MECHANIZED PARKING INSTALLATIONS

1. INTRODUCTION

For new buildings as well as for reconstructed buildings, the planner and the architect are confronted with the problem of creating effective and sufficient parking space in a limited area as small as possible.

Generally, this requirement has been fulfilled until now by a conventional design, e.g., by an underground or a multi-storey car park. In the meantime, however, the parking space requirements defined by the planner or by the community regulations (parking space regulations) especially in city quarters with a high density of utilization may be increasingly realized with traditional methods only to an insufficient extent.

By innovative means such as a flexible space allocation for rental parking or instead of fixed assigned and frequently utilized parking spaces as well with simple storage rooms, attempts were made to utilize available parking space more intensively. For this reason, the lanes in underground car parks are additionally utilized as the installation of movable plates, or, by means of lifting platforms, a multiple usage of floor space of a conventional parking lot was achieved. However, these mechanical devices in traditional parking buildings may increase the parking space capacity of a given floor space only to a limited extent.

The present paper in anticipation describes the different parking devices and their respective features while obvious terms independent from manufacturers were used for individual parking systems. Principally, the terms used in the "Empfehlungen für asphaltic dehnungsfähiger Verkehrsflächen" (For Untersuchungsausschuss der Verkehrswege, Köln 1969) were taken into account. However, partial deviations were made in order to achieve a better adaptation in the total of the terms. With the terms introduced, a contribution to the discussion about the further guideline establishment is intended.

The authors express their gratitude to Dr. L. Durken, Head of the working committee who has drawn out the "PARK 1991", for the suggestions and hints in the preparation of this contribution.

Mechanisches Parken - Eine Umfrage

Im Zuge der Bestrebungen zur Schaffung von ausreichend und anspruchsvollen Parkflächen, prüfen Planer und Architekten auch die traditionellen Methoden des Bauens von Parkhäusern. Auch die Gebrauchsmuster parking systems and Mechanical Parking Equipment in Town Planning and Traffic Concept" is financed by resources of the Federal Ministry and the City of Frankfurt/Main and is handled by Hagen Spand & Kaufler GmbH (VAG).

An essential aspect of the research is the study of parking and traffic integration possibilities as well as appropriate fields for use of mechanical parking equipment and thus offer a decision finding support with architects and planners. A final report of the projects results is expected by 1993.

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2. CLASSIFICATION OF SYSTEMS

General

Mechanical parking equipment is understood as being permanently installed, floor driven installations exclusively intended for parking vehicles.

Parking buildings may be classified as follows according to size and the type of mechanical support for the whole parking process after entering the parking building:

- Conventional parking buildings
- Semi-mechanized parking buildings
- Fully mechanized parking buildings

Considering today's state of technology, a fully automatic flow of the mechanical parts of the parking process may be assumed.

Conventional parking buildings also include multi-storey car parks on underpasses and car parks accessed through ramps, besides ground level parking spaces. The complete parking process from entrance to exit is controlled by the drivers without the aid of any mechanical support.

Semi-mechanized parking buildings are understood as being primarily hay accessible, conventional parking buildings in which the number of parking spaces is increased by means of mechanical parking equipment whilst maintaining a constant floor space. Here, for example, the available lanes are additionally utilised by movable parking plates or parking spaces are laid out for multiple occupancy by lifting platforms. A special case is the parking lift which allows the vertical transportation of vehicles instead of using ramps.

Parking lift

The most simple version of a mechanical parking device is the parking lift. This term may be used as a synonym to the "Car Lift" used in the "BAR" system. A decisive factor for the choice of the term was the linguistic classification in the total of the words indicated in the following. It is installed in multi-storey car parks and takes over the function of the ramps which as a rule may not be used for space reasons. The lift automatically transports the vehicle, parking in or driving out of the storey selected. The horizontal transport on the corresponding parking level as well as the parking in or out of the lift and into the parking space, is effected in the traditional manner by the driver.

Parking plates

With the use of cross or longitudinal sliding parking plates (Fig 1), where the cars left are transported without any driving forces of their own, the available space of parking level may be utilized more intensively by parking additional cars e.g. on parts of the lanes or in the "dead" space behind columns.
The cross-sliding plates are arranged in one or multiple rows in front of a row of conventional parking spaces. They are designed so that the selected space may be freely accessed or left due to the specific dimensions and the track system with a sliding drive. Cross-sliding plates are not suited for retrofitting (according to "PARK")

Longitudinal sliding plates are installed and moved in the lane and they allow repositioning if the vehicle is parked on a pile. Making a conventional parking space located behind it, the plate is moved until this space becomes free if the plates located in front are empty, they do not have to be displaced and they may be chosen over individual designs of longitudinally sliding plates allow the accommodation of up to four vehicles (according to "PARK")

Both types operate on the basis of the same mechanical principles: the plates are guided on a slot and rely on two rails. The plates are displaced by means of an electric motor which is activated by a control panel. The mechanical sliding parking system may be installed either above or below in underground parking. Practically, an installation - given the corresponding clearance - in any additional underground car park is feasible; however, then it becomes part of a semi-mechanized parking building.

Per installation, a magnitude of 20 to 30 new parking spaces makes sense. The lower the number of parking lots, the shorter the access time.

According to the manufacturer, a maximum of 45 parking spaces per lift may be realized.

Parking Scaffold

A further system for semi-mechanized parking buildings is the parking scaffold, which may be installed as a self-supporting unit in smaller and larger complexes. Unlike currently offered systems, up to three vehicles may be parked on top of each other. They are parked on platforms, one of which is at ground level and the second (or third) platform is lifted by means of a hydraulic cylinder or another equipment. With the vehicle without a pit, the lower vehicle is reached via the platform before the upper vehicle may drive off ("dependent parking"). The design with a pit, on the other hand, allows independent parking.

Sliding Parking System

For the fully automated sliding parking system (Fig. 2), a vertically sliding conveyor unit similar to the parking scaffold lifts or lowers the vehicles ready in the entrance area for parking, so a parking level with multiple cross-sliding plates in a row. A transfer unit at the end of the parking level may also transport the parking spaces if required - from one level to the other. This automated process is necessary for example if an entry point is needed for transformation of vehicles to be parked and these spaces may only be accessed by the conveyor unit, which must be at a predetermined level.

Depending on the manufacturer and the requirements, the conveyor unit may be installed at the end or in the centre of the system, so that it is possible to adapt the system to existing estate dimensions and building standards. The space requirement per parking lot depends, of course, on the individual conditions of the space. As a guideline, between three and eight square meters per parking lot may be realized.

A variant of the sliding parking system is a system which has been installed in Germany only once, but which is now available as a semi-mechanized parking system. In this system, a sliding plate andNormal parking may be moved in the longitudinal direction (Fig. 2). With this system, 16 parking spaces were installed in one level (area of approx. 300 square meters) in the case already realized.

PARKING TOWER

For the fully automated parking tower (Fig. 4), the additional parking spaces are not generated through floor space being cut out from an existing building. Instead, the vehicles are parked on a conveyor unit, which then transports the vehicles to the levels where the parking space is available. The vehicles are driven onto the transfer platform and conveyed by a telescopic arm, which then moves the vehicles into the parking spaces.

The parking tower lends itself to sites where 10 to 40 parking spaces have to be established either above or below in underground parking. The space requirement for such a system is specified with 50 square meters. Here, the space requirements are also additional to the fully mechanical systems. The driveways need to be added to the floor space requirement. Normal installations to long-term parking or to short-term parking of a direct access from the road is possible subject to corresponding building laws, while for large installations, a building permit may be needed.

Parking Rack

Parking racks (Fig. 5) are fully automated parking installations which are mounted on high-level foundation systems. The rack systems are either closed or open. In these installations, vehicles are moved into stationary or movable parking spaces by a conveyor unit (Fig. 5). Compared with the parking tower, the conveyor unit may be movable in a vertical direction as well as in a horizontal direction.
The horizontal circulating parking system, on the other hand, is rather suitable for the creation of underground parking spaces. The entrance into the horizontal circulating parking system is preferably centrally located underground, with the vehicle parked on a pallet being emptied by a conveyor belt to the upper level or being displaced afterwards by gravity. The entrance and exit position may be incorporated at any given location. If the circulating parking system is installed into a conventional underground car park, a direct access to one of the two levels is also possible. To achieve an access time as short as possible, the conveyor belt may run in both directions. At both ends of the circulating parking system, the vehicles are lifted or lowered by a transfer device in a horizontal position to another level.

The capacity of the horizontal circulating parking system is as high as that of the vertical one so that it is primarily suitable for especially long narrow estates. For example, the floor space requirement for approx. 40 parking spaces is reduced to about 2/3 under 300 square meters.

Circulating Parking System
The principle of the fully mechanical circulating parking system is based on the field of material-handling technology or — as also used by an Austrian manufacturer — on a pattern of the old Chinese "Rosemary mills" designed after their "Principle of Chain Mills." Circulating parking systems are effective in vertical as well as in horizontal layouts. The vertical circulating parking system may be compared to a passenger elevator for persons while the horizontal parking system is similar to a conveyor belt.

The technology of the vertical circulating parking system has been adapted from Japan and U.S., where this type of equipment has been used for more than two decades. Conventionally, 20 to 40 parking platforms are linked to each other by a chain system. If a driver wishes to enter the parking system with his vehicle or the works to call it out from the system, the platforms will circulate until the free platform on the requested vehicle has reached the entrance area.

The design of the equipment is especially suitable for applications on long, narrow estates or in exclusive narrow working areas. The layout is from a Rotate Planning Point of View as well as being necessary for noise protection reasons. Due to the small dimensions of the vertical circulating parking system, there is a small minimum requirement of approx. 50 square meters per installation (in the case of a dimension of 5 x 9 m in diameter). An average of 20 passenger spaces can be accommodated. A disadvantage of the other hand, is the higher demand of the mechanical system and the drive. A subterranean construction is possible, but is often more difficult than an above-ground solution.
### 3. PRODUCT SUPPLY BY THE MANUFACTURERS

Currently, the range of manufacturers of mechanized parking equipment is quite distinct. Thus, at the time of the survey in summer 1981 and autumn in winter 1982, approximately a dozen federate suppliers were found. In addition, an Austrian company is documented. However, for the product survey in Table 1, the list should be taken into account that some manufacturers do not market their products themselves but cooperate with a distributor. For finally, only manufacturers of mechanical parking equipment are listed. These can satisfy further information on request.

Obviously, fully mechanized parking equipment in particular offers promising market perspectives to the manufacturers and distributors of this equipment in the near future. Although currently the diversification of the product range is quite distinct, more and more suppliers of this equipment are working on their way into the market, offering new, modified, traditional or advanced systems. But also established manufacturers incorporate their experience gained with the operation of their electric equipment, into their product range.

The course is currently determined by the fully mechanized systems which control the market, but then, many manufacturers will dominate the market in future. Therefore, many manufacturers specifications are very variable, e.g. with reference to access times, parking lot capacities, a parking lot's cost and, above all, the costs for such systems, especially concerning the costs, it has to be taken into account that the price of a parking lot, which is often given in comparison to conventional installations only refers to the mechanics as such. As a rule of thumb, it may be said that the remaining construction costs (fencing, foundations and other building costs) are about the same as for the mechanics. Moreover, the manufacturers are not willing to indicate any fixed prices for their systems since the costs per parking space increase with increasing numbers.

As a rough estimate, a price range of ca. 30,000 to 60,000 DM per storage unit is found. Mechanical parking space systems for fully mechanized parking buildings may be assumed. It is also important to know that the manufacturers and distributors are increasingly putting together a complete package of equipment used for practical reasons. This experience has shown that manufacturers are frequently willing to produce practical drawings, including a statement of cost for a detailed plan.

One can expect that in the near future more engineering firms, electro-industry firms and manufacturers of similar products and the automotive industry press into the market for mechanical parking equipment which seems to be possible. Therefore, it cannot be said that Table 1 has not taken into account some of these new suppliers. The authors would appreciate any information about changes in the range of products.

### 4. OUTLOOK

Mechanical parking equipment increasingly becomes an alternative to be taken seriously compared to conventionally equipped parking buildings. Operational and economical problems which partially are still a handicap for the selection of the option for parking space generation, certainly become less important in the near future.

What else we would address is the problem of the respective appropriate range and the application limits of these parking units. Given integration possibilities, integration into traffic control systems, local acceptance and economical aspects are only part of the factors giving an idea of the complexity of this field of topics.

Within the framework of the model project of the City of Frankfurt/Main "Parking Guidance Systems and Mechanized Parking Equipment in Town Planning and Traffic Concept", the office of Albert Speer & Partner GmbH (AS&P) will also deal with these questions, going beyond the introduction given here. A final report may be expected next year.