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**Dry Coring and Dry Wire Sawing  
in Reinforced Concrete**

**BAUMA - IACDS 2010**



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**Dry Coring and Cutting – Typical Applications**

**Applications**

- Probes to assess level of contamination in chemical and nuclear plants
- Removal of anchors to prepare surface removal in power plants
- Drilling of through holes for installations in sensitive environment
- Sawing of openings in reinforced concrete
- Sawing of wood/concrete structures e.g. parquet on concrete
- Rehabilitation of historical buildings

**Challenges**

- Drilling and sawing methods involved usually need water cooling
- Cooling water leads to secondary damage in sensitive environment

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**Proposed Solutions for Dry Cutting and Coring**

**Dry drilling in reinforced concrete**

- Polycrystalline diamond cutters PCD
- Efficiency of drilling process allows dry operation
- Through holes for diamond wire


**Hilti solutions**



**PCD**

**Dry wire sawing in reinforced concrete and steel**

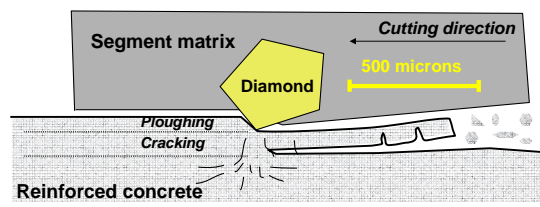
- Electroplated Diamond wire
- Cooling length allows for dry operation
- Cutting of reinforced concrete
- Cutting of steel structures



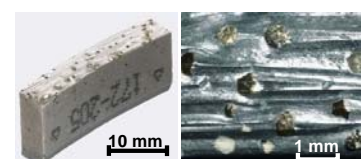
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**Conventional Technology needs water cooling**



- Process with low efficiency
- Primarily a grinding process → fine debris produced
- Water cooling needed except for wire sawing



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### Polycrystalline Diamond PCD for Dry Drilling

Reinforced concrete

- Process with high efficiency
- Primarily cutting → coarse debris produced
- Air cooling feasible

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### PCD cutting – Effect on Grain Size of Debris

| Grain size [µm] | PCD Share in volume [%] | Diamond Segment Share in volume [%] |
|-----------------|-------------------------|-------------------------------------|
| 1               | 0                       | 1.5                                 |
| 10              | 0.5                     | 2.5                                 |
| 100             | 1.5                     | 8.5                                 |
| 400             | 10.5                    | 0                                   |
| 1000            | 4                       | 0                                   |

- Coarse debris can be removed easily
- Energetically favorable process
- Coarse debris facilitates dust collection

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### Energetic Considerations

| Diamond impregnated segments – wet      | PCD cutter – dry                       |
|---|--|
| $W_0 = 1900 \text{ J/mm}^3$             | $W_0 = 380 \text{ J/mm}^3$             |
| $W_{\text{heat}} = 1600 \text{ J/mm}^3$ | $W_{\text{heat}} = 330 \text{ J/mm}^3$ |
| Fracture energy                         | Fracture energy                        |
| Plastic deformation                     | Plastic deformation                    |

→ 5x higher efficiency with PCD

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### Geometrically Defined Cutters

```

FRAME NO 01652
TIME 052
-0094
36711111
REC RATE 4500
ID NO 10
PLAYBACK
PLAY
LIVE BLOCK
END
MULTI REC MODE
READY REC
  
```

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### Dry drilling with Poly Crystalline Diamonds

#### PCD Drill bit Ø 1 5/8", 7 ft deep hole coring

6.6 ft

Alu 0.06"   Graphite 10"   Fe St.37 1"   Lead 4 cm   C-Steel 1/2"   Concrete 60"   C-Steel 1"

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### Dry drilling with Poly Crystalline Diamonds

Complete core   Stainless steel with anchor   Steel core

Lead core   Graphite   Aluminium

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### The Hilti Dry Coring System – DD 200 air cooled

Starting aid

Core Bit DD-B PCD

DD 200 air cooled motor

DD-HD 30 drillstand

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### The Hilti Dry Wire Sawing System

#### Diamond equipment

DS WS15-E electrical 400V wire saw cpl. system

#### Key features enabling dry sawing

- Adjustable wire speed
- >10 m internal wire storage → cooling by convection
- Wire guards to protect operator
- Dust collection channels

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### Hilti VC 40-U Vacuum Cleaner with APFC

**Outlast**

- Robust design in- and outside, → **Jobsite suitability**
- Easy filter access → **Comfortable handling, easy cleaning, time saving**
- Robust tank and big wheel diameter → **Reliability, easy transport on the jobsite**

**Outperform**

- Compact filter and intelligent placing of hose connection in suction head → **Best in class volume/capacity ratio**
- Advanced Power Filter Cleaning Technology → **Permanent and high suction performance**
- Easily changeable dust bag → **Comfortable handling, easy dust removal, time saving**



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### Cost of Diamond Tools and Coring Equipment

**Diamond tools**

|                      |    |           |                           |
|----------------------|----|-----------|---------------------------|
| Core bits            | 4" | 1200 USD  | 0.5 – 2 m life expectancy |
|                      | 2" | 900 USD   |                           |
| Wire (electroplated) |    | 150 USD/m | 1 m <sup>2</sup>          |

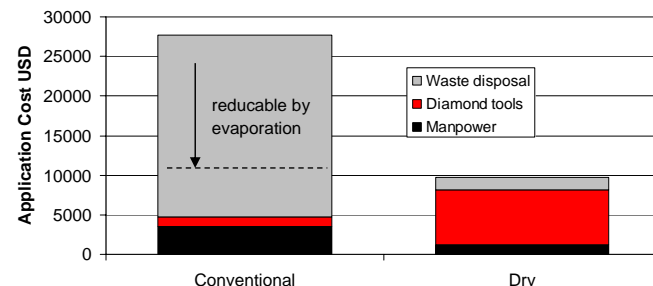
**Diamond equipment**

|                      |          |
|----------------------|----------|
| Dust collection unit | 350 USD  |
| Starting aid         | 1000 USD |
| DD 200 core rig      | 3000 USD |

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### Does it pay off? – Example Nuclear Application




Application: Opening in reinforced concrete of 2 x 2 x 1.5 m  
 Manpower 80 USD/h, including preparational work  
 Disposal 8000 USD/m<sup>3</sup>  
 Total drilling and cutting time comparable for conventional and dry

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### Dry wire sawing in reinforced concrete



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Dry wire sawing with - dust removal



Dry wire sawing – Dust Collection Channel



Dry wire sawing in nuclear power plant, UK



Opportunities & Applications

**Renovation in critical areas**

- All double walled structures in sensitive environment
- Wood/concrete combinations
- Operation in sensitive environment:  
Food processing/storage, IT infrastructure, concrete plants, nuclear installations
- Historic monuments

Application cost are higher than in conventional operation

20x for coring

4x for wire sawing

## Conclusions

- Efficient and reliable dry decommissioning of reinforced concrete structures is only possible by combining PCD drilling and dry wire sawing.
- Dry drilling of reinforced concrete is only possible with PCD technology. → High energy efficiency allows air cooling.
- Dry cutting of reinforced concrete is possible with wire sawing.  
→ Short engaged length of wire gives high cooling length.

**Reliable dry cutting and coring of reinforced concrete and steel is available.**