COMPARISON OF THE PERFORMANCE PARAMETERS OF THE TOOLS FOR A DECONTAMINATION OF CORNERS

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ABSTRACT

Currently, corners are worked on with hand-held tools with a connected vacuum exhaust system for the reduction of the dust emissions, such as needle gun, milling tool and concrete grinder. These tools are not specially designed for the decontamination of corners, so that they can not provide a good workperformance to decontaminate the corners. Because of the high needs of the suitable tools for the decontamination of corners beginnt the research project “EKont”. The aim of the research project is to compare the performance parameters and investigate the fracture mechanisms of the currently used tools for the decontamination of corners. Based on these results, an innovative, partially automated demonstrator for a dry-mechanical decontamination of corners in nuclear facilities will be developed.

INTRODUCTION

During the deconstruction of a nuclear facility, depending on the type of nuclear power plant, about 70.000 up to 140.000 m^2 of concrete surface area has to be decontaminated. [1]

For the decontamination of flat concrete surfaces, a wide variety of tools are available. But these tools are not suitable to be used for the decontamination of corners. The better method for the decontamination of nuclear power plant will help to reduce the radioactive waste, avoid the environmental pollution and improve the environmental protection. [2]

In addition, the corners are often difficult to access or are overhead located. Several factors like the heavy hand operated tools with exhaust systems, working areas which are difficult to access, the forces and vibration make the task of decontamination a burden and add the operator physical stress.

In this paper the progress of project “EKont” (Project number: 15S9416), funded by the German ministry for education and research (BMBF), will be explained. Firstly, the test bench which designed and built for the project will be introduced. After that, several currently used tools and the new developed prototypes for the decontamination of corners will be presented. Finally, some tests to compare the performance parameters between the prototype A and the milling tool enviro C25 are evaluated. Reaction forces, vibrations and noise emission will be investigated during the comparison of the performance parameters.

TECHNICAL DESIGN OF THE TEST BENCH

A test bench for testing different tools has been set up. The test bench in Figure 1 enables the measurement of forces, torques, vibrations and noise emission of the tools during the tests.

The linear unit (LRE 8 D14 80x80) in the test bench offers the constant speed at which the tested tools ablates. The 6-axis force / torque sensor (K6D80) is used to measure the forces and torques during the removal process. Figure 2 (left) shows the prototype to be tested in the tool holder and ready for the test. The concrete surface after the processing with the prototype ist shown in Figure 2 (right).

Before the test is carried out, the concrete test specimen is placed in the test bench with a crane and checked for evenness. The height and horizontality of the linear unit are set by the chain hoists on both sides and checked by means of the laser scanner. The tool to be tested is then fastened in the tool holder. The first series of tests are concentrated on the horizontal surface in order to compare the various parameters.

In the next chapter, the currently used tools and the new developed prototypes are shown. Our project also aims at the scientific evaluation on experimentally collected performance parameters among these different new developed prototypes. Due to the time schedule of the project, the comparison of the relevant parameters between the prototype A and milling tool enviro C25 is shown here first.

Figure 1: The test bench

Figure 2: Tool to be tested in the tool holder (left) and concrete surface after the processing (right)

THE CURRENTLY USED TOOLS AND THE NEW DEVELOPED PROTOTYPES

Based on the analysis of different decontamination methods and tools, three prototypes are being developed. The ideal tool will have a flexible housing with an integrated exhaust system to reduce the dust load. This tool should make the decontamination of corners more effective regarding the time duration and the generation of secondary waste and lower the vibrations and weight of this tool to spare the musculoskeletal system of the operator’s physical stress. Figure 3 shows the new developed prototypes A, B and C.

The prototype A uses the Bosch drive and has 5 diamond discs rotating in the same direction with different diameters. The sensible arrangement of the 5 diamond discs forms the almost 90-degree cross-section to enable removal in the corners.

The prototype B is designed with two Bosch drives and 6 counter-rotating diamond disks. The 3 diamond discs on the left and the 3 diamond discs on the right can rotate in the same or opposite direction. It must be validated whether such an arrangement of the diamond discs can compensate for the resulting forces and torques.

The prototype C works with opposite rotation of the middle diamond disc. But here only one Bosch drive is required. Particularly is the planetary gear set for the middle diamond disc. This planetary gear set consists of a smaller sun gear and three pairs of planet gears, while a larger sun gear and three individual planetary gears are used for the two diamond discs from the right and left side. The opposite rotation of the middle diamond disc is realized by the two different types of planetary gear set.

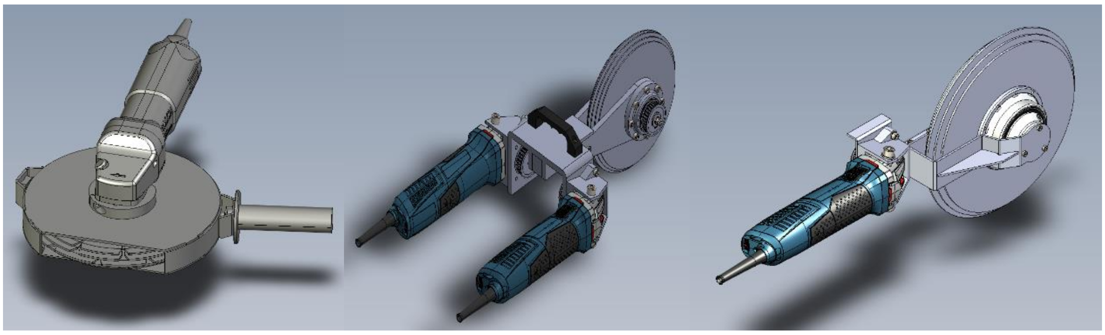

Figure 3: New developed prototypes A, B and C (from left to right)

In order to ensure the competitiveness of the tool to be developed, the following tools which are available on the market have also been examined. All the three currently used tools have an integrated exhaust system and the currently used tools B and C are equipped with the Bosch drives like the prototypes.

Currently used tool A: needle gun DIMU type 34 B

Currently used tool B: milling tool enviro C25

Currently used tool C: concrete grinder enviro ASM 125

RESULTS

The tests are firstly carried out with the currently used tool A (milling tool enviro C25) and the new developed prototype A in order to compare the different Parameters during the tests.

According to the manufacturer's specification, the maximum removal depth of the milling tool enviro C25 is 8 mm, therefore in the tests 5mm is determined for the removal depth. The tests are carried out with different removal rates of 10, 15 and 20 mm/s. To include all the experimental results in this work is cumbersome and makes this report long. So only a limited number of them are presented here.

Reaction force /Specific reaction force

Figure 4 (left) shows the reaction forces of prototype A and milling tool during the tests with the removal depth of 5 mm and removal rate of 10 mm/s. The X axis is the feed direction. The Y axis is the direction perpendicular to the concrete specimen upwards. The Z axis is transverse to the feed direction. The reaction forces of Y axis are much larger than those of other axes. It means that the operators should mainly absorb the reaction force of Y axis and at the same time exert a contact force in the opposite direction, so that the concrete surface could be removed with constant depth. Figure 4 (right) shows the specific reaction forces of prototype A and milling tool. Thanks to the formation of right angle by the 5 diamond discs with different diameters, the prototype A causes lower specific reaction forces compared to the milling tool. As shown in Figure 4, the curves are not smooth. One reason is due to the inhomogeneous composition of the concrete specimens. The reaction forces become larger when the stone aggregates with higher compressive strength are removed. During the removal with cement, the reaction forces are relatively lower because the cement has lower compressive strength compared to the stone aggregate. In addition, the random porosity in the concrete specimen may cause some low points in the curve.

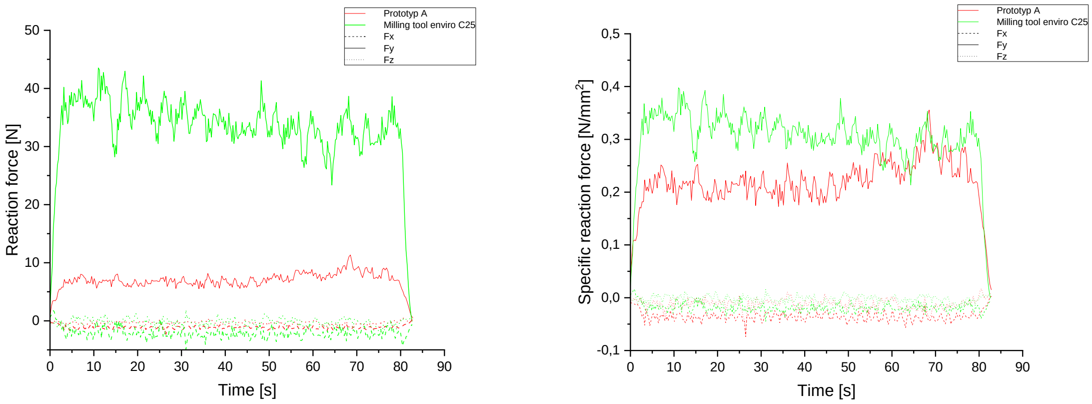

Figure 4: Reaction forces (left) / specific reaction forces (right) against time during the tests

The reaction forces for prototype A during the tests with the removal depth of 5 mm and the removal rates of 10, 15 and 20 mm/s can be taken from Figure 5. As Figure 5 shows, the removal rate always has a significant effect on the reaction forces. The higher the removal rate is, the greater the reaction forces are.

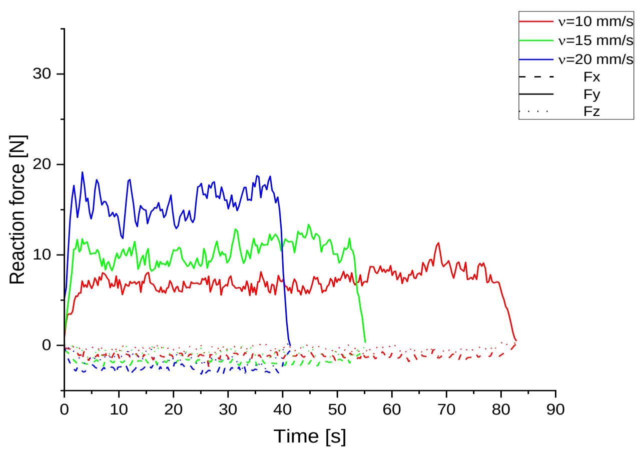

Figure 5: Reaction forces against time during the tests with different removal rates

Vibration emission

Vibration emission is an important investigation parameter in tool development and optimization. During the test phase, the vibration measurement with the hand-arm vibration meter (Pulsar vB) is also included. The vibration sensor is attached to the Bosch drive with a 9 mm hose clip. Using the vibration sensor attached to the Bosch drive, the time-averaged and W_h-weighted acceleration value (Aeq) and the highest peak level of W_h-weighted instantaneous acceleration (Pmax) are determined. The Figure 6 shows the determined values of X, Y and Z axis for the tests with the removal depth of 5 mm and the removal rates of 10mm/s which are represented as spatial points. It can be easily seen that Aeq and Pmax values from the test with milling tool are larger than those from test with prototype A.

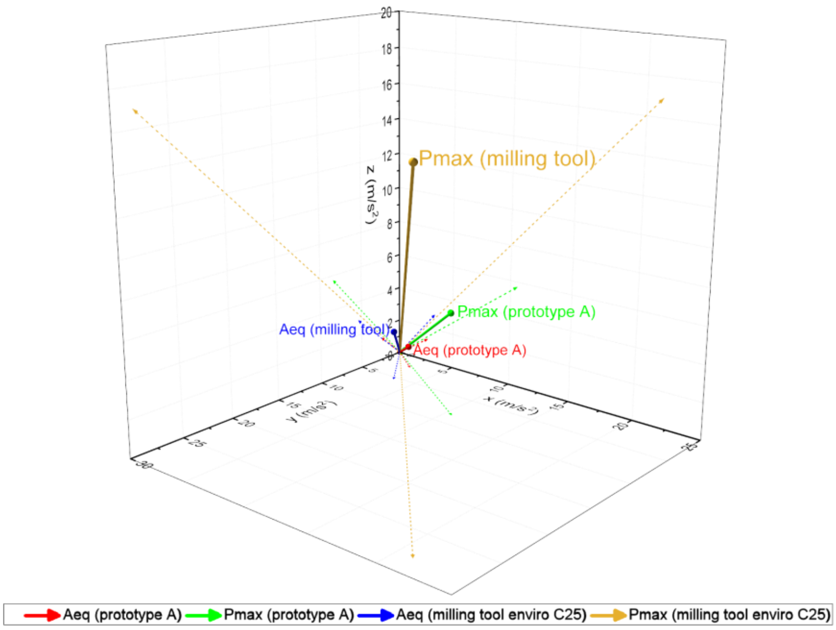

Figure 6: Vibration measurement for the tests with prototype A and milling tool enviro C25

Noise emission

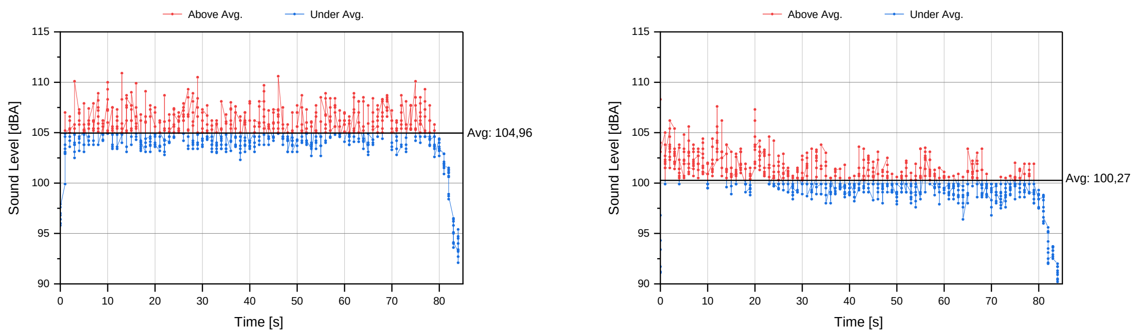

Figure 7: Sound level during the tests with prototype A (left) and milling tool enviro C25 (right)

The A-weighted sound pressure level for prototype A during the test is stronger than that for the milling tool enviro C25. If the daily working time with the prototype A or milling tool enviro C25 is 8 hours, both values have exceeded the upper action level in terms of daily noise exposure level. Some measures to protect hearing must be used appropriately by the operators.

Laser scanning

Figure 8 shows the 3D displays of the corner before and after the processing with the prototype A and indicates the applicability of the prototype A for the decontamination of corners. The special arrangement of the diamond discs enables the access to the corner. The prototype A creates the surface with a relatively low roughness and at the same time by using the spacer it can remove the concrete surface with a precisely defined depth.

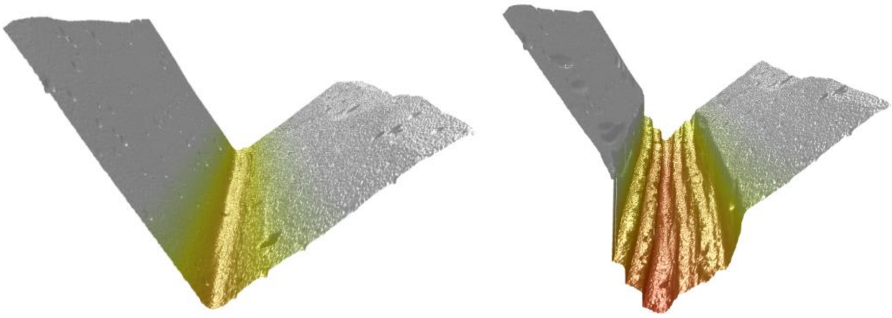

Figure 8: 3D displays for corner before (left) and after (right) the processing with prototype A

CONCLUSION

Prototype A has better usability for the decontamination of corners than the milling tool. When using the milling tool, the work must be divided into two operations (horizontal plane and vertical plane). The right angle formed by 5 diamond discs with different diameters in prototype A fits well to corners during decontamination, which can save half processing time compared to processing with the milling tool. At the same time, the specific reaction forces and vibration emission are smaller with the use of prototype A, which enables more comfortable operation.

ACKNOWLEDGMENTS

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