

Automatical Hydrodemolisher System
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Abstract

The high pressure water technics more and more serve as a worktool for cutting as well as for surface treatment. Especially in the construction industry this kind of technology is significant. Before mentioned method enables the operating staff to remove the deteriorated concrete in precision work, avoiding damage of the reinforcement and preventing further cracks. This high removal quality and also efficiency could never be reached with manually operated water jet equipment.

The advantages of water jet technic can only be realized with a mobile flexible computer controlled machine. The new generated equipment family leads the water jet in an exact defined distance to the concrete surface with an exactly velocity on an fixed course. In fact, one water jet unit can easily replace 30-50 jackhammers.

Due to the modular constructing the demolition robot can be use on declined areas, walls and for overhead work. The robot system can be mounted on a standard scaffolding, thanks to the light constructing. All drive units are supplied with 24 constant voltage.

The repulsion caused by the water jet power when removing the concrete runs up to abt. 2000 N.

1. Introduction

The reasons a building has to be reconstructed are:

- aging stability
- environment disruption
- error of design

Prerequisite for the rust protection of the concrete steel in a part of a building is the high alkalinity (ph-value 12-13) of the concrete covering the same. In case if concrete is in direct contact with air the alkalinity in the part nearest to the surface will be decomposed time by time. This process, caused by the carbon dioxide in the air is

called carbonization. If the carbonization gets along to the concrete steel, the concrete will lose its rust protection. The result will be corrosion. The formation of rust is combined with a growth in volume of abt. 2.5, causing in general cracks, local flaking and loosening of the surface. This leads to a loss of compressive strength because of reduced concrete area, and all loss of tensile strength due to corroded steel. Damages in concrete buildings have to be mended in an early stage otherwise the rehabilitation will be more expensive.

Another danger is that salt water can get in contact with the concrete steel and that the chloride leads to a local destruction of the steel (localized corrosion). This may happen without growth of volume (no flaking and loosening of surface) and can, therefore, hardly be realized.

Each successful reconstruction makes a solid pretreatment of the ground absolutely necessary. High pressure water jetting has been introduced successfully to the process of mass concrete removal. It has high productivity and favourable economies when compared to jackhammers. Reinforcement bars will not be damaged; they are cleaned. Single or multiple straight jets, or dual rotating jets have been successfully used as concrete cutting tools. The water pressure ranging from 800 to 1500 bar, the mass flow up to 300 l/min. and the jet power up to 600 kW.

Hydrodemolition is a well established rehabilitation method. For the best results, however, the equipment must be flexible transportable. For humanization of the working place a fully automatically driven system is inevitable. In this paper an hydrodemolition-model-system will be presented.

2. Technical Description

Like architecture has created all different kind of buildings, so different are the various requirements at the buildings to be redeveloped. Since more than 5 years people are busy with the development of a flexible and combinable nozzle leading system which can universally be set in. Furthermore, it should be a system which can be accommodated to the architectonic needs at any time. The system introduced herewith is the result of a successful cooperation between construction, fluid dynamic studies, feedback from field testing and a long time jobs application that suggested continuous improvements. The basic unit is an especially light and compact construction (fig. 1) for leading and driving of a to and from moving high pressure spraying head. Each single module has an own electrical 24V drive and an own control electronic. The transport modul (1) realized the adjustable step size (dx). The nozzle modul (2) moves the nozzle with a constant speed (STEP and GO modus). With the GO and GO Modus both movements are activated at the same time.

First of all, the water jet nozzle must be leaded exactly with a constant distance to the surface to be repaired. The exact distance is necessary as the pressure on the concrete surface caused by the water jet depends on the distance between nozzle and ground /1/.

For this reason it is recommended to move the nozzle leading system over the surface to be worked. This is possible with the help of rails. In order to put the rails in the required position independent from the ground they have to be connected to a mounting frame by means of a cross capping piece (3). On four corner points of the mounting frame you have to install a seat for screw spindles of corner roller, defining the distance to the ground. Thanks to the modular construction the mounting frame can be used on the ground, on the wall and on the ceiling. For deeper dismantling (more than 10 cms) in general several coatings are more effective than one single only. When working with high pressure water jet retouching work cannot be avoided. This can be done without much efforts by the concept of the mounting frame, as this system can be used independent from the ground.

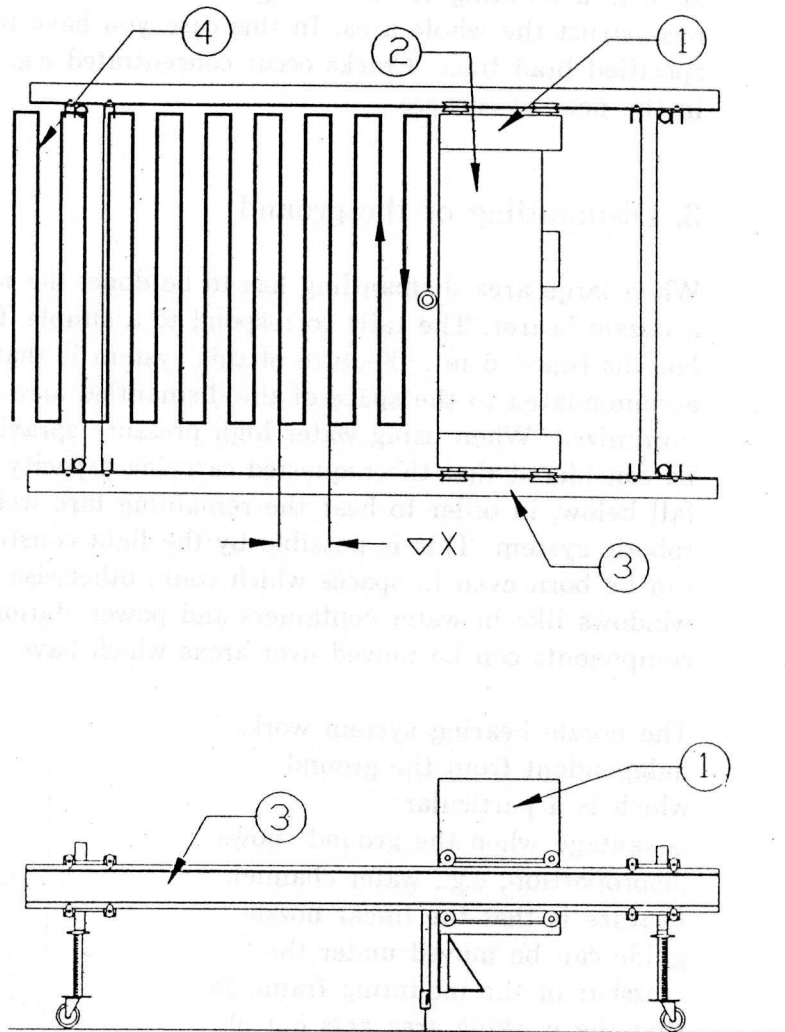


Fig. 1 robotic system

Several coating will particularly be necessary when e.g. you have to get through to the requested depth of dismantle step by step. For this purpose this mounting frame construction is especially suitable. The size of the mounting frame is limited by the maximum allowed deflexion of the rails, depending on the nozzle power of repulsion as well as on the length of the rails.

The basic equipment of the frame admits a rail length (60x40) of 6 m and a power of repulsion of 1000 N. On using special rails (100x40) the power of repulsion can be 2000 N and the beam length 6 m. The carrier with drive chains as well as the crossbeams can be applied for both rail types.

Further progress of development of the use of the hydrodemolisher moduls system is

connected with an microprozessor system with additional softwares. When cracks arise in a building or on a bridge due to error of construction it is not necessary to reconstruct the whole area. In this case you have to follow the crack according to a specified brad trace. Cracks occur concentrated e.g. in a parking garage, a columns or in the near of corners.

3. Dismantling of the ground

When large area dismantling has to be done, the nozzle modul (2) can be replaced by a nozzle bearer. The rails correspond to a simple T-section available in different lengths (max. 6 m). Feature of this system is that each working width can be accomodated to the space of the dismantled area. Transfer of the equipment can be minimized. When using water high pressure spraying at intermediate ceilings it must be considered that the requested carrying capacity around the working area does not fall below, in order to bear the remaining tare weight of the ceilings as well as the robotic system. This is possible by the light construction of the single component. It can be born even in spaces which could otherwise only be reached by dormer windows like in water containers and power stations. Another advantage is that the components can be moved over areas which have no more carrying capacity.

The nozzle bearing system works independent from the ground which is a particular advantage when the ground shows disproportion, e.g., water channel. Feature is that the linear nozzle guide can be moved under the crossbar of the mounting frame so that the working area gets out of the restriction of the frame (fig. 1). Thanks to this method the ground can be dismantled nearly to the wall. This situation is very often given when a parking garage has to be repaired.

4. Vertical use

The same robot mounting frame can be fixed on the wall by means of chain adjuster. For aerial working up to a height of the wall up to abt. 2 m. The robot can be mounted on a base carrier which can quickly by placed at any wall

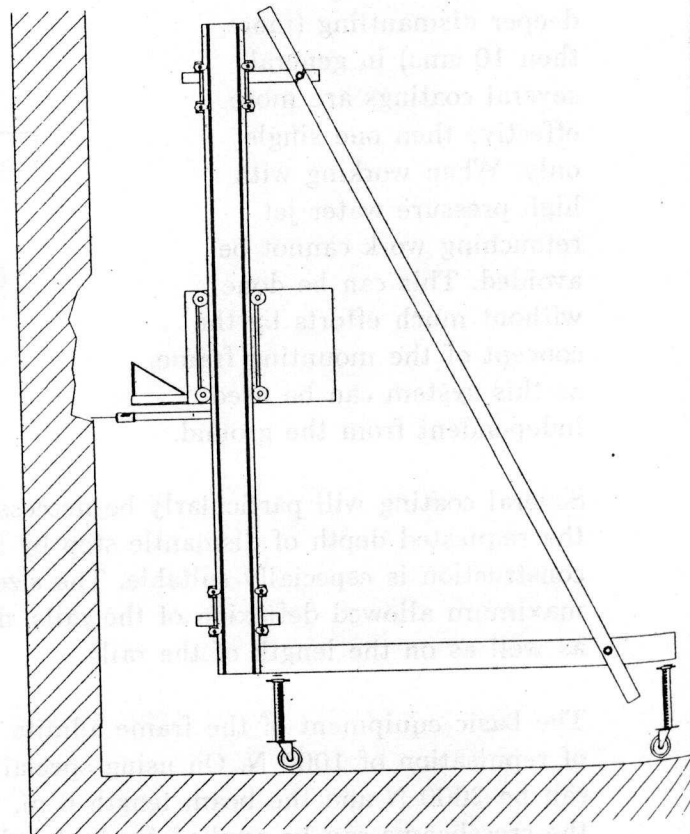


Fig. 2 Vertical use

or column (photo 4). Dismantling of the wall can easily be done by the adjustable method of bearing of nozzle module even under earth level.

As the device is particularly flat and light it can be used even on a scaffold at a housewall.

5. Dismantling of the ceiling

The same device can be adjusted on a ceiling by fixing device. When the basic size of the mounting frame had been developed it was considered that it can be accommodated on each scaffold. Scaffolds have a high flexibility and, therefore, nearly every working of the ceiling in overground and civil engineering works is possible as quick and easy mounting of the equipment can be done.

For 3-dimensional aerial working like on ceilings of parking garages (fig. 3) the moving device can additionally be equipped with a lifting device modul (photo 3). The adaptive accommodation of the nozzle leading system to the surface structure is possible with two sensors placed in the flushing in which the nozzle is moving.

Thanks to the light construction of the equipment the mounting frame can be installed on a bridge inspection unit whose platform has very limited carrying capacity.

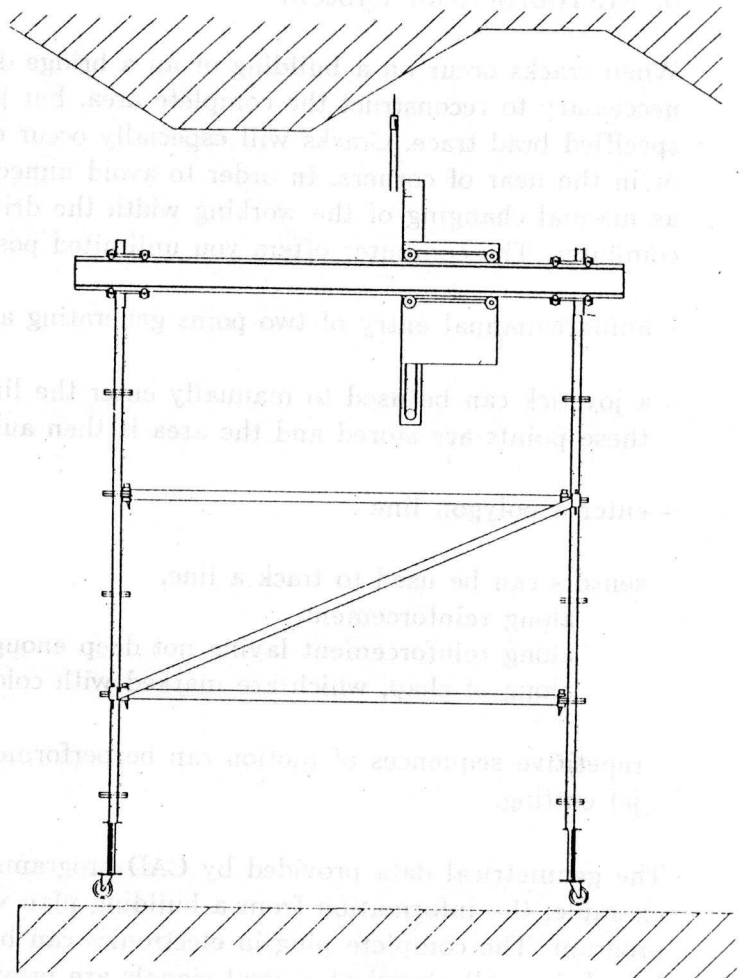


Fig. 3 Dismantling of the ceiling

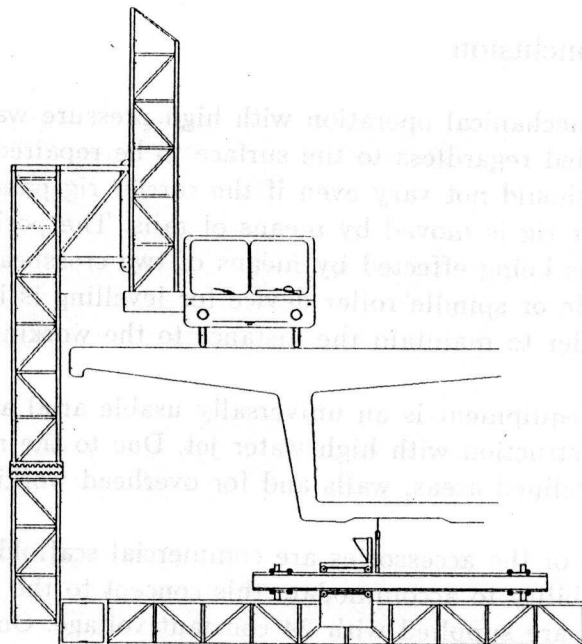


Fig. 4 Overhead work

6. Microprocessor System

When cracks occur on a building or an a bridge due to error of construction it is not necessary to reconstruct the complete area, but just to follow the cracks according a specified brad trace. Cracks will especially occur e.g. in a parking garage at columns or in the near of corners. In order to avoid unnecessary moving of machine as well as manual changing of the working width the driving device is assemblbed by a computer. The computer offers you unlimited possibilities in working:

- numericmanual entry of two poins generating a rectangular area
- a joystick can be used to manually enter the limit points of any desired area; these points are stored and the area is then automatical pass over.
- enter a polygon line
- sensors can be used to track a line,
 - along reinforcement,
 - along reinforcement laying not deep enough under the concrete surface,
 - along of chap, which are marked with color.
- repetitive sequences of motion can be performed, as is required, for example, for jet cutting.

The geometrical data provided by CAD programs can be directly processed, for example, the information from a building plan which has been produced with a CAD program. The complete plug-in electronics can be replaced without special technical knowledge. All electrical control signals are provided with LEDs for monitoring purposes.

7. Conclusion

The mechanical operation with high pressure water requires that the carrier rig is installed regardless to the surface to be repaired. The nozzle distance to the working area should not vary even if the carrier rig passes uneven surfaces. This is why the carrier rig is moved by means of rails. The positioning of the rails to any working area is being effected by means of two crossbeams which are connected to a frame. A spindle or spindle roller device for levelling is installed on each corner of the frame in order to maintain the distance to the working area.

This equipment is an universally usable arial and line-working system for concrete reconstruction with high water jet. Due to the modular desin, the frame can be used on declined areas, walls and for overhead working.

Most of the accessories are commercial scaffolding, so that every applicator has the possibility to accommodate this concept to the architectonic situation. All electric units are supplied with 24 constant voltage. On the job, the electromotors are

powered with the cableconnected pump engine. The complete system has not only well proved in tests, but also in long time jobs, as shown in attached photos.

Acknowledgements:

The authors would like to thank URACA Pumpenfabrik GmbH Bad-Urach and Antoch GmbH Wasserhochdrucktechnik, Schlier, for their support

/1/ J. Wiedemeier, Flüssigkeitsstrahlen grosser Relativgeschwindigkeit und Bruchkinetik spröder Werkstoffe, Diss. Hannover 1981.

Photo 1. Dismantling of the ground

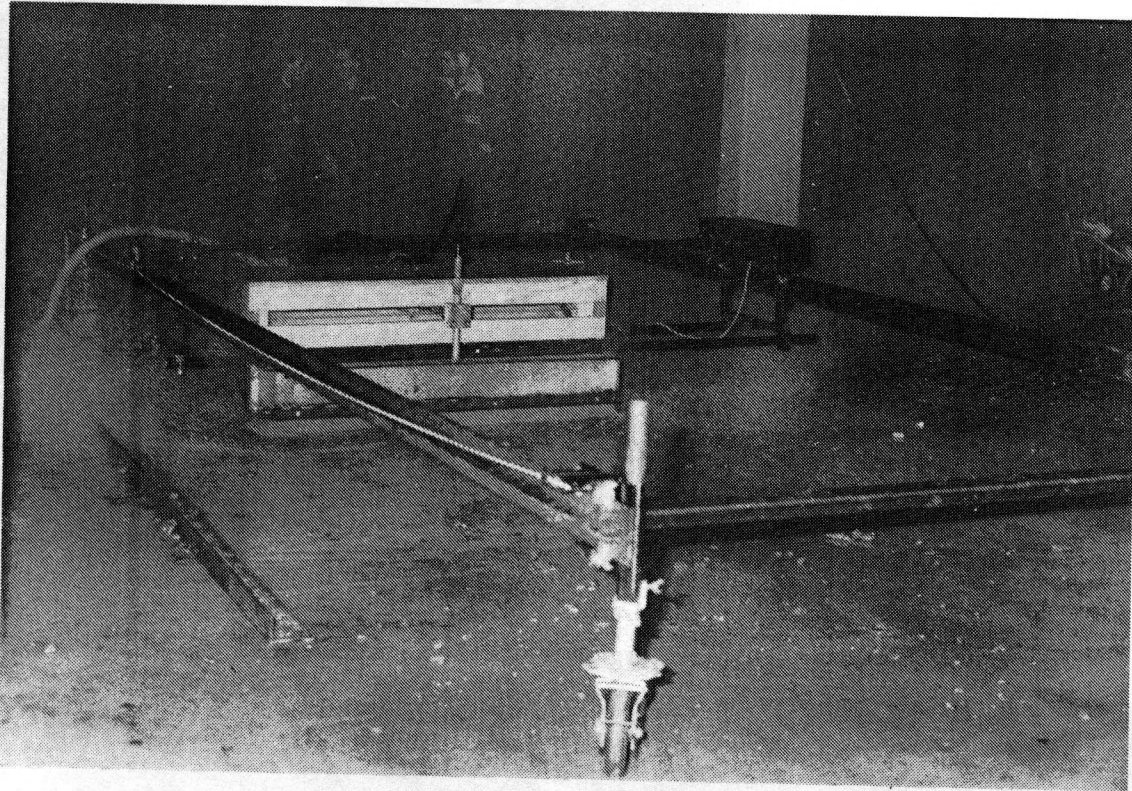


Photo 2. Dismantling of column and the ground

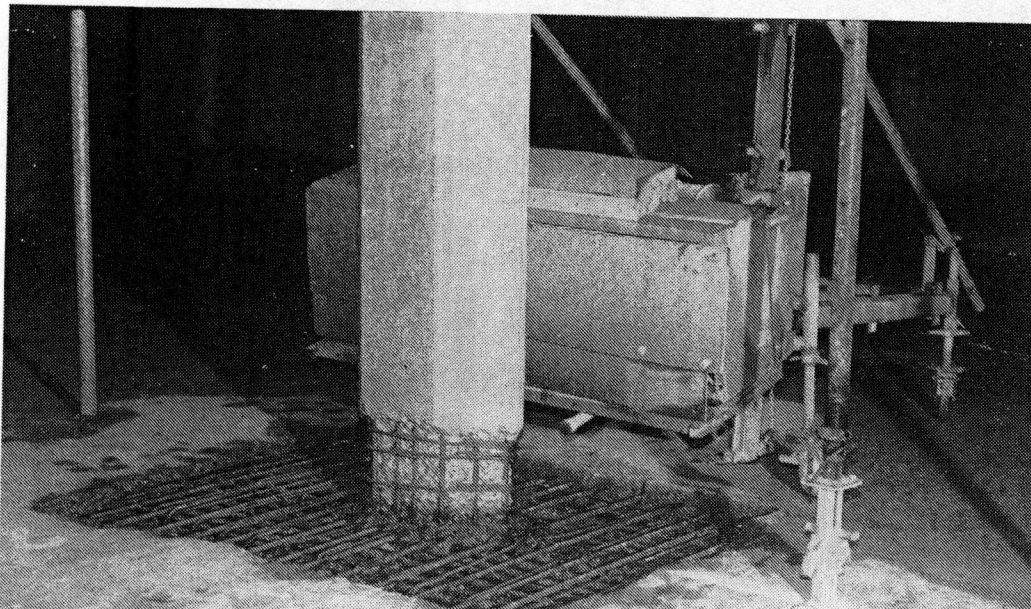


Photo 3. Dismantling of a decline ceiling

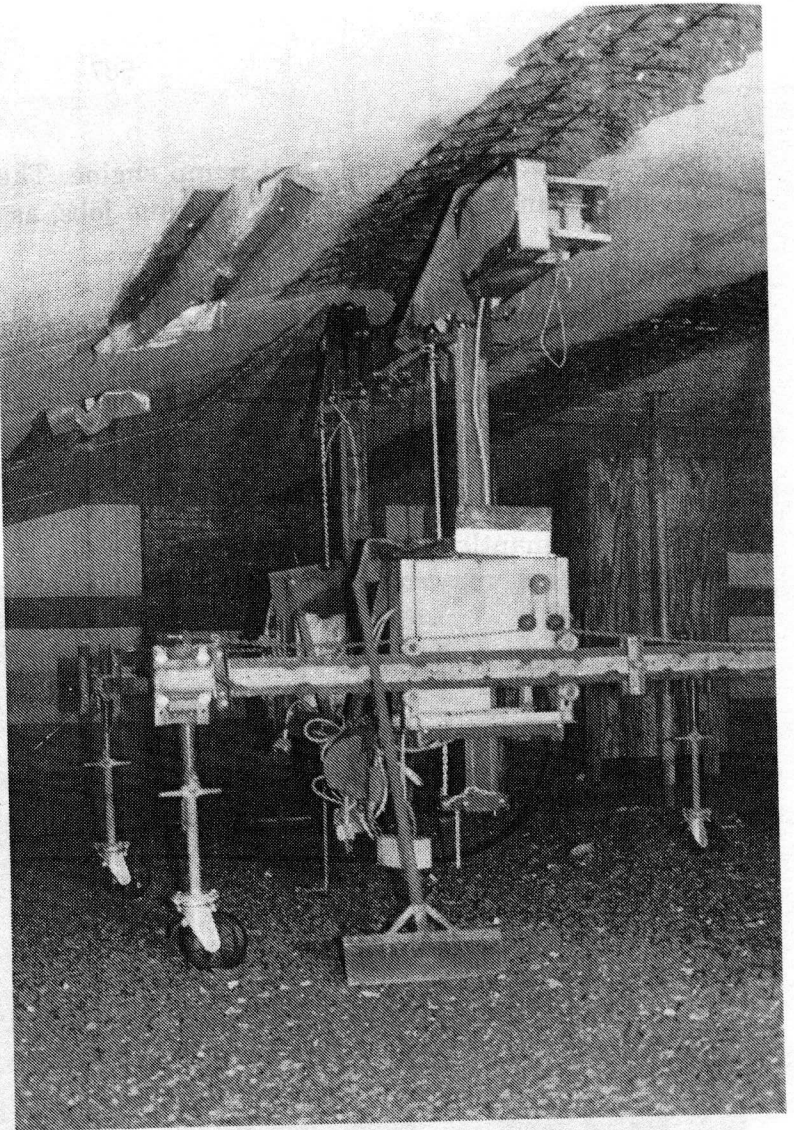


Photo 4. Dismantling of a wall

