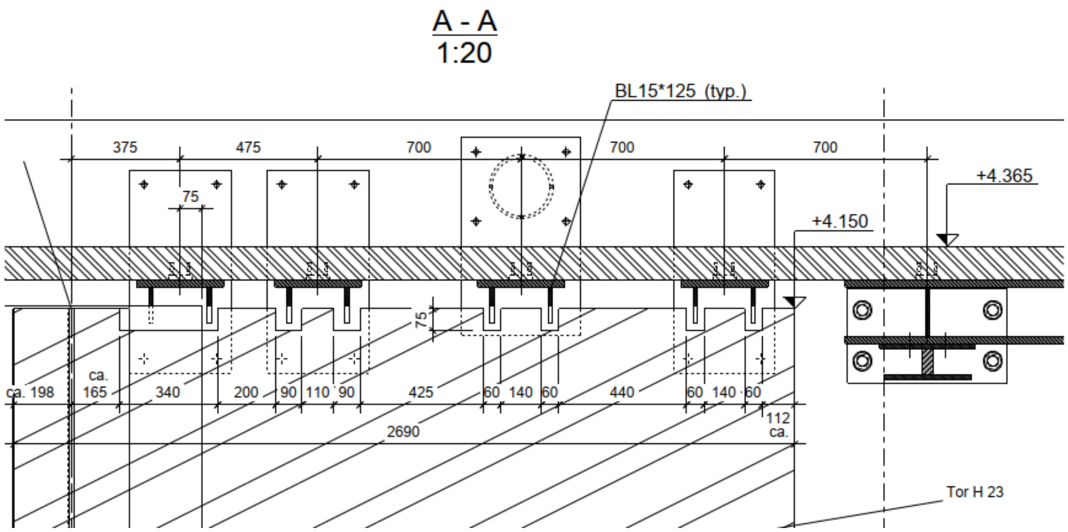

Figure 5. Slots in the swing gates for collision avoidance

Interfering edges on the back of the wall

As previously described, a large number of the brackets were fastened with through-wall-anchors. This required a precise interference check in the adjacent spaces and the design optimization of the steel structure.

Figure 6. Back side of the through-wall-anchor in the neighboring room

In places where through-wall-anchors were not possible due to the conditions in the neighboring rooms, elaborate dowel anchorages with, in some cases double shear keys were designed for the transmission of the large vertical forces of the new crane system.

Deviation of the as-built documents from the on-site situation

There were significant deviations between the (incomplete) as-built documents and the on-site conditions. As a result of these deviations, individual components that had already been manufactured and delivered had to be adjusted. Some deviations are listed below and shown in Figures 7 and 8.

- The longitudinal walls of the cells do not run parallel to each other. This results in different distances between the rail and the wall. Holes had to be subsequently drilled in the brackets and the load-bearing capacity of the brackets and anchor plates had to be checked for longer than expected lever arms.

- The cells are longer than specified in the as-built documents. Lining plates had to be retrofitted at the head plate connections, which then had to be designed for the changed construction.

- Not all wall openings were specified in the as-built documents. In some cases, channels in the wall were also larger than indicated, so that fasteners would have ended up in voids. As a result, several anchorages had to be redesigned.

- In the area of new anchorages there were existing steel parts embedded in concrete. The anchorages had to be adapted to avoid these and redesigned.

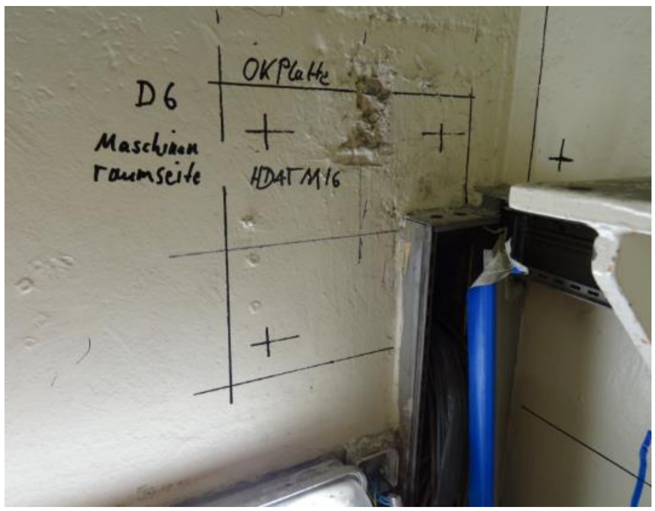

Figure 7. Cable duct as an interfering edge

Figure 8. Openings in the concrete and previously installed steel plates

CONCLUSION

The planning and execution of constructions in building structures with a high local dose and outdated as well as incomplete as-built documents form complex challenges for those involved.

On the one hand, the structures have to be planned in such a way that they can be assembled as easily and quickly as possible; ideally from other rooms, e.g. by means of through-wall-anchors. On the other hand, creativity is also required, as one has to react to unforeseen conditions on site and adapt the designs accordingly. Thus, special solutions and rescheduling are the rule rather than the exception in the course of such a project.

The renewal of the crane system in the cells of MAW Disposal is a suitable example of this, as the diverse boundary conditions required demanding preliminary planning, rescheduling during construction, as well as complex implementation.