PRELIMINARY DRAFT

NATIONAL BUILDING CODE OF INDIA

PART 8 BUILDING SERVICES

Section 5 Installation of Lifts, Escalators, Moving Walks and Parking Systems

5C Parking Systems

BUREAU OF INDIAN STANDARDS

CONTENTS

National Building Code Sectional Committee, CED 46

FOREWORD

This Code (Part 8/Subsection 5C) covers the requirements for planning and design, installation and operation, of car parking systems to ensure efficient operation of system with satisfactory performance.

This Section was first published in 1970 and was subsequently revised in 1983, 2005 and 2016. This Section covers the requirements for installation of lifts and escalators in buildings. This Section shall be read with Part 4 'Fire and Life Safety' of the Code from fire safety requirements point of view. The major changes in the first revision of 1983 were the addition of outline dimensions of different types of lifts and detailed requirements of escalators in buildings. Emphasis was laid on coordination between the engineer/architect and the lift manufacturer to arrive at the number and position of lifts for attaining optimum efficiency in serving the building with safety.

The significant changes with respect to lifts incorporated in the 2005 revision, included the addition of new clauses/recommendations on the building management system; the addition of new clauses on the fireman's lift, infrared light curtain, safety and Braille button for blind people and updation of provisions as per the revised standards on lifts on which this Section was based.

In the 2016 revision, the erstwhile Section 5 on Lifts and Escalators was divided into two subsections namely:

5A Installation of Lifts
5B Installation of Escalators and Moving Walks

The growing demand for efficient and space-saving parking solutions for passenger cars in urban environments has led to the development of this new Subsection (5C) that addresses the requirements of hydraulic lifts for multi-level car parking systems. These systems, which may be either automated or semi-automated, are crucial for optimizing land use in densely populated areas. Recognizing the importance of such systems, this Code (Part 8/Subsection 5C) has been developed to provide comprehensive guidelines for the planning, design, installation, operation, maintenance, and inspection of parking systems to ensure the safe and efficient movement of vehicles.

In recent years, the number of cars on the roads has increased significantly, turning car parking into a major hassle. Numerous manufacturers are striving to implement innovative solutions to address this challenge. However, with the rise in the number of cars to be parked in an available space and the use of ill-engineered systems, safety concerns have also escalated. There have been a few fatal accidents in the past, making it a prime responsibility to ensure the safety of parking systems.

The Code in its Part 3 'Development Control Rules and General Building

Requirements' together with related standards provided the basic guidelines regarding off-street parking (on-site parking) space dimensions. In the case of parking lifts, typically, the following sizes are used: 2.3 m × 4.5 m for small sized cars and 2.5 m × 5.5 m for large sized cars. While these dimensions are adequate for parking vehicles, they prove insufficient when mechanized systems are involved. Therefore, this Code suggests the requirements that enhance the functionality and safety of parking systems.

This Section (new chapter) on hydraulic lifts for parking systems reflects the evolving technological advancements and urban planning needs and its integration within the lift and escalators related building services chapter underscores the significance of vertical transportation solutions in modern building infrastructure.

The following important provisions are addressed in this Subsection:

a) *Multi-Level Car Parking Systems* – These systems can either be standalone public car parks or integrated within office, retail, or residential complexes. The primary objective is to maximize parking efficiency while ensuring user safety and convenience.
b) *Automated Parking Systems* – Fully automated car parks allow drivers to leave their vehicles at designated entry points, from where the vehicles are transported and parked automatically. This system minimizes human intervention, reduces parking time, and enhances space utilization.
c) *Car Lifts and Ramps* – In semi-automated systems, the movement of cars depends on the use of car lifts and/or ramps. It is essential to conduct a detailed analysis to determine the optimal number of car lifts required, ensuring that the average car retrieval/parking time does not exceed 3 min.
d) *Design and Safety* – Car lifts must be designed to accommodate the largest vehicles intended for use, providing adequate space for door opening to facilitate passenger evacuation in case of emergencies. Additionally, designers must account for potential queues and provide sufficient holding areas for vehicles.

This Subsection aims to set forth the essential requirements for the effective implementation of multi-level car parking systems, addressing key aspects such as operational efficiency, safety, and user experience. The guidelines provided herein will serve as a benchmark for the design and installation of parking systems, contributing to the overall improvement of urban infrastructure.

This Code (Part 8/Subsection 5C) deals with the installation requirements for planning, design, installation, operation, maintenance and inspection of hydraulic lift parking systems so as to ensure safe movement of cars within and out of the building spaces and with satisfactory performance.

The information contained in this Subsection is largely based on the following Indian Standards/ Special Publications:

IS 3043 : 2018 Code of practice for earthing (*second revision*)

IS 732 : 2019 Code of practice for electrical wiring installations (*fourth revision*)

SP 30 : 2023 National Electrical Code of India 2023

Assistance has also been derived from the following publications in the revision of this Subsection:

IBC 2024 – International Building Code, International Code Council, Washington, USA

Safety of machinery – Equipment for power driven parking of motor vehicles – Safety and EMC requirements for design, manufacturing, erection and commissioning stages (including Amendment A1:2009)
English version of DIN EN 14010:2009-12

For the purpose of deciding whether a particular requirement of this Subsection is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Subsection.

Members are requested to share their inputs/comments on the draft particularly w.r.t the changes listed above in the foreword; and specially on those text highlighted in yellow in this draft.

Important Explanatory Note for Users of the Code

In any Part/Section of this Code, where reference is made to **'good practice'** in relation to design, constructional procedures or other related information, and where reference is made to **"accepted standard'** in relation to material specification, testing, or other related information, the Indian Standards listed at the end of the Part/Section shall be used as a guide to the interpretation.

At the time of publication, the editions indicated in the standards were valid. All standards are subject to revision and parties to agreements based on any Part/ Section are encouraged to investigate the possibility of applying the most recent editions of the standards.

PRELIMINARY DRAFT

NATIONAL BUILDING CODE OF INDIA

PART 8 BUILDING SERVICES

Section 5 Installation of Lifts, Escalators, Moving Walks and Parking Systems
5C Parking Systems

1 SCOPE

1.1 This Code (Part 8/Subsection 5C) covers the requirements for planning, design, installation, operation, maintenance and inspection of hydraulic lift parking systems in buildings so as to ensure safe movement of cars with satisfactory performance.

1.2 This Subsection gives information that should be exchanged among the architect/engineer, the consulting engineer and the car parking solution providers /installers from the stage of planning of installation including up to the functioning and maintenance stage.

2 TERMINOLOGY

For the purpose of this subsection, the following definitions shall apply.

2.1 General

2.1.1 *Parking Unit* – A parking unit refers to one or several load carriers connected together mechanically and moving as a single entity.

2.1.2 *Parking Equipment Attendant* – A person tasked with operating, cleaning, and/or supervising power-driven parking equipment.

2.1.3 *Public Use* – Those parking systems designed and intended for access and use by the general public, as opposed to private or restricted use.

2.1.4 *Transfer Area* – An area within a semi-automatic / fully automatic parking facility into which cars are parked in and/or from which they are removed. Normally only the driver should be allowed to enter in this area.

2.1.5 *Working Area* – Power-operated parking system for motor vehicles / cars, in which the transfer area is the same as the working area. A main sliding door (recommended for safety) is located in front of each transfer area which stores and makes the car available again in sequential operation. During the operation of the parking system, access of any personnel is prevented in this working area.

2.1.6 *Operating Panel* – Stationary or mobile device giving command for parking space request. Signal transmission for mobile controls can be based on different technologies

(radio, infrared, RFID, Bluetooth, etc).

2.1.7 *Grid* – One or more (sideways) working areas load handling devices standing vertically one above the other.

2.1.8 *Series* – One or more load-handling attachments placed horizontally and one behind the other as a grid.

2.2 Terms Relating to Parking Systems

2.2.1 *Hydraulic Parking Systems* – A parking system that utilizes fluid-driven mechanisms, including hydraulic cylinders, to lift and lower vehicles into designated parking spaces, typically allowing for multiple vehicles to be stacked vertically in a compact space.

2.2.2 *Mechanical Parking Systems* – A parking system that employs mechanical components such as gears, pulleys, and chains to move vehicles horizontally or vertically into parking positions, often using automated platforms or carriages.

2.2.3 *Automatic Parking System* – A parking system that consists of parking equipment along with its linked ancillary equipment, such as main doors, working area doors, side doors, and emergency doors all of which operate in an automatic /preprogrammed manner.

2.2.4 *Safety Switch* – A control switch with one or more break-contact elements connected via non-resilient members, ensuring full contact opening when the actuator is moved through the specified positive opening travel.

2.2.5 *Wheel Track Width* – The distance between the centre lines of the wheels on a single axle of a vehicle.

2.2.6 *Wheel Base* – The distance between the centres of the wheels on the front and rear axles of a vehicle.

2.2.7 *Locking Device* – A mechanism that prevents the load carrier from leaving a defined position within the parking system.

2.2.8 *Puzzle Parking System* – A type of automated parking system in which vehicles are moved on platforms in vertical direction and horizontal direction (similar to a puzzle); while the system makes empty slots to let the vehicles move in and out of the parking slots as required.

2.2.9 *Safety Gear* – A mechanical device designed to stop and hold the load carrier in case of overspeeding within the parking system.

2.3 Terms Relating to Semi-Automatic Parking Systems

2.3.1 *Area of Parking* – The area reserved for the car parking system where the system is supported at various load bearing points shall ensure firm support from flooring/ceiling where the following parameters should be followed: A level difference of 25 mm (max) or

not more than 1 degree of tilt, measured between any two corners of a load handling attachment.

2.3.2 *Restricted Access* – Access restricted to authorized persons to use the parking facilities and are controlled through access code, magnetic card, key switch, etc.

2.3.3 *Drive Way* – The front open space in the parking system (minimum 6.0 m in length or the diagonal distance of car + 500 mm) where the car enters in 90 degrees into the system.

2.3.4 *Vertical Movements* – The transporting of vehicles between different levels vertically, typically using car lifts or stacker systems to maximize vertical space.

2.3.5 *Horizonal Movements* – The lateral shifting of vehicles within a parking level, often using automated platforms or conveyors for efficient space utilization.

3 GENERAL

3.1 Conformity with Act and Rules

3.1.1 The installation of parking systems, including stack parking, puzzle parking, tower parking, and other automated parking systems, is governed by different Acts and Rules across states, intended to ensure the safe installation and operation of such systems.

3.1.2 The installation shall be carried out in conformity with relevant Acts and Rules wherever they are in force, ensuring compliance with all safety and operational guidelines.

3.1.3 It is the responsibility of the owner (or his representative) of the premises where the parking systems will be installed to obtain necessary permissions from the Authority before and after the erection of the parking systems and for their subsequent operation.

3.1.4 A license for public use is a safety provision issued by state authorities under applicable Acts and Rules, wherever they are in force.

3.2 Conformity with the Indian Electricity Act and Rules

3.2.1 All electrical work related to the installation of parking systems shall be carried out in accordance with the provisions of *the Indian Electricity Act* 2003 as amended up to date, along with the rules and regulations framed thereunder. Additionally, the installation shall comply with the provisions of Part 8 'Building Services, Section 2 Electrical and Allied Installations' of the Code.

3.3 Conformity with Indian Standards

3.3.1 All materials, fittings, appliances, etc, used in the installation of parking systems shall conform to Indian Standard specifications wherever these exist. In cases where Indian Standard specifications do not exist, the materials shall be approved by the competent authority. The installation shall adhere to best practices as outlined in relevant standards such as SP 30, IS 732, and IS 3043.

3.4 Conformity with Fire Regulations

3.4.1 The installation of parking systems shall be carried out in conformity with Part 4 'Fire and Life Safety' of the Code and the applicable state fire acts/local fire regulations, wherever they are in force. The installation shall be carried out in conformity with relevant Acts and Rules wherever they are in force, ensuring compliance with all safety and operational guidelines.

3.5 Safety Design Considerations

The design consideration for type and selection of parking systems walk shall be based on following criteria:

a) *Location* – To ensure reliability and longevity, the design specifications of parking systems must suit the environmental conditions of the installation site. Factors such as exposure to weather elements, seismic activity, and temperature variations should be considered when selecting and designing a parking system.

b) *Physical Requirements* – The physical characteristics of the site, such as available space and the building's structural capacity, play a crucial role in selecting the appropriate parking system. The system must be designed to accommodate the vertical and horizontal dimensions of the space. The building infrastructure must also be evaluated to ensure it can support the weight and dynamic loads of the components of the parking system.

c) *Type of Segment and Traffic Patterns* – The design and selection of parking systems depend on the type of segment where they will be installed, such as residential buildings, commercial complexes, transit hubs, or public parking facilities. The expected traffic patterns and peak demand should be carefully analyzed to ensure that the parking system's capacity matches the anticipated usage, preventing congestion and delays.

d) *Safety Considerations* – Parking systems must be designed and installed with a focus on safety to prevent accidents and injuries. Safety features should include proper load limits, emergency stop functions, and clear signalling systems. Operators and users must adhere to the rules for safe operation, including compliance with all safety signals and instructions outlined in the operation and maintenance manual. Routine inspections should be conducted before operation to confirm the equipment's condition, and overloading must be strictly avoided to prevent mechanical failure.

e) *Aesthetic Preferences* – The aesthetic integration of the parking system with the surrounding environment should be determined in consultation with all relevant stakeholders. This may involve choosing materials, finishes, and designs that complement the architectural style of the building or site.

4 PARKING SYSTEMS – OVERVIEW AND SPECIFICATIONS

4.1 Parking systems are essential in urban environments where space is limited and the demand for efficient vehicle storage is high. These systems optimize the use of vertical and

horizontal space, ensuring that vehicles are securely and conveniently parked. The choice of a parking system should be based on factors such as the type of vehicles to be parked, the available space, the required capacity, and specific site conditions**.**

4.2 Stack Parking System

An optimized system in which vehicles are stacked vertically is known as stack parking system. Such systems are particularly useful in urban settings where land space is scarce. The stack parking system operates by lifting vehicles and placing them on platforms supported by vertical columns. They are ideal for residential and commercial buildings having limited space and are also suitable for above-ground installations where space constraints prevent extensive horizontal expansion. There are two types of stack parking systems, namely:

a) *Dependent stack parking system* – A vertical parking arrangement where two cars are parked one above the other. The lower car must be removed to access the upper car. This system is suitable for both indoor and outdoor installations and offers a cost-effective solution by utilizing a single driving level to create two parking levels (*see* Fig. 1).

b) *Independent stack parking system* – A parking system that allows multiple cars to be parked vertically above each other, with each parking level being independently accessible. This system maximizes space efficiency by providing multiple parking levels on a single driving level, making it an ideal solution for areas with limited space (*see* Fig. 2).

4.2.1 *Key Features and Components*

The following are the key features and components of stack parking systems:

a) *Vertical support* – Supported on two sides by vertical columns with a pair of slides that hold the platform and allow movement along the columns.
b) *Balancing chain* – A chain fixed at both ends that supports the platform during travel, having sufficient strength to withstand impact loads in case of a sudden fall.
c) *Locking mechanism* – Lockers positioned on both sides of the vertical columns engage during downward movement. These lockers restrict the free fall of the platform in the event of power failure, which require lockers every 100 mm in the downward direction. *See* Note.
d) *Hydraulic cylinder* – The system uses hydraulic cylinders designed to bear the load of the vehicle on the platform during vertical transportation.
e) *Hydraulic power pack* – A single hydraulic power pack can serve multiple systems, with individual controls for each system.
f) *Non-Return valve* – Controls the flow of hydraulic oil in one direction with a self-locking arrangement to prevent accidental movement.
g) *Foundation support* – The system is anchored by RCC foundations (M20 /M25 grade) capable of sustaining the pull-out loads exerted through foundation bolts.
h) *Ceiling or side supports* – The upper end of the system is supported by either ceiling or side supports.
k) *Four-column support* – The car’s weight is transferred to four supporting pillars, typically driven by mechanical traction machines using ropes or chains.

m) *Braking system* – The movement is controlled by brakes, though the system lacks a secondary stopping mechanism if the brakes fail.
n) *Limit switches and Sensors* – Limit switches control movement, but over-reliance can lead to accidents. Sensors below the platform detect vehicles, though potential blind spots exist.
o) *Operational safety* – The system requires a "Hold to Run" operation to ensure no objects are within the parking area before activation. An emergency safety switch is mandatory for every operating panel.
p) *Security features* – Each operating device must have a key lock to prevent unauthorized use. The system's components should have an IP rating of 67 for outdoor installations.

NOTE – Until the Indian Standard on the subject is formulated, specialist literature like EN 14010:2003 *'Safety of machinery. Equipment for power driven parking of motor vehicles. Safety and EMC requirements for design, manufacturing, erection and commissioning stages'* may be referred to.

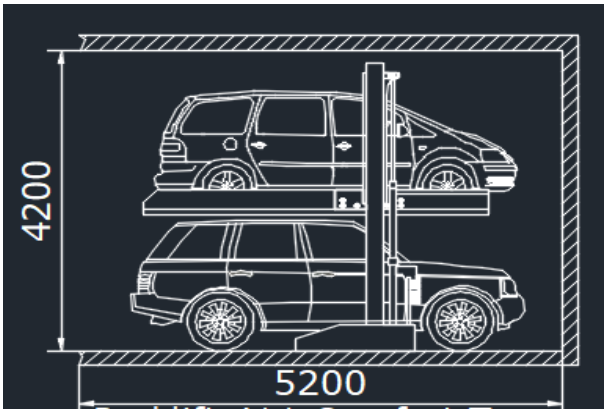


FIG. 1 DEPENDENT STACK PARKING SYSTEM

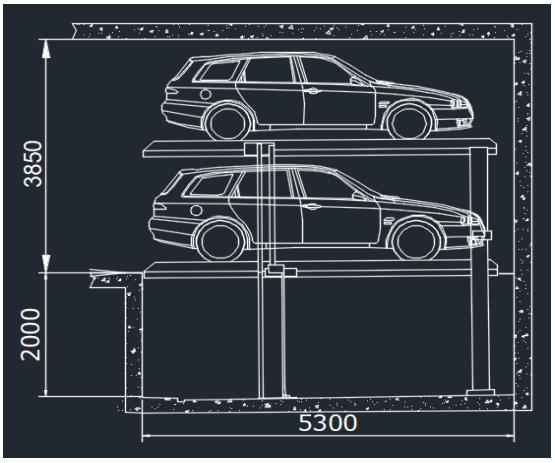


FIG. 2 INDEPENDENT STACK PARKING SYSTEM

4.3 Puzzle Parking

Puzzle parking system is a type of semi-automatic parking system designed to maximize parking space efficiency by utilizing a combination of vertical and horizontal movements. The system mechanically arranges vehicles in a grid-like structure to optimize space utilization and minimize the need for manual parking. *See* Fig. 3 to Fig. 8 that depicts various options of puzzle parking and the essential systems in them.

4.3.1 *Key Features and Components*

The features and components of the puzzle parking are described hereunder:

a) Vertical movement:

i) *Geared motor and machine* – The geared motor and machine for vertical movement shall be located at the side or rear of the system. Movement shall be facilitated using ropes or chains.

ii) *Hydraulic cylinders* – Vertical movement using hydraulic cylinders may be located either vertically or horizontally, depending on the system design.

b) Horizontal movement – Horizontal movement shall be controlled by a traction motor utilizing a chain sprocket mechanism.

c) Safety precautions:

i) *Entry to transfer rooms* – Access to transfer rooms must be controlled with sliding doors to ensure safety. Sensors may be used to halt the system in case of obstruction, but reliance solely on sensors may not fully prevent accidents.
ii) Flood Sensors – Flood sensors shall be installed in the pit to monitor water levels. A warning hooter shall be provided to alert of any potential malfunction in the sump pump system.

d) Pit requirements

i) *Waterproofing* – The pit shall be waterproofed to prevent water ingress. A sump shall be provided for efficient water removal.
ii) *Condition before installation* – The pit shall be handed over with a whitewash applied before the installation of the puzzle parking system.

e) Maintenance and inspection – Regular maintenance and inspection schedules shall be established to ensure all components are functioning correctly and to prevent system failures.

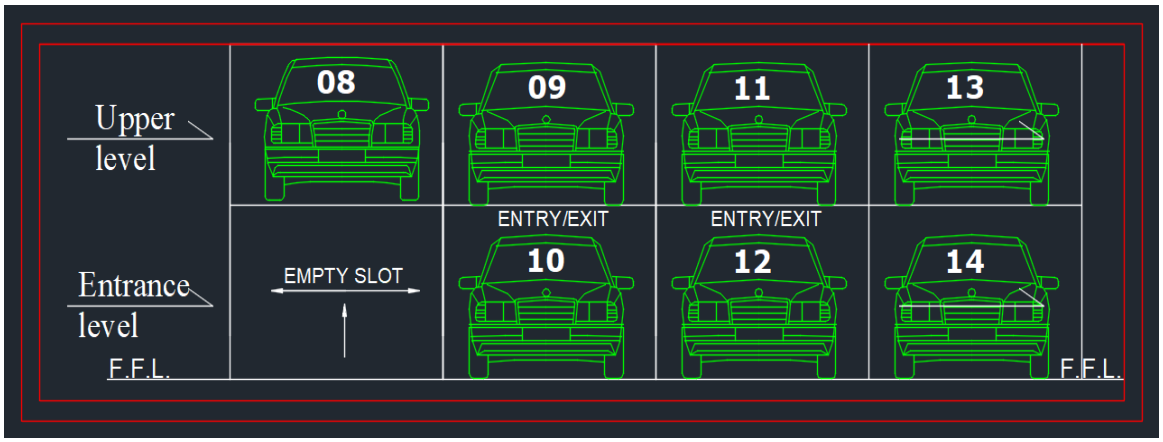


FIG. 3 SYSTEM SHOWING 2-LEVEL PARKING ABOVE GROUND

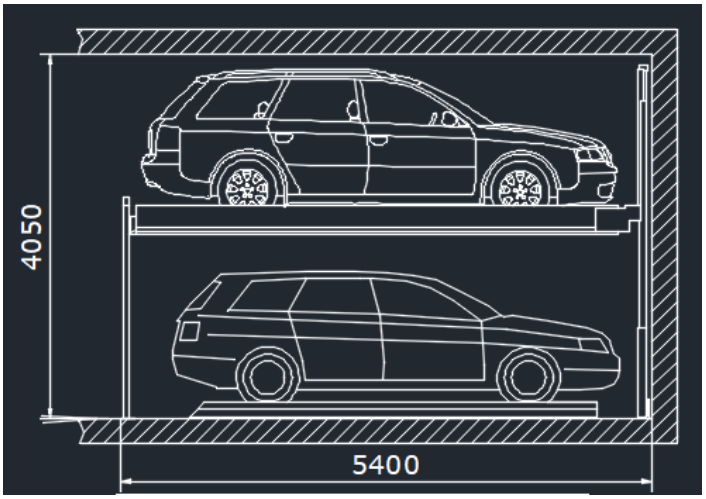


FIG. 4 CROSS SECTION SHOWING FREE SPACE FOR SERVICES LIKE FIRE SPRINKLERS

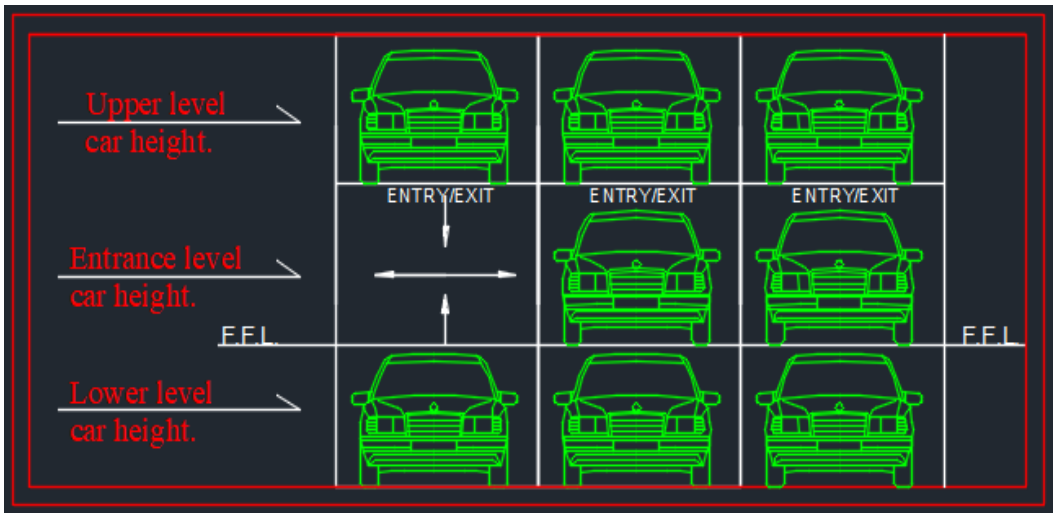


FIG. 5 SYSTEM SHOWING 3 LEVEL PARKING WITH PIT

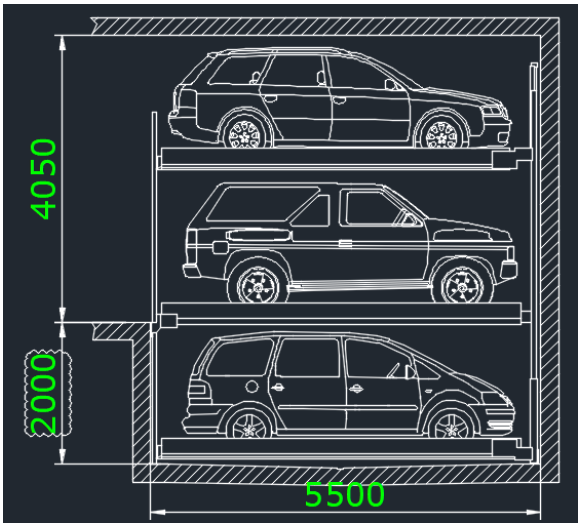
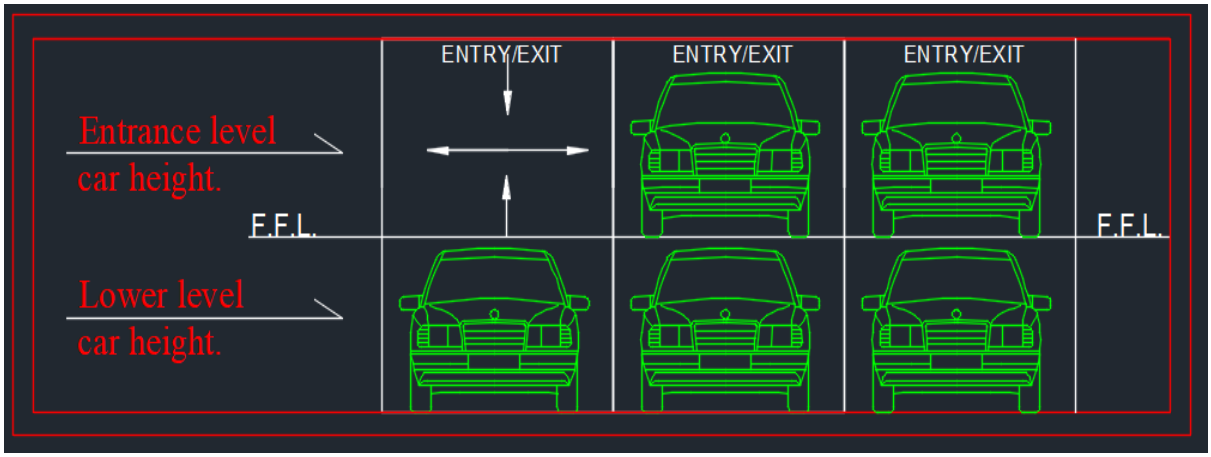


FIG. 6 CROSS SECTION SHOWING FREE SPACE FOR SERVICES LIKE FIRE

SPRINKLERS



(FFL – Finished Floor Level)

FIG. 7 ARRANGEMENT OF PUZZLE WITH PIT

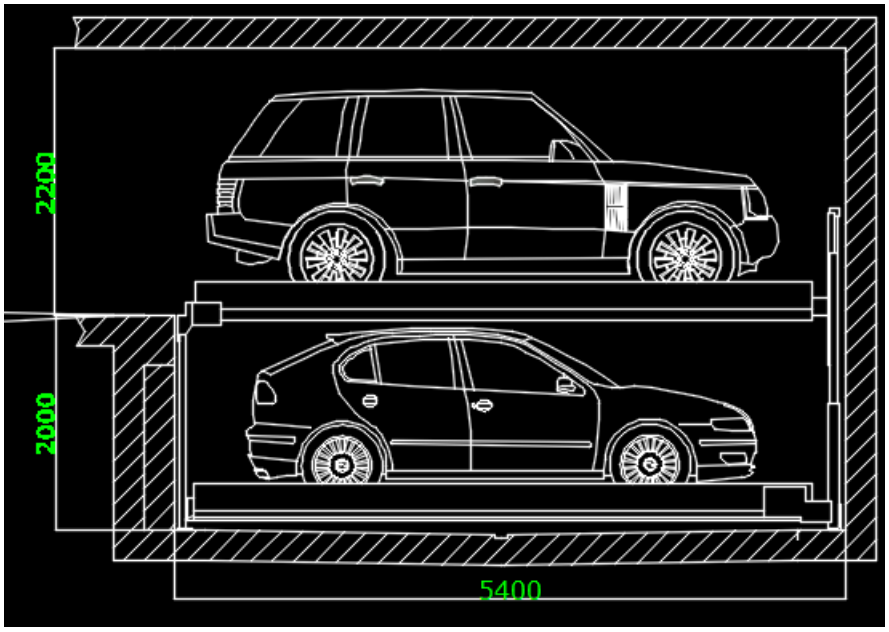


FIG. 8 CROSS SECTION SHOWING FREE SPACE FOR SERVICES LIKE FIRE SPRINKLERS

4.4 Automatic Tower Parking System – Inside RCC Shaft

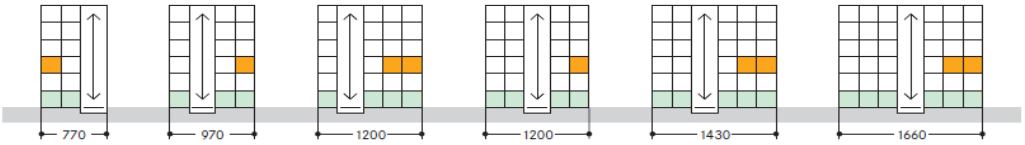
Automatic tower parking system within an reinforced cement concrete (RCC) shaft is a vertically oriented automated parking system designed to efficiently utilize space by stacking vehicles in a cylindrical tower. The system combines mechanical and automation technologies to transport vehicles to designated parking spots within the tower.

4.4.1 *Key Features and Components*

The following shall be applicable:

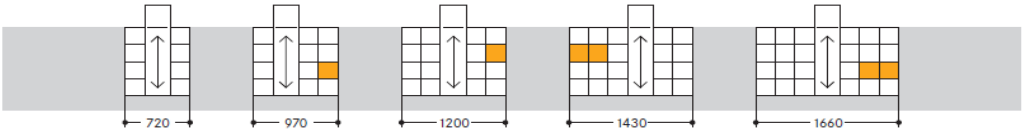
a) *System configuration* – The system features a central lift with various configurations including 1/1, 1/2, 1/3, 2/2, 2/3, and 3/3 arrangements, as illustrated in the system's design, see Fig. 9.

b) The lift facilitates the vertical transportation of vehicles to different levels within the tower.



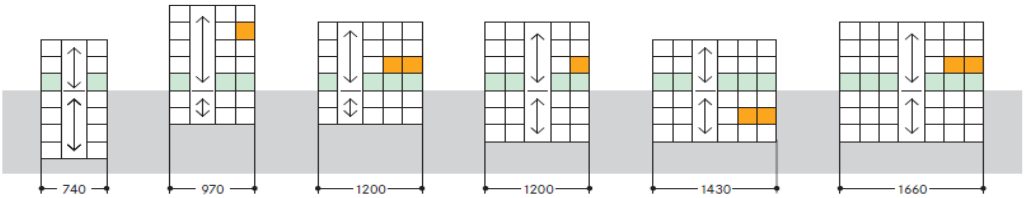
CONFIGURATION:
2/0 1/2 1/3 2/2 2/3 3/3

9A TOWER TYPE (ABOVE GROUND)



CONFIGURATION:
1/1 1/2 2/2 3/2 3/3

9B SHAFT TYPE (BELOW GROUND)



CONFIGURATION:
1/1 1/2 1/3 2/2 2/3 3/3

9C TOWER & SHAFT TYPE (STRUCTURE IS PARTLY ABOVE AND PARTLY BELOW GROUND)

FIG. 9 VARIOUS ARRANGEMENTS DEPICTING THE SECTIONS/ SLOTS FOR PARKING

c) *Entrance room* – Its location shall be positioned for convenient access to vehicles entering the parking tower thereby allowing smooth entry and exit of vehicles, facilitating the parking process.
d) *Car handling and turning* – Turntables or turning devices to rotate vehicles to ensure proper alignment for exit direction.
e) *Car hold area* – There shall be adequate space in front of the entrance room to accommodate vehicles during the parking and retrieval process.
f) *Car handling capacity* – The system should be able to handle approximately 25-30 cars per hour, with a full cycle of filling or evacuating the tower completed in about 3 h.

g) *Parking capacity* – The tower should have a capacity to accommodate up to 90 cars.
h) *Lift locking mechanism* – It should be ensured that the lift platform is securely locked before any vehicle transfer or retrieval operation is performed.
k) *Platform guide rails* – Closed-type guide rails shall be employed to provide stability and ensure safe vehicle movement within the tower.
m) *Platform locking mechanism* – Each platform shall have built-in feature which includes an integrated locking mechanism to secure vehicles in place.
n) *Tower structure stability* – Proper anchoring of the tower structure should be ensured for stability and safety during operation.
p) *Illumination inside shaft* – Light points shall be installed every 6.0 m, controlled by 3-phase 16A switches to ensure adequate visibility inside the shaft.
q) *Sound and vibration control* – The structure should be connected to the RCC with sound isolation pads to mitigate noise and vibration transmission.
r) *Shaft size* – The shaft dimensions shall be designed to accommodate large-size cars comfortably.
s) *Finish of the structure* – The structure should be finished with hot-dip galvanization and is fire-resistant for up to 2 h to ensure durability and safety.
t) *Entrance door* – Safety doors shall be able to withstand a force of 300 N applied perpendicular to the surface without permanent deformation or impairment of functionality. The force should be distributed evenly over an area of 500 mm² (5 cm²).

4.5 Longitudinal Parking System

This is a parking system having lift at centre with front and back arrangement when there is more space available in length than in width. This system is thus considered and designed to maximize parking efficiency in narrow spaces, particularly in narrow broad strips between buildings, such as the area between the set-back lines and the building.

4.5.1 *Key Features and Components*

The following shall be applicable:

a) Vehicle Accommodation:

   i) *Car height and length* – The system shall be designed to accommodate various car heights and lengths, ensuring flexibility for different vehicle types.

   ii) *Capacity* – The slim parking system shall be capable of parking up to 30 cars, depending on the specific design and available space.

b) Design Efficiency:

   i) *Floor Plan* – The system shall be designed with a very small floor plan area and a slim construction, maximizing the use of narrow spaces.

   ii) *Ramps and Driveways* – No space-intensive ramps or driveways shall be required for this system, allowing for a more compact and efficient design.

c) Configurations and Arrangements:

i) *Configurations* – The system shall offer configurations of 1/1 or 2/2, which are particularly suitable for the side margins of buildings.

ii) *Above or Below Ground* – The system should allow for both above-ground and below-ground arrangements, depending on the site's requirements (*see* Fig. 10 and Fig. 11).

iii) *Lengthwise Transportation* – Vehicles shall be transported lengthwise with restricted levels to control the number of vehicles within the system.

iv) *Capacity* – The slim parking system shall have a capacity of around 30 cars, accommodating the needs of various building types.

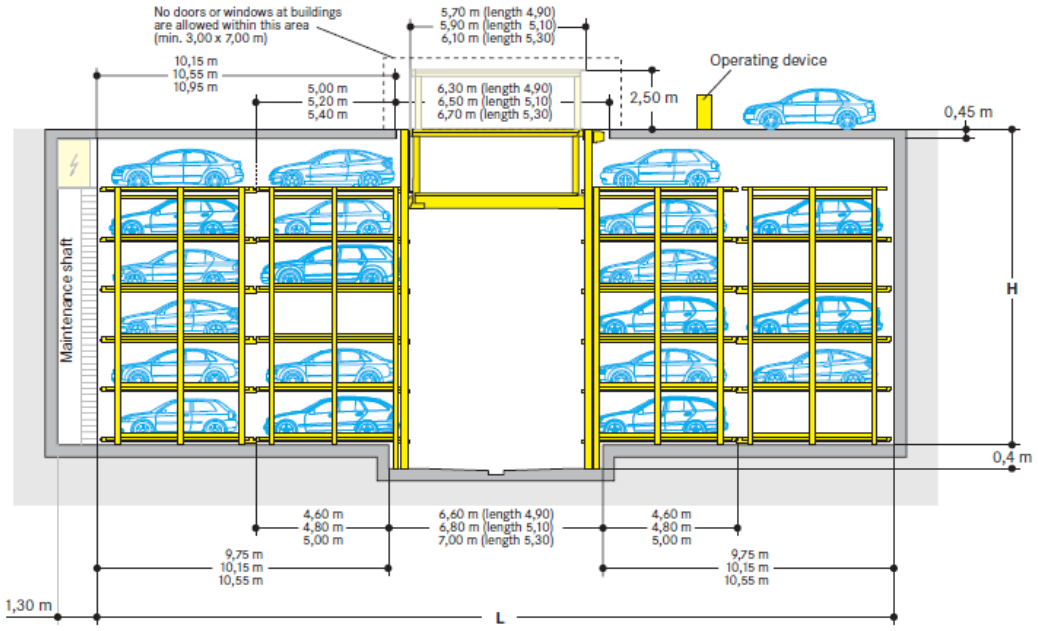


FIG. 10 ARRANGEMENT BELOW GROUND

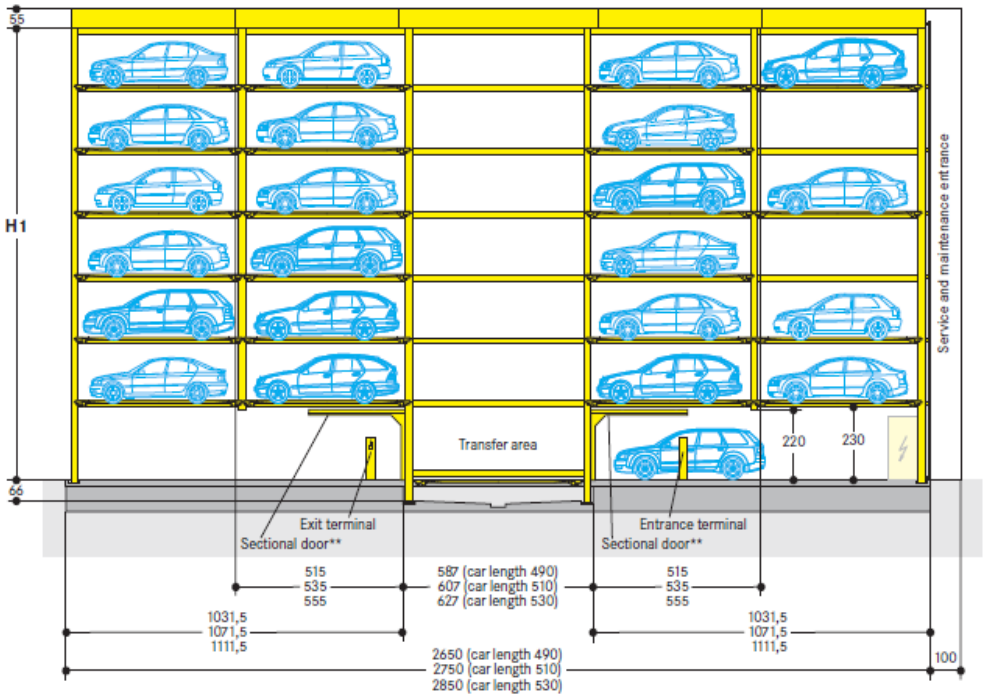


FIG. 11 ARRANGEMENT ABOVE GROUND

4.6 Chess Parking System (Level Parker)

The chess parking system, also referred to as the level parker, shall be employed in scenarios where vertical space is optimized for vehicle storage. This system features a vertical lift serving multiple levels, with vehicles being horizontally circulated in a loop and transported to an Entrance Room or Transfer Area. See Fig. 12 and Fig. 13 for details of typical arrangement of the vehicles and the operation sequence.

4.6.1 *Key Features and Components*

a) Vertical Lift – The system shall be equipped with a vertical lift that serves various levels, enabling the vertical movement of vehicles within the parking structure.

b) Horizontal Circulation – Vehicles shall be circulated horizontally in a loop, allowing them to be transported efficiently to the designated Entrance Room or Transfer Area.

c) Synchronized Movement – All platforms within the loop shall move simultaneously in synchronization, ensuring the coordinated transportation of vehicles.

d) Performance Considerations:

i) *Speed* – The chess parking system should be noted for its slower operational speed compared to other parking systems, as the synchronized movement of all platforms can reduce efficiency.

ii) *Power requirements* – The system shall require more power due to the simultaneous movement of all platforms in the loop, making it a more energy-

intensive option.

e) Design Efficiency:

i) *Space utilization* – The system shall be designed to maximize vertical space utilization, making it suitable for locations where horizontal space is limited.

ii) *Loop configuration* – The loop configuration should be designed to ensure smooth and continuous movement of vehicles within the system.

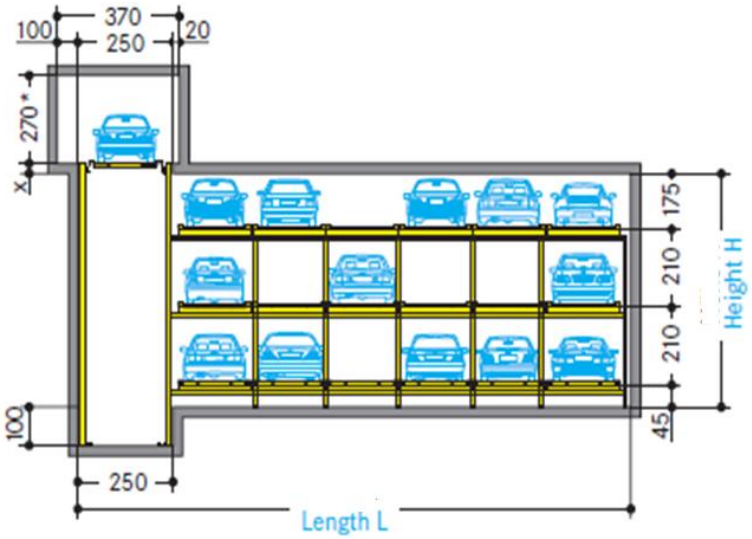


FIG. 12 CROSS SECTION SHOWING LIFT MOVEMENT AND PLATFORMS ARRANGEMENT

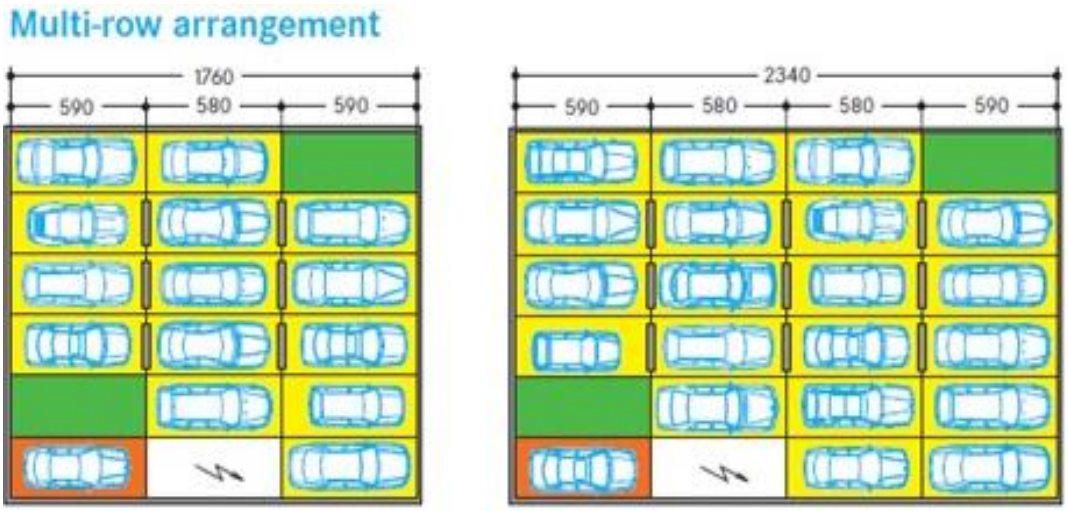


FIG. 13 ARRANGEMENT SHOWING MULTI ROW ARRANGEMENT IN PLAN

4.7 Robotic Parking System

The robotic parking system is an advanced automated vehicle storage and retrieval system that shall utilize robotics technology to move vehicles efficiently within a parking facility.

This system operates on the X, Y, and Z axes, either with or without pallets, using steel or RCC structures. The system ensures precise and swift car placement and retrieval, optimizing both space and time. Figures 14 to 16 depict the typical arrangement in robotic parking system.

4.7.1 *With Pallets*

4.7.1.1 *Key Features*

a) *Parking arrangement* – Vehicles shall be parked on pallets, which shall remain under the vehicles from the time of parking until retrieval. The system may be arranged above or below the ground, depending on the location of the Entrance Room.

b) *Structural requirements* – Steel structures used in this system shall be galvanized to ensure durability and protection against corrosion.

4.7.2 *Without Pallets*

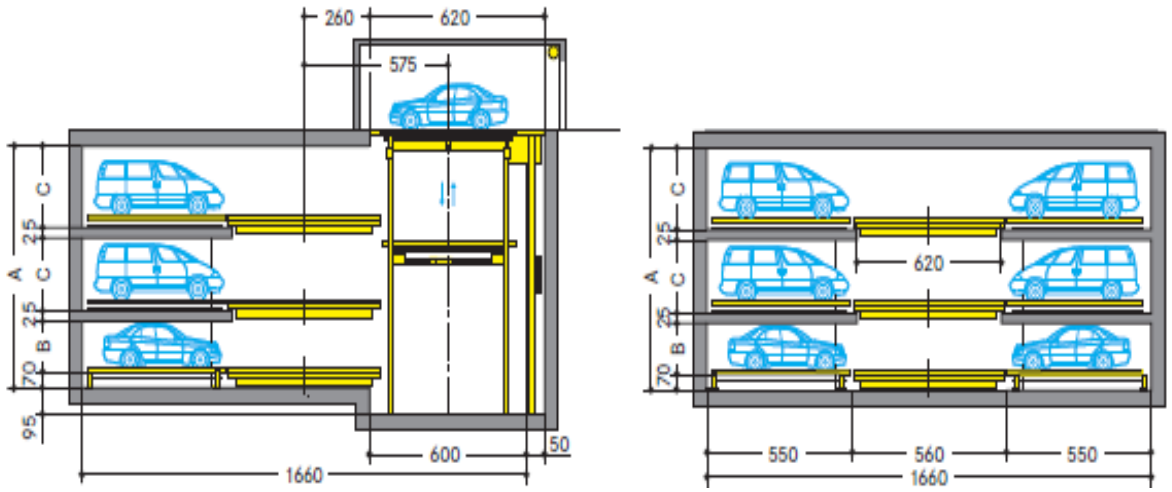
4.7.2.1 *Key Features*

a) *System movement* – The system shall operate on the X, Y, and Z axes, with vehicles parked directly on RCC slabs without the use of pallets. The system shall be faster in service as the car is transferred by a lift to the robot, utilizing a shuttle and dolly mechanism for movement.

b) *Noise reduction* – Parking vehicles on RCC slabs should help reduce noise levels compared to pallet-based systems, providing a quieter operational environment.

c) *Fire safety* – The use of RCC slabs between levels shall aid in controlling the spread of fire from one level to another, enhancing the overall fire safety of the system.

d) *Installation flexibility* – This system shall be possible to install above ground, below ground, or with a combination of both, depending on site-specific requirements and design considerations.



14A WITH PALLETS 14B WITHOUT PALLETS

FIG. 14 ROBOTIC PARKING SYSTEM CROSS-SECTIONAL VIEW

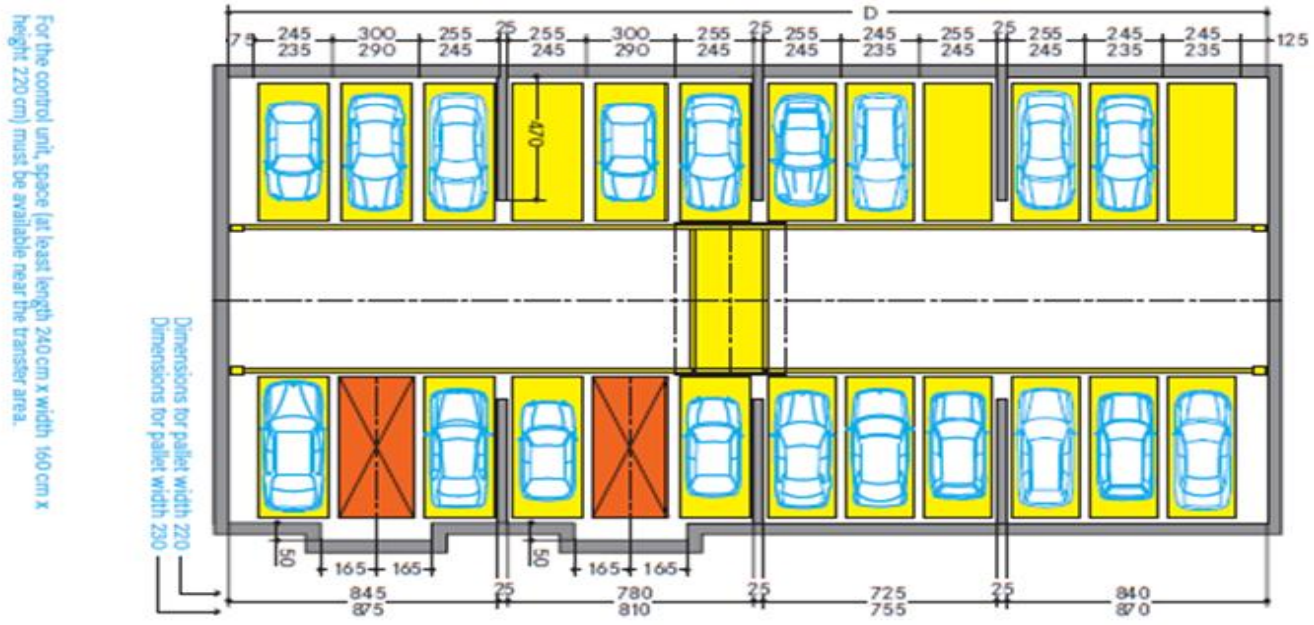
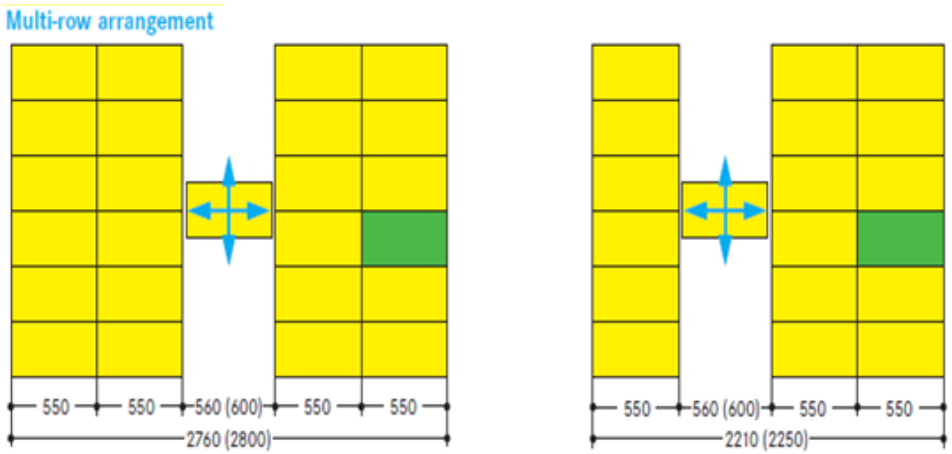


FIG. 15 ROBOTIC PARKING SYSTEM PLAN



NOTE – The multi-row arrangement allows an optimum utilization of the available space and/or land area and saves civil engineering costs, particularly with the shaft variant.

(Dimensions in brackets are for storage and retrieval unit with turning device)

FIG. 16 POSSIBILITY OF MULTI ROW ARRANGEMENT

4.8 Rotary Parking

The rotary parking system is a space-efficient vehicle storage solution designed for locations where ground space is limited, but vertical space can be utilized. This system operates by rotating vehicles in a vertical loop, allowing multiple cars to be parked in a compact footprint.

4.8.1 *Key Features*

The following are important features of rotary parking:

a) Anchoring and Structure – The rotary parking system shall be a free-standing type, securely anchored to the ground. This ensures stability and safe operation, even in areas with limited space or challenging terrain.

b) Entry and Exit – The system shall provide entry and exit at the ground level for easy access by drivers. To ensure safety, the entry and exit points shall be protected by an entrance door or gate that automatically opens and closes as vehicles enter or exit the system.

c) Rotational Movement – The parking platforms within the system shall rotate in both clockwise and anti-clockwise directions, allowing for flexible vehicle placement and retrieval. This bi-directional movement enhances the system's efficiency, enabling quicker access to parked vehicles.

d) Vehicle Capacity and Variations

i) Capacity Options – The rotary parking system shall be available in various configurations, typically accommodating 8, 12, or 24 cars, among other

possible variations. These options allow for customization based on the specific needs and space constraints of the installation site.

ii) Vertical Loop Design – Vehicles are rotated vertically in a loop, with each vehicle occupying a designated platform. The system shall be designed to minimize the time required for vehicle retrieval, ensuring that any vehicle within the system can be accessed quickly and efficiently.

4.9 Sliding Platforms

These parking platforms are used to slide the car sideways or in longitudinal directions. Rails are placed directly on the flooring. Cars are parked on the platform and moved sideways.

4.10 Special Safety Requirements for Parking Systems

Apart from the operational mechanisms, special safety requirements as below are essential for the successful operation of various parking systems:

a) In the case of fully automatic systems, there shall be a separate maintenance door in addition to the main door. This door must open only from the outside by authorized persons with a key. A provision should be made to open the door from inside without a key. Maintenance doors must not open inwards into the working area and must be self-closing.

b) When this maintenance door is opened, the parking equipment should be automatically stopped by a safety switch or other equivalent device. In such circumstances, restarting of the automatic parking equipment shall only be possible when the service door is closed and shall be allowed to operate only by authorized personnel.

c) In order to avoid accidents due to the change from manual to automatic control or vice versa, the parking system shall be provided with one or more key-operated mode selector switches which shall be mutually interlocked or alternative means providing the same level of safety.

d) *Additional Access* – There shall be a separate staircase externally installed and shall have access at every alternative level for inspection. The emergency doors for accessing shall have an electrical/electronic control to switch off the system as explained in **4.10**(b) above.

e) *Selector Switch* – The selector switches must be located outside the working area and should have free access.

f) *Safety Guards* – Fixed enclosure guards or interlocking guards shall be provided to protect persons from the hazards of crushing, shearing, entanglement, entrapment.

g) *Walkway, Control Stands and Platforms* – Safe access routes shall be followed during installation. Permanent access shall be provided in accordance with standard building safety norms applicable in parking areas or basement areas and access to control panels.

h) *Illumination during Servicing Area* – Working areas and locations where maintenance, inspection, cleaning and lubrication work is to be carried out more frequently shall be properly illuminated. Normally the illumination shall be approx. 100 lux.

k) *Safety Railing* – Safety railing of minimum 1 m height shall be provided to avoid accidental access in the open spaces around the system.

m) *Operating Instructions* – Operating Instructions shall be properly displayed at suitable locations.

n) *Illumination in Transfer Area* – Full illumination of the transfer area must be ensured. The lighting of the transfer area may only be switched off after closing the main door. Normally the illumination shall be between 40 lux and 60 lux.

p) *Restricted Entry* – Unauthorized person should be prevented from entering in the transfer and working area during operation of the system.

5 PLANNING AND DESIGN GUIDELINES FOR PARKING SYSTEMS

5.1 Design Criteria for Power-Operated Parking Equipment

When designing or specifying power-operated parking systems, several critical design criteria shall be taken into consideration to ensure the safety, durability, and efficiency of the equipment. These criteria are essential to accommodate various types of vehicles, ensuring smooth operation and long service life of the parking system.

5.2 Nominal Load Capacity

The nominal load capacity of the parking system should be designed to handle vehicles with a weight not less than 2 000 kg and not more than 3 500 kg. This range is typical for most passenger vehicles and ensures that the system can safely accommodate both lighter and heavier cars within this spectrum.

5.3 Wheelset Load Distribution

The load on the wheelsets should be distributed evenly, with 50 percent of the nominal load allocated to the front and rear wheelsets. This balanced distribution is crucial for maintaining stability and preventing uneven stress on the parking platform.

5.4 Individual Wheel Loads

Each wheel should bear approximately 25 percent of the nominal load, ensuring that the weight is evenly distributed across all four wheels. This distribution minimizes the risk of overloading any single wheel, which could lead to mechanical failure or uneven wear on the system.

5.5 Wheelbase Specification

The design should account for a wheelbase of 2.90 m, measured from the centre of the

front wheel to the centre of the rear wheel. This specification ensures compatibility with a wide range of vehicle sizes and provides adequate spacing for secure parking.

5.6 Track Gauge Requirements

The track gauge, or the distance between the wheels in width, should range from a minimum of 1.5 m to a maximum of 2.10 m. This range accommodates different vehicle widths while ensuring that the parking system can handle various car models without compromising stability.

5.7 Tyre Footprint Consideration

The tyre footprint, or the area of the tyre that comes into contact with the parking platform, should measure approximately 0.18 m by 0.18 m. This specification helps distribute the vehicle's weight evenly across the platform, reducing the risk of damage to the system.

5.8 Forces in Direction of Travel

The design should account for forces in the direction of travel equivalent to 1/7 of the nominal load in kilonewton (kN). This consideration is critical to ensure that the system can handle the dynamic forces exerted when vehicles move on or off the platform.

5.9 Transverse Forces

Forces transverse to the direction of travel should be considered as 1/20 of the nominal load in kilonewton (kN). While this does not exclude other design criteria, it ensures that the system can withstand lateral forces, such as those generated by turning or shifting vehicles.

5.10 Load Considerations for Parking Equipment

When designing or specifying parking equipment, it is essential to consider the worst-case loads that may occur. These include loads from the stationary position of the vehicle on the platform as well as dynamic loads during transportation or when the vehicle is driving onto the platform. These considerations help ensure that the system is robust enough to handle peak stresses without failure.

5.11 Equipment Life Expectancy

The parking system should be designed for a minimum operational life of 20 years. This long-term durability requirement ensures that the system remains functional and reliable over an extended period, providing a good return on investment for the facility owners.

5.12 Operation Cycle Requirements

The system should be capable of performing at least one parking-in and one parking-out operation per day, amounting to two cycles per platform or space. This cycle rate should be sustainable every day of the year, ensuring the system can meet the daily demands of a busy parking facility.

6 ARRANGEMENT & PLANNING DIMENSIONS

6.1 Grid and Rows

When planning and designing parking systems, it is essential to define the maximum number of rows and grids to ensure optimal space utilization and system efficiency. The arrangement of grids and rows in a parking module impacts the capacity and operational effectiveness of the parking system (*see* Fig. 17).

6.1.1 Maximum Number of Rows

The parking system shall not exceed a maximum of four rows to maintain manageable distances for vehicle retrieval and to ensure safety and accessibility within the parking structure.

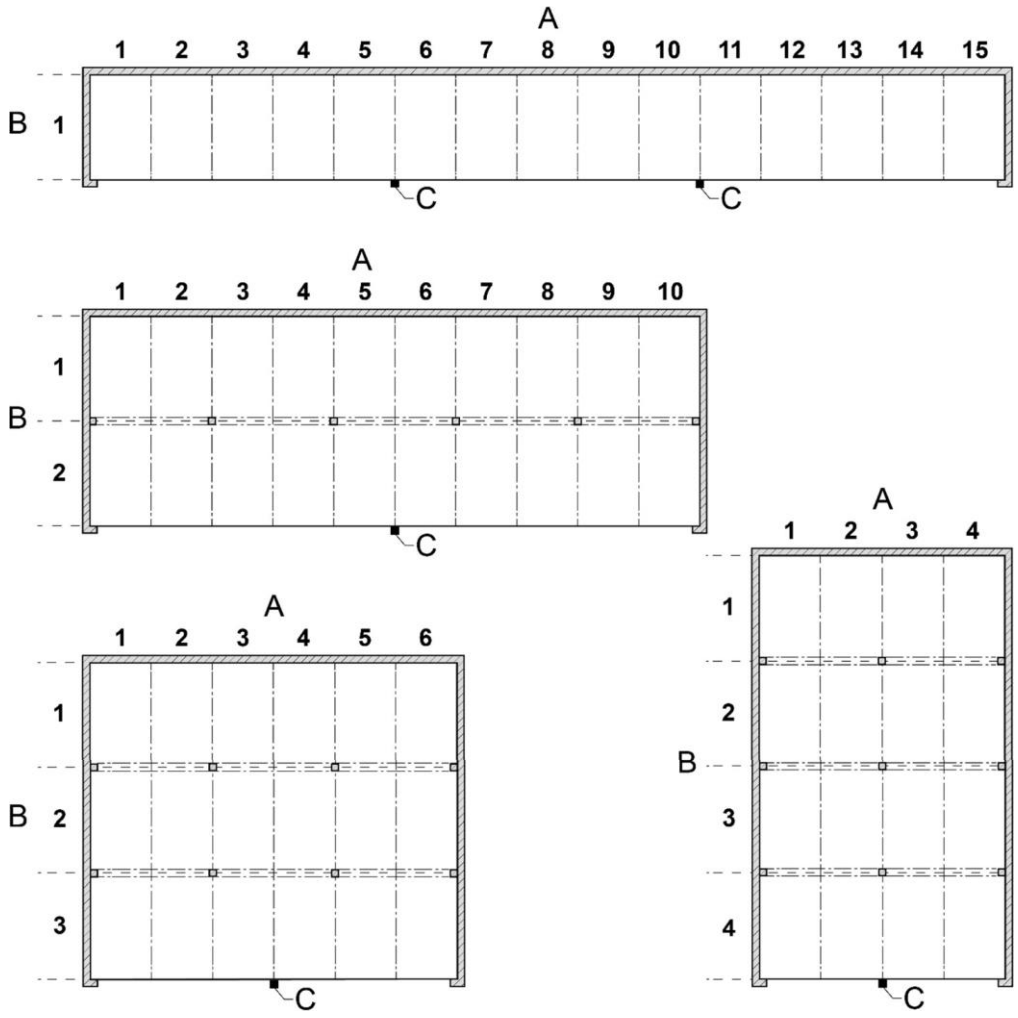
6.1.2 *Maximum Number of Grids*

The maximum number of grids shall be as given below:

a) *1-row system* – A module with a maximum of 15 grids should be utilized. However, it is advisable to limit it to no more than 10 grids to maintain ease of access and operational efficiency.
b) *2-row system* – The module should contain no more than 10 grids to ensure that vehicles can be parked and retrieved with minimal obstruction.
c) *3-row system* – The system should be designed with a maximum of 6 grids to allow for sufficient manoeuvring space within the parking structure.
d) *4-row system* – A limit of 4 grids per module should be adhered to for optimal operation and safety.

6.1.3 *Control Panel Requirements*

An additional control panel shall be installed after every maximum of 5 grids on either the left or right side of the parking system. This requirement ensures that users can conveniently operate the system and enhances the safety and usability of the parking setup.



Key
Grid – Horizontal Parking Spaces
Rows – Back-to-cack Parking Arrangement

FIG. 17 GRID & ROWS IN PARKING SYSTEM

6.2 Arrangement and Planning

The suggested guidance on the arrangement and planning of the parking requirements are given below; see also Fig. 18.

6.2.1 *Open Garages*

Garages protected by one wall on one side, by two walls on two sides facing each other, or by three walls on three sides with an opening on one side.

6.2.2 *Closed Parking Garages*

Parking areas within the building line, in basements, or on lower ground or podium levels inside the building.

6.2.3 *Automatic Parking Spaces*

Unmanned areas where vehicles are transported from the entrance room by means of mechanical systems such as conveyors, lifts, etc, and transported back to the exit room. The parking area shall be marked with a highlighter, and driveways shall be connected to all the parking areas.

6.2.4 *Usable Area* – The usable area is the sum of the parking area and driving area and the same shall be as described below:

Upto 100 m²	Small garage
Over 100 m² up to 1000 m²	Medium garage
Over 1000 m²	Large garage

6.2.5 *Entrance and Exit Room*

The space between the entrance from the connecting road to the garage and the actual parking area shall be considered as the storage space or car hold area.

6.2.6 *Width of Parking Area*

Parking spaces shall be 2.75 m wide for medium and large-sized garages.

6.2.7 *Ramps and Driveways*

For curvatures and circular ramps or driveways, the inner radius shall be 5.0 m. Wider driveways with an inner radius of approximately 10.0 m should be considered for safety purposes. Large garages shall have separate entry and exit points.

6.2.8 *Pedestrian Walkway*

In large parking areas, a separate pedestrian walkway of 0.8 m next to driveways shall be considered, which should be raised above the main parking level or marked permanently and illuminated for visibility and safety.

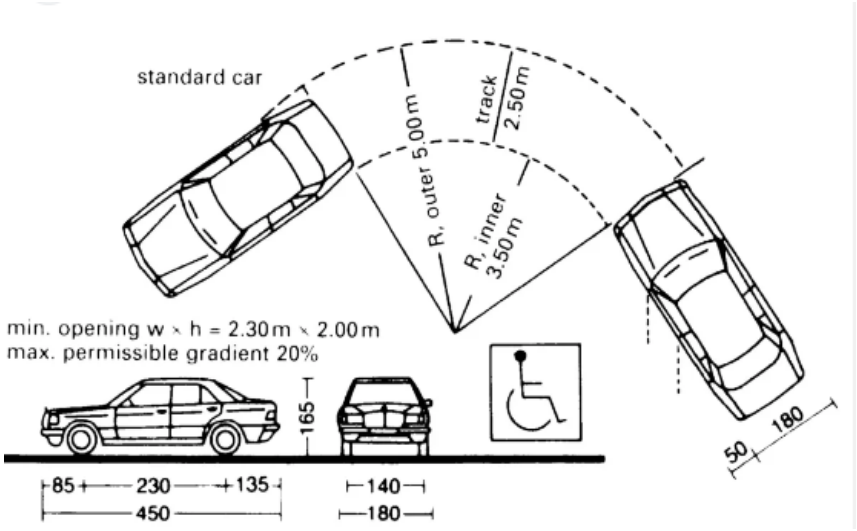


FIG. 18 GEOMETRICAL DIMENSIONS

6.2.9 *Slope of the Ramps*

The inclination of ramps shall not exceed 15 percent or a 1:8 ratio. The recommended slope is 1:10. The width shall not be less than 2.75 m, and at least 3.5 m in circular or curved areas for single-lane traffic. The joint at the start and end of the ramp shall have a slope of 3 percent with proper curvature to ensure smooth travel and prevent vehicles from hitting the bottom or nose of the car. For public parking, a slope not exceeding 10 percent (1:10 ratio) should be considered. An extension of at least 3.0 m in front of the ramp shall be provided. See Fig. 19.

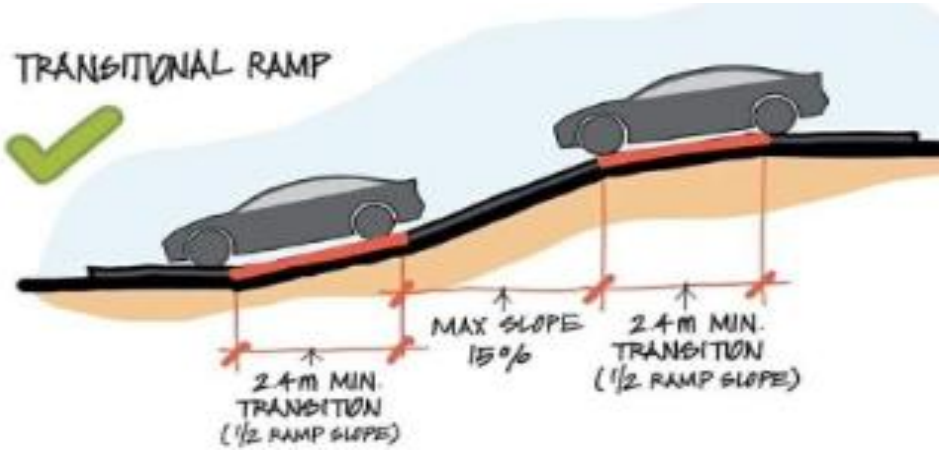


FIG. 19 TRANSITIONAL RAMP

6.2.10 *Size of Parking Space and Women Parking Space*

The length of car parks shall be 5.0 m, and parking arranged alongside driveways shall be at least 6.0 m wide. The entire parking space should be designed as a column-less structure for safety.

6.2.11 *Parking Space*

The minimum width for parking spaces shall be 2.3 m for small cars and 2.5 m for large cars. For power-operated mechanized parking systems, at least 0.2 m of space on either side shall be added to the above basic widths. See also Fig. 20.

a) *Small cars* : 2 300 mm x 5 000 mm (Clear space + additional space of 400 mm for mechanized clearance)
b) *Big cars* : 2 500 mm x 5 500 mm (Clear space + additional space of 400 mm for mechanized clearance)
c) Clearance for door opening : Minimum of 400 mm on the driver's side for normal parking and 1 000 mm for persons with disabilities

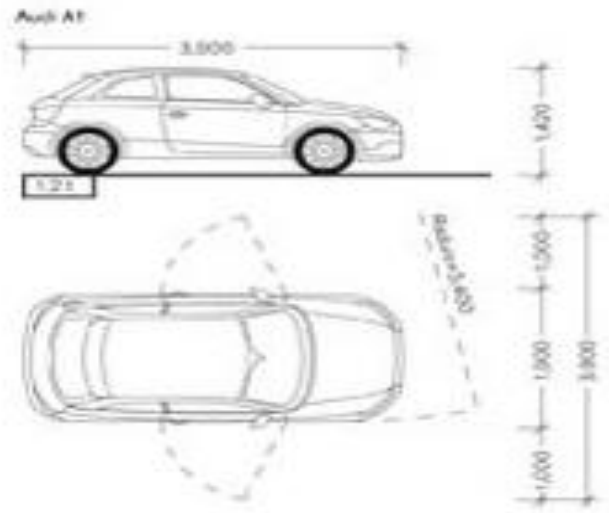


FIG. 20 PARKING SPACE DIMENSION

6.2.12 *Reserved Parking for Persons with Disabilities*

Parking spaces for the persons with disabilities shall be as per **B-3.5** of Part 3 'Development Control Rules and General Building Regulations' of this Code and shall be considered as conventional parking having size 3 900 mm in width with 5 400m in length. One to two percent of the parking spaces shall be reserved as per local norms and the type of project, located close to the barrier-free entrance and as close as possible to the ramp and passenger lifts. The area shall be highlighted with signages.

6.2.13 *Driveway Width for 90° Entry*

The driveway width shall be at least 6.5 m in front of mechanized systems.

6.2.14 *Single Driveways/Passing Driveways*

Single driveways where parking is not connected shall be at least 2.75 m wide, and for two-way traffic, the width shall be at least 5.0 m.

6.2.15 *Identification of Driveways*

Parking systems and driving aisles shall be clearly marked. The signage indicating entry/exit direction of driveways shall be permanently marked and illuminated. See Fig. 21 for guidance.

FIG. 21 MARKINGS IN DRIVEWAYS AND PARKING SPACES

6.2.16 *Demarcation of Parking Space*

Parking spaces shall be marked with numbers on the floor to facilitate easy identification of parking spots.

6.2.17 *Reserved Parking for Women*

Ten percent of the parking spaces in large garages shall be reserved for women drivers and should be located near access ramps/roads, preferably in areas free of columns or other obstructions.

6.2.18 *Clear Height for Pedestrian Passage*

A clear passage height of 2.2 m in pedestrian areas shall be maintained and clearly marked with signages on the floor.

6.2.19 *Escape Route*

Every medium-sized and large-sized garage shall have at least two independent escape routes on each floor. The second escape route may lead via a ramp. In parking areas above ground, one escape route is sufficient. External staircases shall be arranged as per local safety norms.

6.2.20 *Stairway*

At least one staircase or exit to the open air shall be provided from every point of a medium or large garage on each floor. Permanent and easily recognizable signage/indications of exits shall be provided. General electric lighting shall be provided to ensure an illuminance of at least 20 lux in escape routes and driving aisles. Solar-powered illumination should be considered for environmental sustainability.

6.2.21 *Emergency Lighting in Parking Area*

Emergency lighting, with a backup power source independent of the mains supply, shall switch on automatically in the event of a power failure. The lighting shall be designed for at least one hour of operation with an illuminance of at least 10 lux or shall be provided with fluorescent markings that offer adequate illumination for at least 1 h, leading to exits in an easily recognizable manner.

7 SAFETY REQUIREMENTS

7.1 Safety Doors

Parking systems employing pit-type designs shall be protected by safety doors to ensure user safety and system integrity.

7.1.1 *Strength of Safety Doors*

The safety doors shall have mechanical strength in the closed position, capable of withstanding a force of 300 N applied at any point perpendicular to the door surface on either side, evenly distributed over an area of 500 mm^2 (5 cm^2). This force should not cause permanent deformation of the door or impair its normal function. The height of the safety doors shall be considered as 2.0 m unless restricted by a car height of less than 2.0 m. This requirement does not apply to emergency access doors for automatic systems. The size of the emergency access doors may be restricted to 0.65 m in width and 2.0 m in height. If the main door(s) is intended to be closed manually by the user, the control devices shall be located such that the door is visible from the operating position. Safety devices shall not be easily accessible to users. The safety device preventing the door from opening shall be designed as an interlock. The movement of the load-carrying means shall not be possible until the locking device(s) has/have engaged by at least 7 mm. The latch shall resist without permanent deformation or release of the latch when a force of 1,000 N is applied at the height of the latch in the direction of the door opening. The latch shall remain engaged and held permanently in position. Electromagnets, pneumatic, and hydraulic devices shall not be used as retainers.

7.2 Operation of Parking Facilities

7.2.1 *General Operation*

The following lists the general operations in the semi-automatic parking facilities:

a) The user parks the motor vehicle in the transfer area.
b) The motor vehicle shall be automatically stored.
c) The motor vehicle shall be automatically made available for retrieval.
d) The user retrieves the motor vehicle and drives out of the transfer area.

7.2.2 *Parking the Vehicle in the Transfer Area*

For permanent users, the design of the system shall allow the main door to be opened by signals from outside, such as remote control, magnetic card, induction loop, manually operated control devices, or mobile terminals. The particular door from which a "PARKING

IN" or "PARKING OUT" call is registered shall open.

7.2.3 *Checking the Vehicle Dimensions*

The user shall ensure that the maximum vehicle dimensions and weights, as specified in the operating instructions, are not exceeded.

7.2.4 *Closing the Main Door*

The following illustrates the steps involved for:

a) *For manually operated doors* – The user shall exit the motor vehicle and leave the transfer area through the main door. The user shall check that no person remains in the transfer area before manually closing the main door.

b) *For power-operated doors* – The user shall exit the motor vehicle and leave the transfer area through the main door. The user shall check that no person remains in the transfer area before closing the main door using the designated control device, such as a magnetic card or manually operated control device. Access during the closing process shall be monitored by a light barrier sensor.

7.3 Safe Practices

7.3.1 *Monitoring by System Operator*

The user should not remain in the car for an extended period and shall exit the car within 45 s. The operator shall ensure adherence to this practice for safety.

7.3.2 *Automatic Malfunction Detection Devices*

Semi-automatic parking facilities shall be equipped with one or more automatic malfunction detection devices designed and installed to minimize the risk of unsafe operation. When any fault or hazardous condition is detected, an appropriate audible and/or visible warning shall be provided to the user or operator. The equipment shall be immediately stopped using the emergency safety button located on the operation panel. Restarting the equipment shall only be possible by maintenance personnel and under the control of all safety devices.

7.3.3 *Operating Modes*

The changeover from automatic mode to any other operating mode shall only be carried out by authorized or instructed persons. The changeover to safety-related operating modes shall comply with all safety requirements.

7.3.4 *Safety Monitoring and Testing*

The following aspects shall be adhered to:

a) *Type test* – Verification of the machine type to determine whether the parking system meets the requirements.

b) *Individual testing* – Testing each parking system on the market to ensure compliance with safety requirements before delivery.

c) *Design test* – Checking whether the design of the parking system or its components meets the standard's requirements.

d) *Visual inspection* – Determining the presence of required safety features on the machine, system, or component, and ensuring that provided documents meet the standard's requirements.

e) *Measurements* – Ensuring that specified measurable parameters, such as geometric dimensions and safety distances, are met.

f) *Functional test* – Verifying that the parking system operates as intended and that all safety devices function correctly during a normal cycle or part of a cycle without load.

7.4 Safety Devices

Parking systems shall be equipped with the following safety devices to ensure the safe and efficient operation of the equipment:

a) *Limit Switches* – These shall be installed to detect and control the movement of the parking platforms in the upward direction, preventing them from exceeding their designated range of motion.

b) *Non-Return Valve* – This shall be integrated into the hydraulic system to prevent the unintended lowering of the platform in the event of a hydraulic failure, ensuring that vehicles remain securely positioned.

c) *Wheel Stoppers* – Wheel stoppers shall be provided at the end of each parking bay or platform to prevent vehicles from rolling off the platform. These shall be of sufficient strength and size to securely hold the vehicle in place.

d) *Locker* – These shall be fitted in the vertical guide rail element of the parking system to stop the downward movement in case of brake failure.

e) *Electromagnetic Locks* – These shall be used to securely lock the platforms or gates in place when the parking system is not in operation, preventing unauthorized movement or access.

f) *Car Height Sensor* – A car height sensor shall be installed to detect the height of the vehicle and ensure it is compatible with the parking system's designated height restrictions, preventing potential collisions with the platform or ceiling.

g) *Car In-Out Sensor* – These sensors shall detect the presence of a vehicle entering or exiting the parking bay, ensuring that the system only operates when it is safe to do so.

h) *Emergency Stopper* – An emergency stop device shall be provided at accessible locations within the parking area to immediately halt the operation of the system in

the event of an emergency, preventing accidents or injuries.

7.5 Wiring Practices

Wiring practices for power-driven parking equipment, including the connections to the disconnection means from the power supply, shall adhere to the guidelines outlined in Part 1 'General and Common Aspects'/ Section 9 'Wiring Installation' of the National Electrical Code of India 2023.

7.5.1 Wiring methods both inside and outside of enclosures shall be clearly identified and marked to prevent incorrect connections that could result in hazardous conditions, such as unintended movement direction or disruption of safety devices.

7.5.2 Whenever possible, external wiring shall be positioned away from combustible materials and areas where it might be subject to mechanical damage. In situations where this cannot be avoided, the wiring shall be protected using appropriate means such as rigid conduits, flexible tubing, raceways, or other suitable protective methods.

7.5.3 Electrical equipment shall be designed, marked, and arranged to minimize the risk of incorrect connections, which could lead to injury. Proper care shall be taken to ensure all connections are safe and correctly executed.

8 VENTILATION AND FIRE SAFETY REQUIREMENTS FOR PARKING SYSTEMS

8.1 Mechanical Exhaust Air Systems

8.1.1 Mechanical exhaust air systems shall be required in closed medium-sized and large garages. The supply air openings shall be distributed to ensure sufficient ventilation throughout all parts of the garage. If the supply air openings are inadequate, a mechanical supply air system shall be provided.

8.1.2 The mechanical exhaust air systems shall be dimensioned to ensure that the half-hourly mean value of carbon monoxide (CO) concentration in the air, measured at a height of 1.5 m above the floor, does not exceed 100 ppm. This requirement shall be deemed satisfied if the exhaust air systems in garages with low ingress and egress traffic discharge at least 6 m^3 of exhaust air per hour per m^2 of usable garage area. In other garages, the system shall discharge at least 12 m^3 of exhaust air per hour per m^2 of usable garage area.

8.1.3 Mechanical exhaust air systems shall be equipped with at least two equally sized fans in each ventilation system, which together shall provide the required total volume flow during simultaneous operation. Each fan of a mechanical supply or exhaust air system shall be supplied from a separate circuit, to which no other electrical systems shall be connected. If the ventilation system is temporarily operated with only one fan, the fans shall be switched in such a way that in the event of failure of one fan, the other fan automatically switches on.

8.2 CO Monitoring and Warning Systems

8.2.1 Large enclosed garages with substantial incoming and outgoing traffic shall have CO measuring and warning systems. The CO warning systems shall be designed to prompt

users to switch off their engines through acoustic signals and flashing signals if the CO content in the air exceeds 250 ppm. These CO warning systems shall be connected to a backup power source.

8.3 Safety Notices

8.3.1 In enclosed medium-sized and large garages, the following notices shall be prominently and permanently displayed at the entrance and on each floor:

"EXHAUST FUMES ENDANGERS HEALTH. AVOID PROLONGED STAY."

8.4 Fire Safety Provisions

8.4.1 Fire extinguishing systems, smoke and heat extraction systems, and fire alarm systems shall be provided in accordance with the requirements specified in Part 4 ‘Fire and Life Safety’ of the Code.

8.4.2 Automatic garages with more than 20 parking spaces shall be equipped with sprinkler systems. For automatic garages with fewer than 20 parking spaces, power-operated lifting platforms that allow vehicles to be stacked, and parking spaces separated from tramlines by closures, non-automatic fire extinguishing systems shall be provided. The type of system shall be determined on a case-by-case basis in consultation with the fire protection authority, ensuring that all parking spaces within the garage can be reached with an extinguishing agent in every operating state.

8.4.3 Enclosed medium-sized and large garages shall be equipped with fire alarm systems if they are connected with structural installations or rooms for which fire alarm systems are required.

8.4.4 Fire extinguishing systems may also be required for enclosed medium-sized garages if necessary for deploying fire lines for flammable substances or electrical lines connected to the fire tank.

8.4.5 A sprinkler system shall be installed in all parking garages, regardless of size (small, medium, or large), and shall be designed to cover all parked vehicles effectively. This requirement also applies to automatic garages with more than 20 parking spaces. The sprinkler system should preferably not be positioned at the immediate centre (S2 as depicted in Fig. 22) of the top area with respect to the parking system. Instead, it should have some eccentricity from the centre position (S1 and S3 as depicted in Fig. 22) to enhance effectiveness in the event of a fire, ensuring better coverage and rapid response.

FIG. 22 PREFERRED SPRINKLER SYSTEM POSITIONING (AT S1 & S3) IN THE UPPER LEVEL

8.5 Ventilation Requirements

8.5.1 *Natural Ventilation for Small Garages*

For small garages, as well as open medium-sized and large garages, natural ventilation shall be considered sufficient.

8.5.2 *Natural Ventilation for Low Traffic Garages*

In closed medium-sized and large garages with low traffic, natural ventilation should also be sufficient.

8.5.3 *Ventilation Openings and Shafts*

Permanent ventilation openings or ventilation shafts, with a total free cross-section of at least 0.15 m^2 (1 500 cm^2) per parking space, shall be provided up to a height of 2 m to ensure proper air circulation. These provisions shall comply with the requirements outlined in the local building code to maintain safety standards and mitigate fire risks.

8.6 Restrictions on Parking Locations

Motor vehicles shall not be parked in stairwells or generally accessible corridors, including ramps.

9 SPECIAL TECHNICAL REQUIREMENTS

This is considered for special applications of parking; for example, parking systems within the side margins of the existing buildings. These systems can be considered above or below the flooring within the side margins.

9.1 Cantilever Systems

These systems are also installed within side margins, however due to its construction, the systems are not suitable for long life.

9.2 Suspended Systems

These systems are hung from top connected through building beams and are not safe and not recommended.

10 PERFORMANCE REQUIREMENTS FOR PARKING SYSTEMS

10.1 Design Considerations

When designing or specifying parking equipment, consideration shall be given to the worst-case loads that may arise from both the stationary position of a motor vehicle on the platform or load-carrying equipment, as well as during the vehicle's movement on the load-carrying equipment, where such movement may cause higher stresses.

10.2 Service Life Definition

The parking system shall be designed to meet the following minimum service life criteria:

a) Service life : 20 years
b) Cycle definition : 1 parking in and 1 parking out operation
c) Cycles per day : 2 cycles per platform or space
d) Operating days per year : 365 days

11 ENQUIRY OR INVITATION TO PARKING SYSTEMS

A typical enquiry form is given below for reference.

a)	Name of the Sender	
	Details of Customer	
b)	Company Name	
c)	Contact details of concern person	
d)	Office Address	
e)	Project Address	
f)	Details of Architect	
g)	Contact details of the concerned person	
h)	Planning status	
	1) Under planning	
	2) Under construction	
	3) Ready	

i)	Drawing required	Layout plan/Section plan/Beam layout
j)	Type of Building	
	1) Commercial	
	2) Residential	
k)	Type of slab	
l)	No. of cars required to be served	
m)	Type of System Required	
n)	Carrying Capacity of System	
o)	Dependent	
	Independent	
p)	Product Suggested	
	1) Stack parking	
	2) Puzzle parking	
	3) Automatic	
	4) Others	

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