IAEA Workshop
Remote Handling / INAS

Dipl.-Ing. Steffen Reinhardt

Technology and Management for the Decommissioning of Nuclear Facilities – Prof. Dr.-Ing. Sascha Gentes

Part 1- Remote Handling

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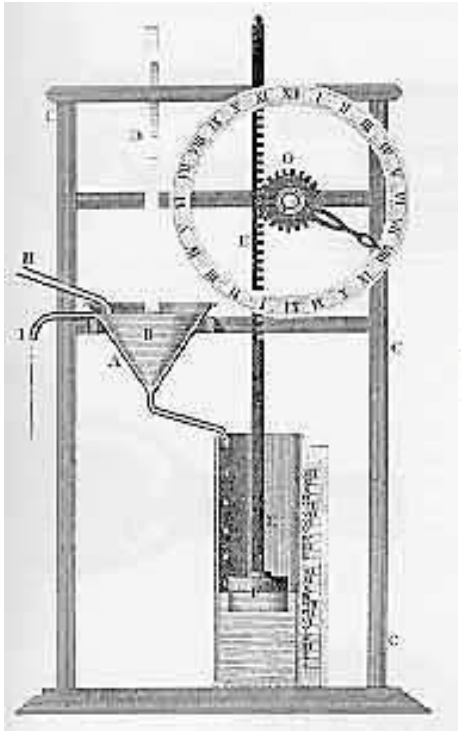
Content

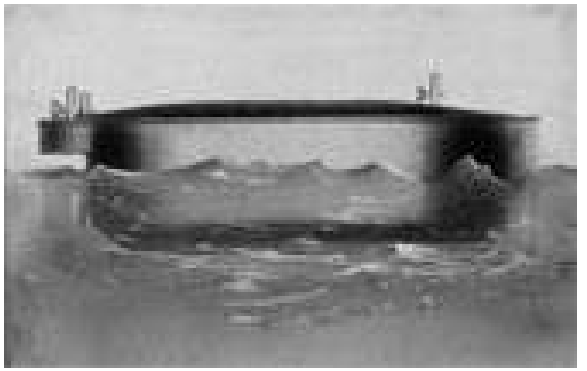
- Part 1 - Remote Handling
  - Conceptual explanation
  - Historical development
  - Remote handling technology

Conceptual Explanation

- The remote handling allows it to operate by remote control a machine which is in a danger area
- The system consists of an operator and a manipulator. The operator gives instructions and the manipulator executes them. So that the operator can stay at a safe place, an information and/or energy transfer must exist between him and the manipulator
- The information and energy transfer happens about cable, wirelessly only information can be transferred
- A remote-handled manipulator mostly has multiple video cameras therewith the operator can also navigate and work on non-accessible places

Historical Development





Ctesibius of Alexandria
approx. 250 BC

1495
Leonardo da Vinci

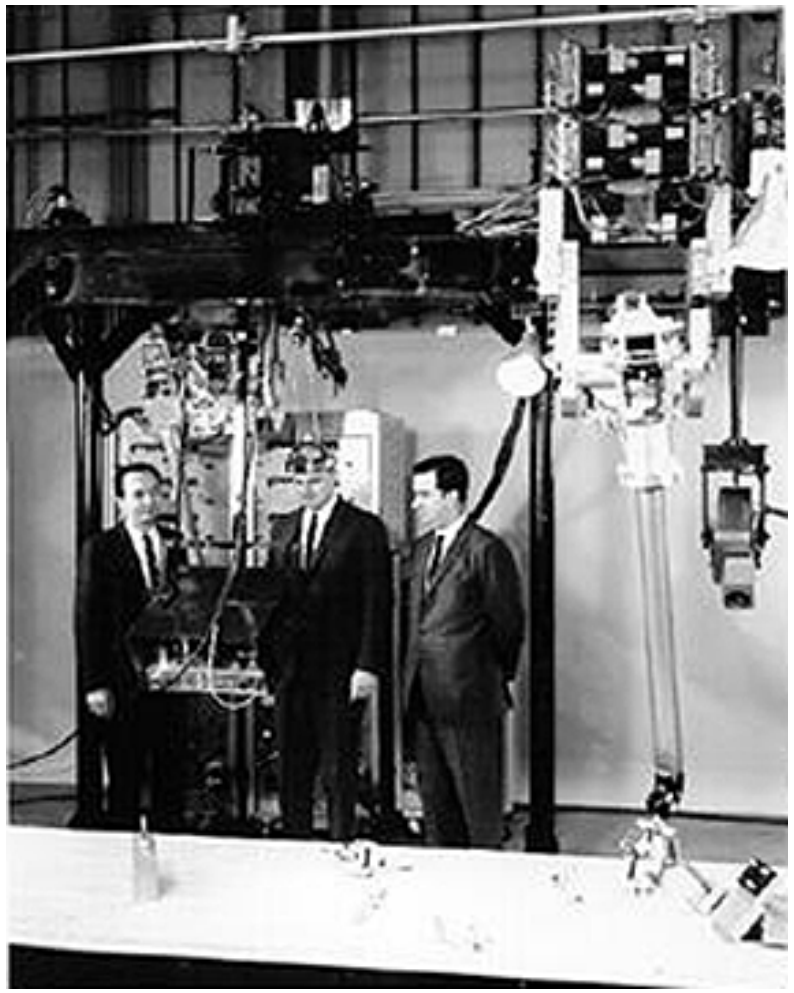
1897
Nikola Tesla

Historical Development

- 1945 - Development of master-slave manipulators (remote handling)
- 1954 - "Programmed transportation of goods" (industrial robots)
- 1959 - First commercial robots from Planet Corporation (controlled via Cam discs and limit switches)
- 1961 - Using freely programmable robots
- 1968 - First mobile robots with image recognition of the surrounding area and touch sensors
- 1969 - The first industrial robots in Japan
- 1970 - The first industrial robots in Europe
- 1975 - SCARA robots in Japan (six-axis articulated arm)
- 2010 - Humanoid Robot
- Next - Artificial intelligence & multi-function implement

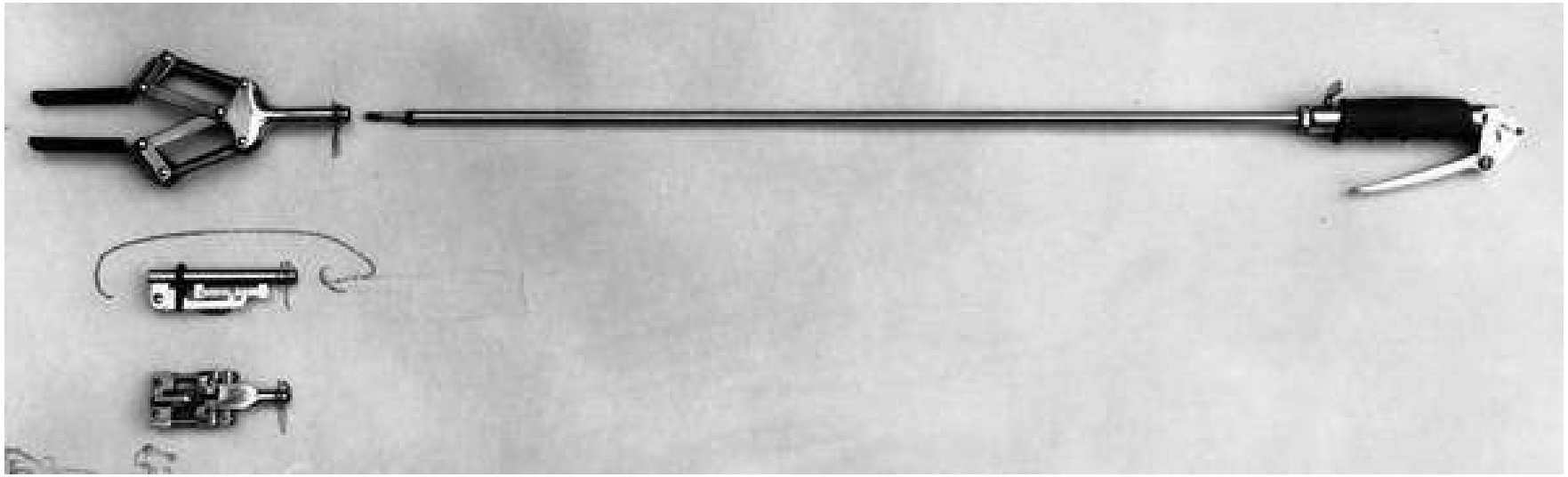
Historical Development

- The first master-slave-manipulator was developed in 1949 to move around components in the research reactor in Argonne Nationwide Laboratory (USA)



Remote Handling Technology

- Remote handling device



  - Diameter rod: 14 or 20 mm
  - Handle of anodized aluminum
  - Rod and tongs of stainless steel
  - Dimensions / weight: L = 1000 mm / weight approx. 1 kg

Source: Wälischmiller Engineering GmbH, Universally grab arm A01

Remote Handling Technology

- Master-slave-manipulators
  - Main application
    - Versatile, particularly for people in hazardous environments where heavy work is run
  - Advantage
    - Functions of the human arm modeled
    - Universal/multi-use
    - Extensive equipment
  - Disadvantage
    - Permanently installed in the wall
    - Limited working range
    - Limited power and strength

Source: Wälischmiller Engineering GmbH, Master-Slave-Manipulator system HWM A100

Remote Handling Technology

- Master-slave-joint-manipulators
  - Advantage
    - Functions of the human arm modeled
    - Universal/multi-use
    - Rotational and pivoting motion of the gripper are transmitted in a 1:1 ratio
    - Extensive equipment
  - Disadvantage
    - Permanently installed in the wall
    - Limited working range
    - Limited power and strength

Source: Wälischmiller Engineering GmbH, Master-Slave-Manipulator system HWM A200/A201-E

Remote Handling Technology

- Master-slave-manipulators in use

Source: WAK Karlsruhe GmbH

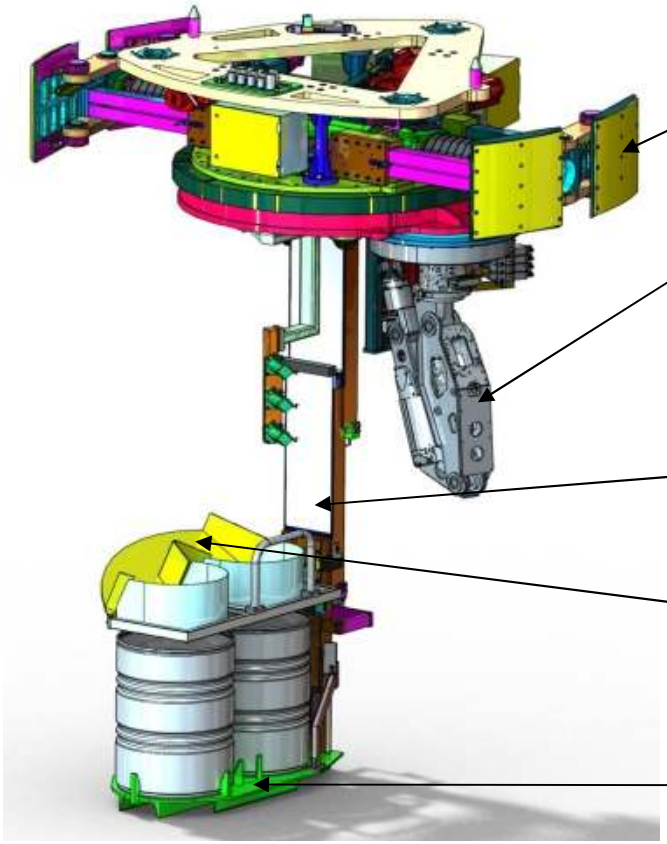
Remote Handling Technology

- Power manipulators
  - Advantage
    - High load capacity
    - Versatile use with optional crane hook
    - Extensive equipment
  - Disadvantage
    - Relatively slow
    - No mechanical adjustment possibility

Source: WAK Karlsruhe GmbH, Manipulator TA 40

Remote Handling Technology

- Power manipulators in use



Source: WAK Karlsruhe GmbH, Hersteller Siempelkamp

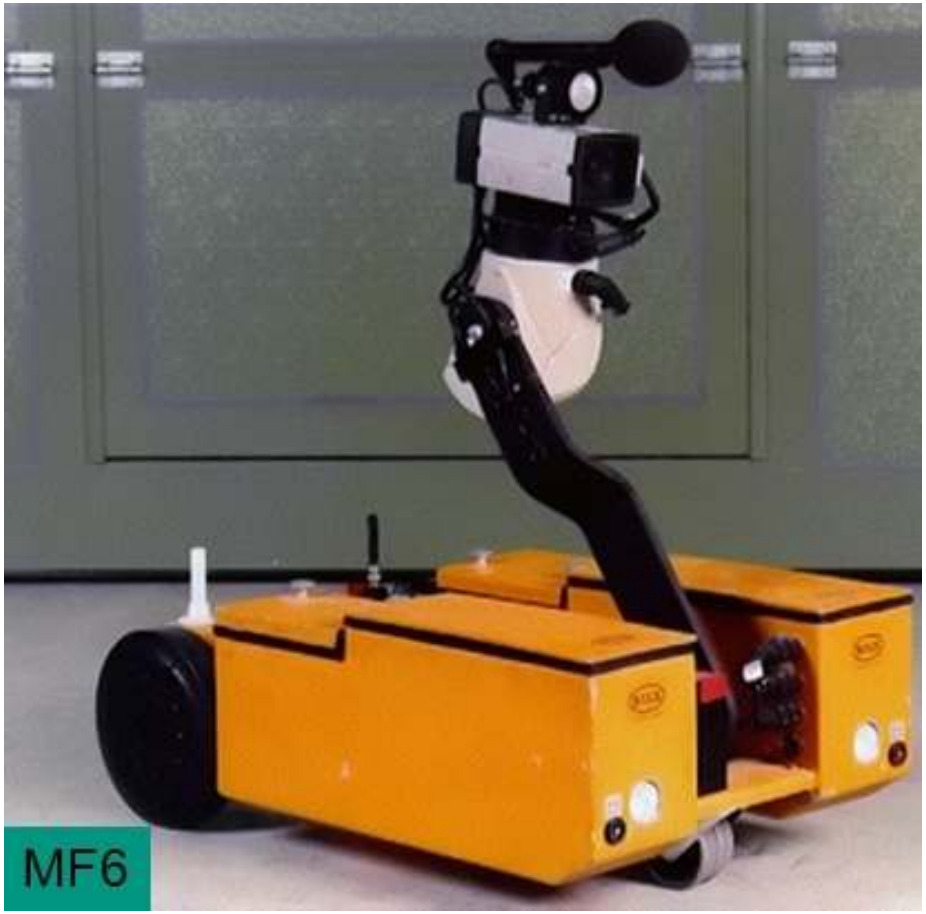
Remote Handling Technology

- Driverless transport systems
  - Main application
    - Highly contaminated/ activated areas
    - Accident investigation
  - Advantage
    - Most remote radio-controlled
    - Relatively mobile
    - Versatile used
  - Disadvantage
    - Limited load
    - Soil bound
    - Energy supply, restricted workspace

Source: Kerntechnische Hilfsdienst GmbH

Remote Handling Technology

- Driverless transport systems



Source: Kerntechnische Hilfsdienst GmbH

Remote Handling Technology

- Driverless transport systems

either radio or cable control possible

Source: Kerntechnische Hilfsdienst GmbH

Remote Handling Technology

- Driverless transport systems

Source: Kerntechnische Hilfsdienst GmbH

Remote Handling Technology

- Driverless transport systems

Source: Kerntechnische Hilfsdienst GmbH

Remote Handling Technology

- Driverless transport systems in use

Source: WAK Karlsruhe GmbH

Part 2 - Innovative Demolition Of Massive Reinforced Concrete Components - INAS

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Content

- Part 2 - Innovative Demolition Of Massive Reinforced Concrete Components - INAS
  - General project data
  - Procedure chain
  - Cutting technology
  - Outlook

General Project Data

- Aim of project:

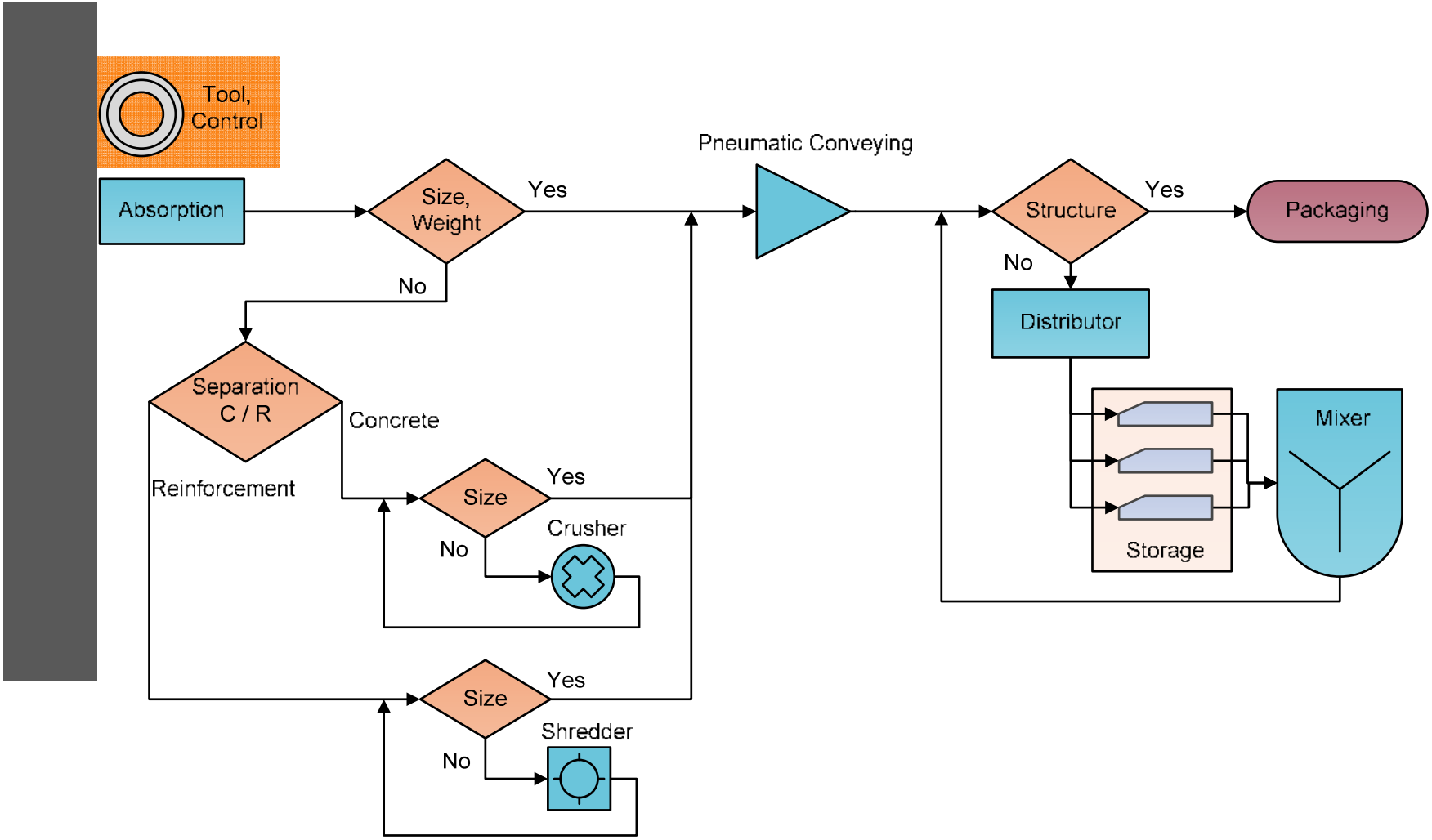
Description of the comprehensive procedure chain of the demolition of reinforced concrete up to the appropriate packaging for final disposal site in contaminated or activated areas

- Sponsored by the

Federal Ministry of Education and Research

- Cooperation between university and industrial enterprise

Procedure Chain



Cutting Technology

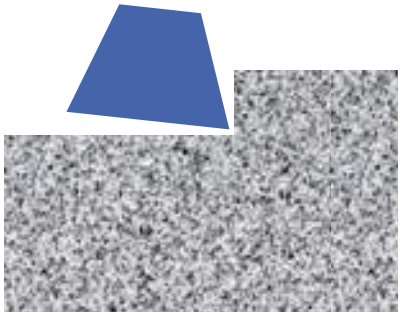
- Application of mechanical processes
  - Separation of the functions and test of both processes independent of each other for the demolition of concrete and reinforcing steel
  - Combine both methods in one tool

  - Concrete
  - Adaptation of the undercutting technology for high-strength rocks
  - Additional suggestion with impulse forces (ODC)

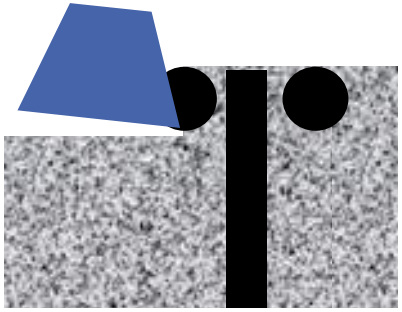
  - Reinforcement steel
  - Demolition by means of defined cutting edge (mill cutting)

Cutting Technology

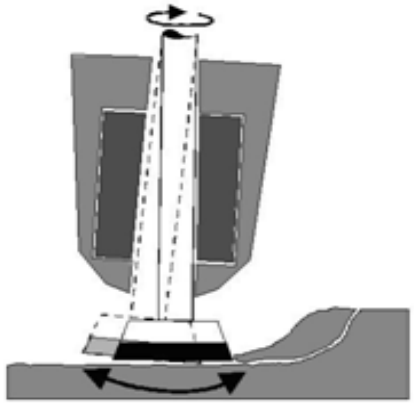
- Combination of undercutting and mill cutting

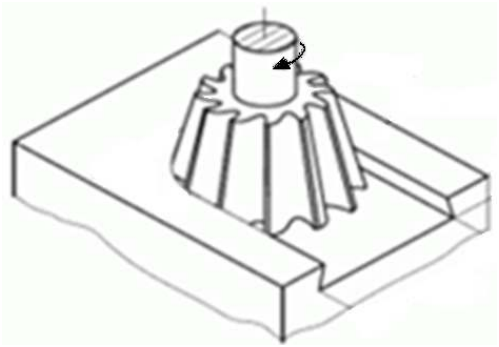


Undercutting of concrete (ODC)



Mill cutting of reinforcement

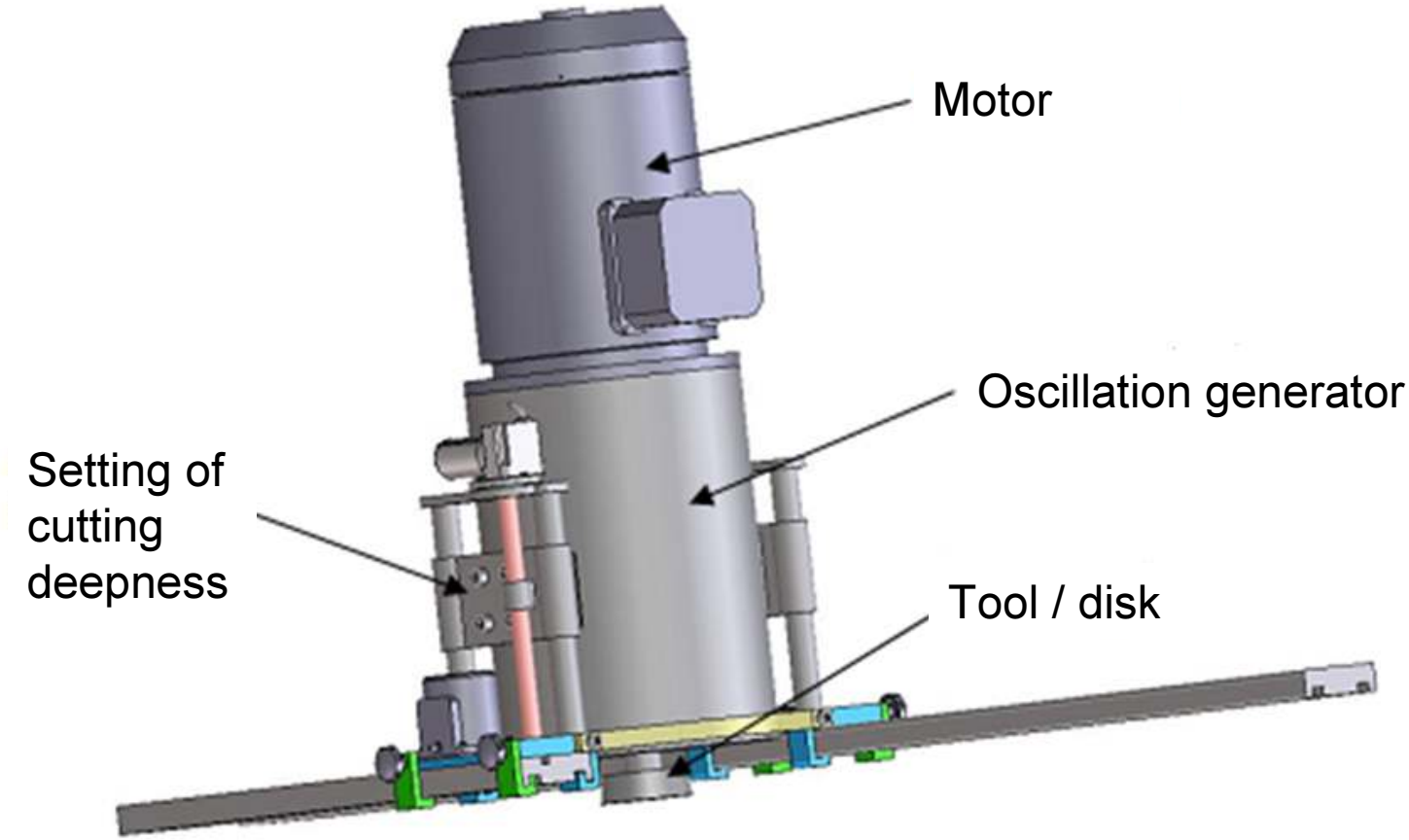




Source: Herrenknecht AG

Cutting Technology

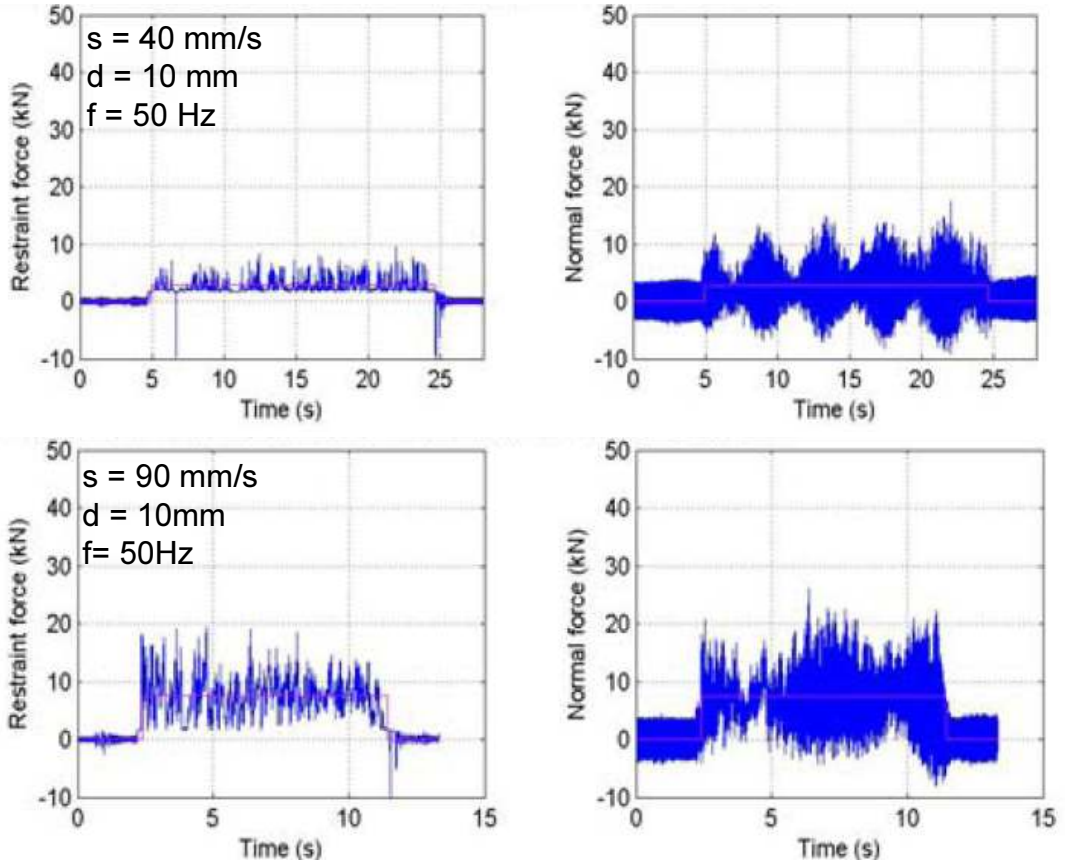
- Oscillating disc cutter ODC

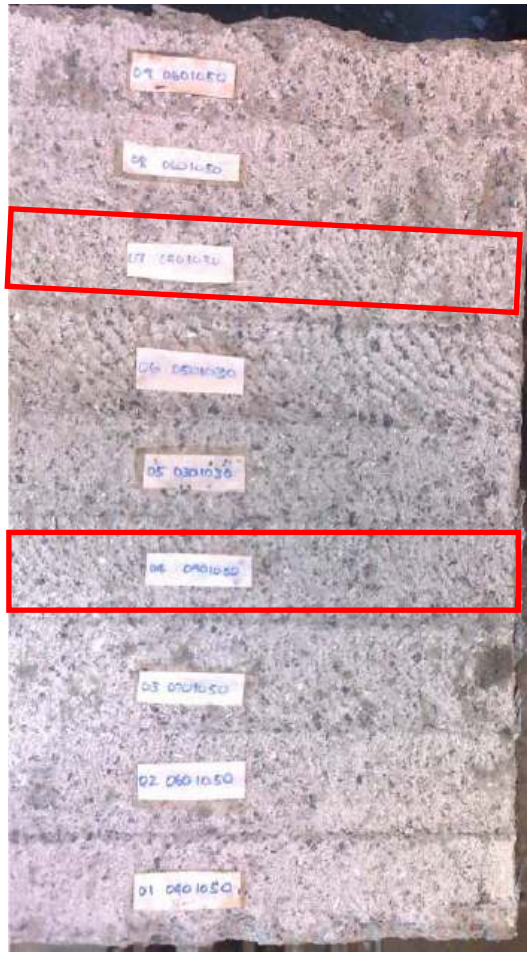


Source: Herrenknecht AG

Cutting Technology

- Oscillating disc cutter ODC – test results





Source: Herrenknecht AG

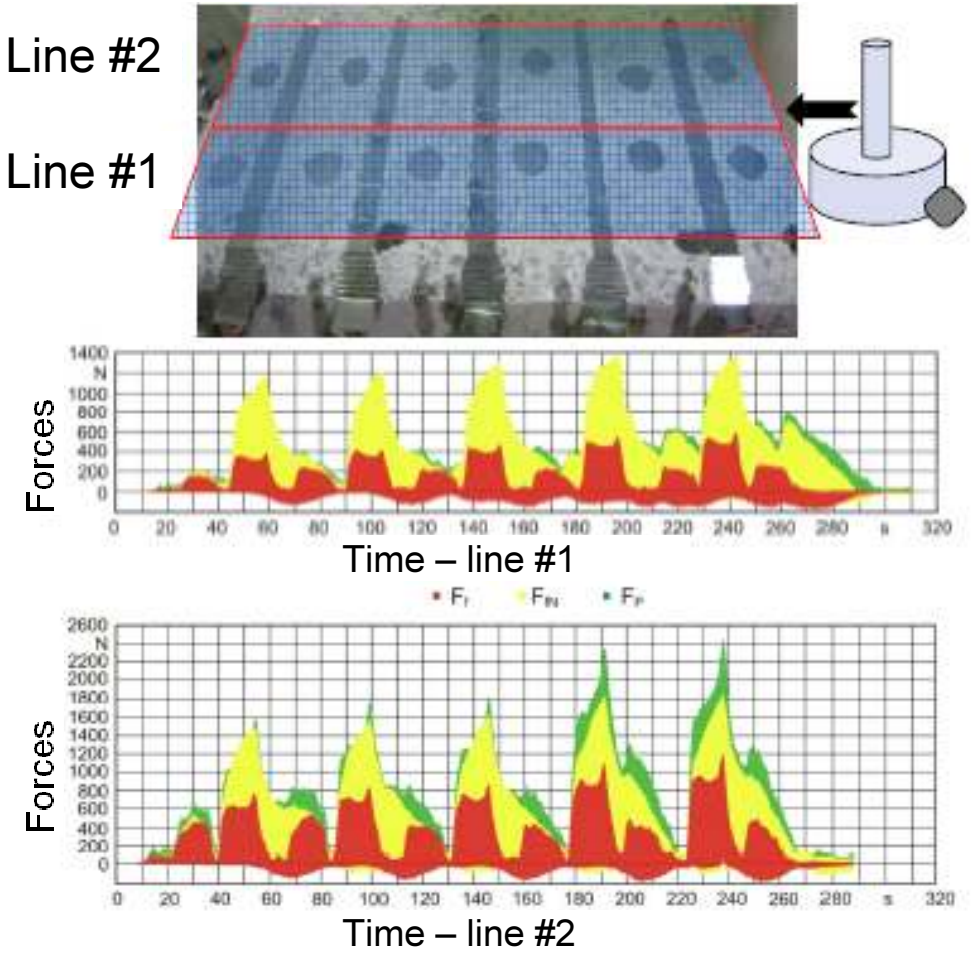
Cutting Technology

- Mill cutting of reinforcement
  - Cutters with exchangeable inserts
  - Variety of exchangeable inserts
    - Design
    - Substrate of the base metal
    - Coating, layers
      - CVD - Chemical Vapor Deposition
      - PVD - Physical Vapor Deposition
      - CBN - Cubic Boron Nitride
      - PKD - Polycrystalline Diamond

Source: Herrenknecht AG, NGK

Cutting Technology

- Mill cutting of reinforcement – test results



Source: Herrenknecht AG,

Outlook

- Carry out further tests of concrete and reinforcement cutting
- Choice of the suitable tool geometry and cutting materials

- Combination of both cutting technologies
- Investigation of the process parameters and the reaction forces
- Optimization concerning the level of demolition

Thank You
For Your Attention!