Mechanical Parking + Adaptive Reuse

City of Santa Clara Planning Commission

10/13/2021

WATRY DESIGN, INC.

Architects • Engineers • Parking Planners

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12+ years
parking design

B.A. in Architecture (UC Berkeley)

M.U.R.P – Transportation Planning (UCLA)

- Studied under Donald Shoup

Worked on mechanical parking projects since 2007

Affiliations:

- National Parking Association, International Parking & Mobility Institute , Women in Parking

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- 15+ years as Senior Project Manager
- Watry Design Adaptive Re-use Team
  - White paper on adaptive re-use for confidential Client

4+ years
parking design

MECHANICAL & AUTOMATED PARKING


AUTOMOTION
PARKING SYSTEMS


u·tron


PARKWORKS
THE FUTURE OF PARKING


Westfalia


Parkmatic


KLAUS
multiparking


AutoPark


cityLift


HARDING STEEL


PARKPLUS
HIGH DENSITY PARKING SYSTEMS

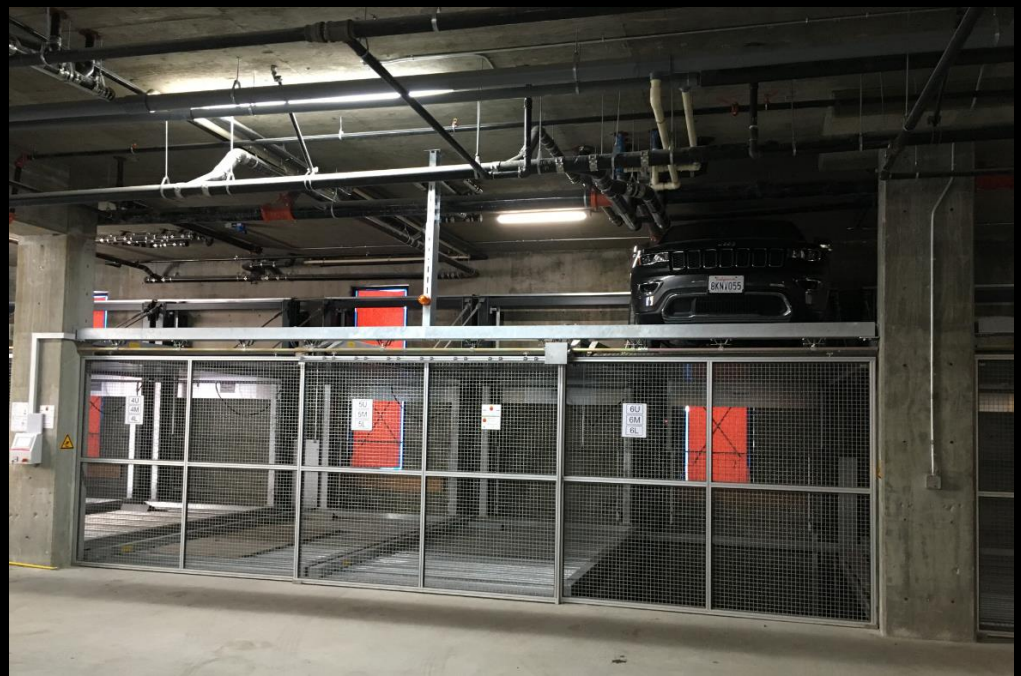

SOTEFIN SA
Computerized Parking
Systems

Dependent Systems

- Requires a human to move another car
- Usually incorporates a valet, unless the same person controls both cars

Independent Systems

- Every space can be accessed without manually moving another vehicle.
- Does not require a human to physically move a car to reach another parked vehicle.



Mechanical Stacker

- Usually placed in a parking facility or on-grade and operated manually by the person parking the vehicle.
- The mechanical stacker stores vehicles on a pallet or platform that goes up or down and holds approximately 2 to 4 vehicles per system.
- The vehicles are usually dependent to each other meaning a person must move the entry level vehicle to get access to the other stacked vehicles above or below
- It can be independent if it has a pit

Semi-Automated System

- A mechanical parking system often called a “puzzle system”, usually placed in a parking facility or on-grade outside and offers independent access to any stored vehicle in the mechanical parking system
- Typically stores vehicles on pallets or platforms where the person drives the vehicle into the entry level pallet or platform and then proceeds to exit and close the system so it is ready to accept another vehicle or retrieve the next person’s vehicle when requested
- Can move the vehicles both horizontally and/or vertically usually ranging in size from 6 vehicles to 40 vehicles per system
- One missing space on each level except the top and bottom level of a pit to allow cars to move.

Fully Automated

- Parking system that offers independent access to any vehicle by using a computer system to control the movement of the vehicle (palletted or pallet-less)
- The vehicle is parked in a transfer cabin (left) and exits the vehicle
- The person initiates the computer system after existing the transfer cabin
- The vehicle is transported and stored in the parking facility by the mechanized system
- These systems are often the largest of the mechanical parking systems and can range in size from 10 vehicles to hundreds or thousands
- The unoccupied car storage area is only entered during maintenance or an emergency
- Transfer cabin can be made ADA compliant
- Industry standard is passenger pulls into transfer cabin but some manufacturers require outside loading and only the driver or valet enters the transfer cabin

Classifying

D = Dependent
I = Independent

- **Mechanical Stackers**
  - Dependent Stackers (D)
  - Independent Stackers (I)
  - Suspended Pallet (D)
  - Suspended Pallet Over Aisle (I)
  - Sliding Pallet (I)
- **Semi-Automated**
  - Lift & Slide/Puzzle (I)
  - Carousel (I)
- **Fully Automated**
  - Rack & Rail (I)
  - Traveling Tower (I)
  - XY Palleted (I)
  - AGV (I)
  - Modular Tower (I)

A Closer Look at

Mechanical Stackers

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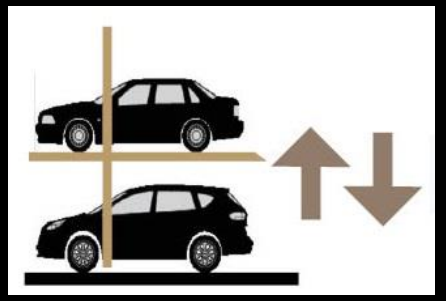


WHY?

- Simple
- Cheaper than other options
- Easily retrofited

WHY NOT?

- Unsecured
- Less aesthetic

GOOD FOR:

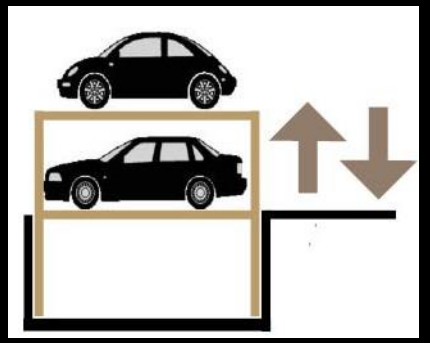
- Residential
- Valet

NOTES:

- Usually hydraulic

Dependent Stackers

Independent Stackers



WHY?

- Simple
- Provides security
- More aesthetic storage
- Independent access makes it applicable in more situations

WHY NOT?

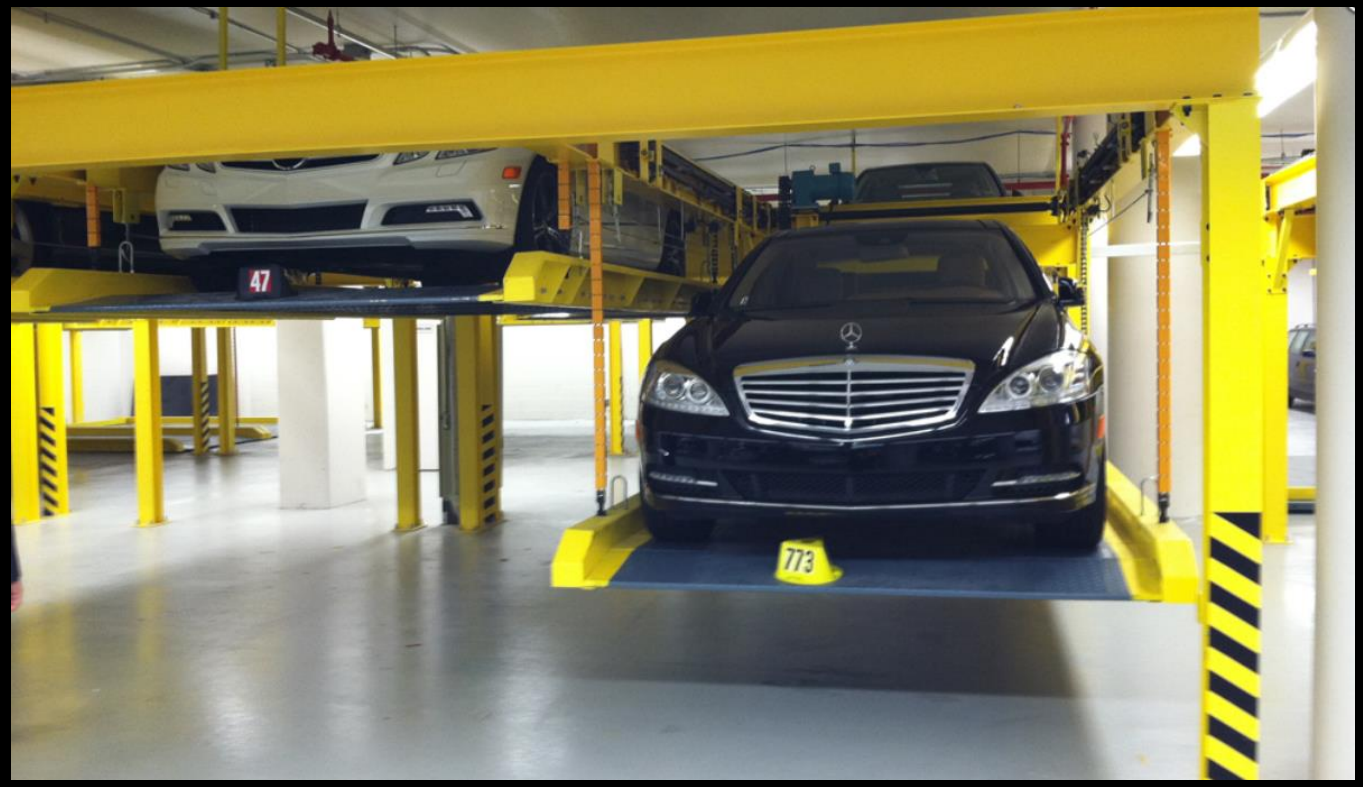
- Excavating pits is a large additional cost

GOOD FOR:

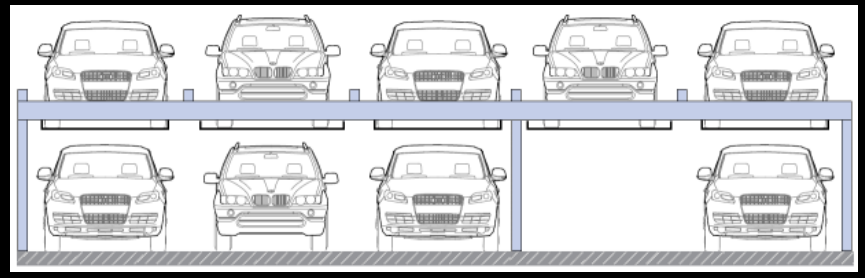
- Residential
- Office
- Valet

NOTES:

- Usually hydraulic
- Can be electric



Suspended Pallet–w/corner columns



WHY?

- No columns between up to three cars allows easier and quicker in an out movements

WHY NOT?

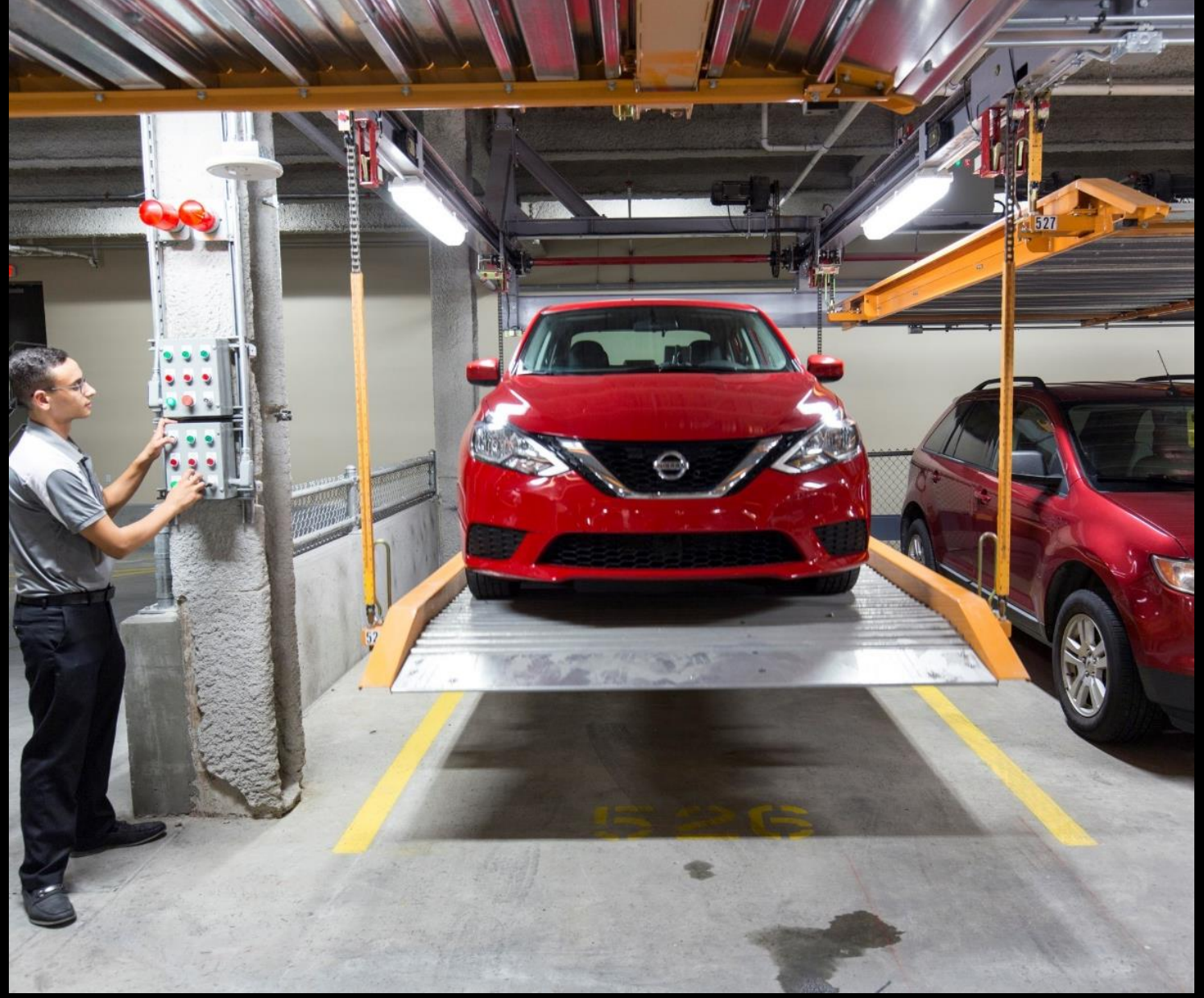
- Structural Integration is more complicated

GOOD FOR

- Valet or valet assist

NOTES:

- Electric



Suspended Pallet – ceiling hung

WHY?

- No columns other than the structural columns makes it easier and faster to get cars in and out

WHY NOT?

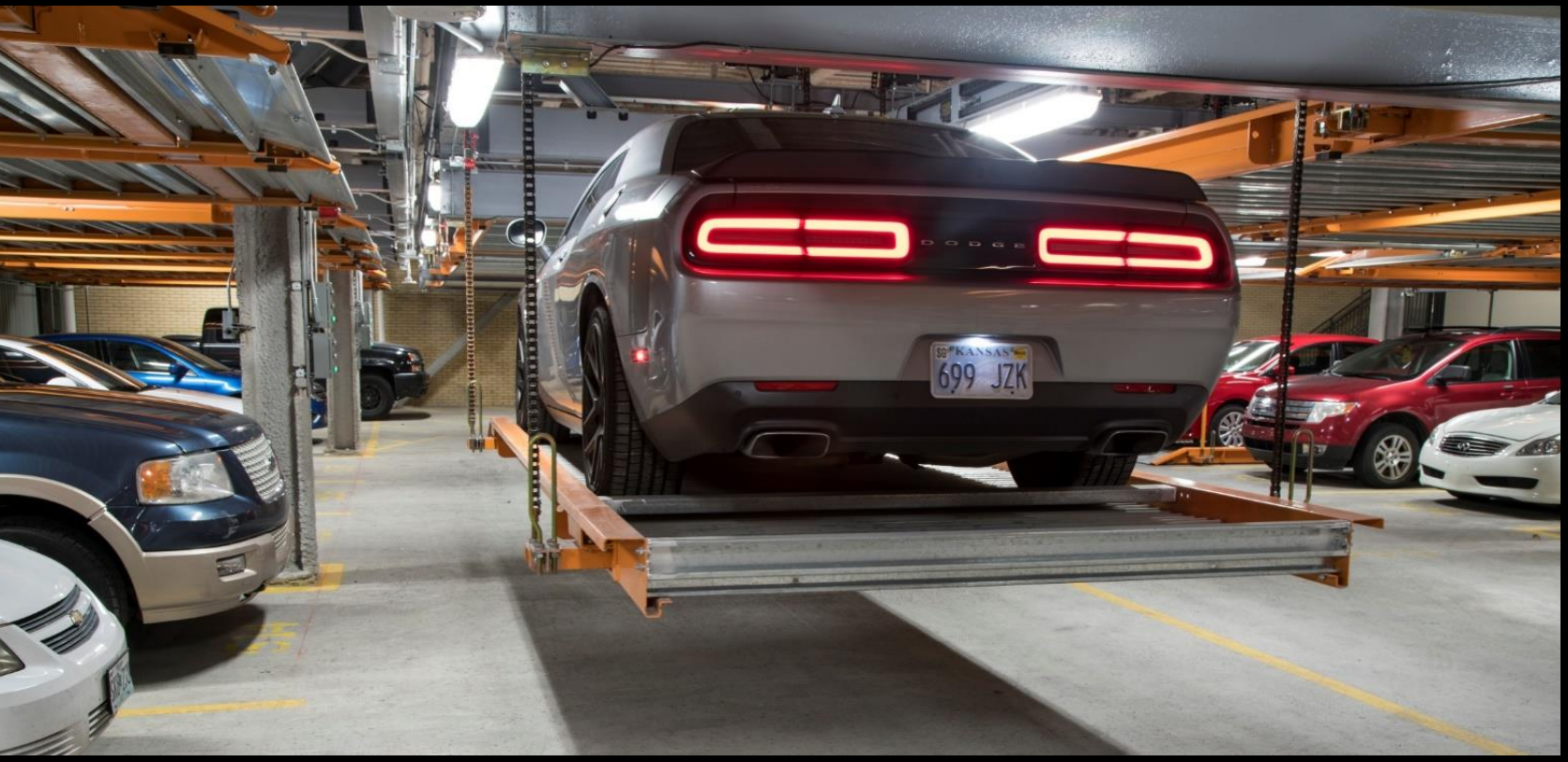
- Structural Integration is more complicated

GOOD FOR

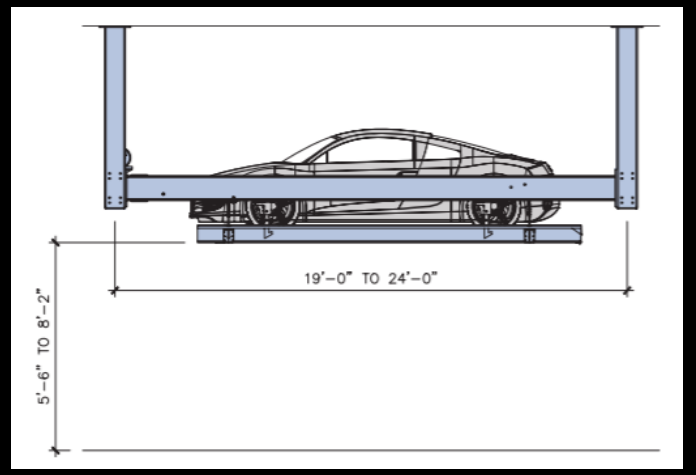
- Valet or valet assist

NOTES:

- Electric



Suspended Pallet Over-Aisle



WHY?

- Independent valet operation move less cars
- Increased density

WHY NOT?

- Structural Integration
- Requires Valet (no public allowed to drive underneath)

GOOD FOR:

- Valet

NOTES:

- Needs fire/life safety approval early, during initial planning phase
- Electric
- Can be ceiling hung or supported by corner columns

Sliding Pallet

WHY?

- Can be used to create independent access and more density for valet in lower clearance areas
- Independent access in a tandem configuration

WHY NOT?

- Per stall cost can be high compared to similar vertical systems
- Column integration

GOOD FOR:

- Residential assigned parking
- Office assigned parking
- Valet

NOTES:

- Electric

A Closer Look at

Semi-Automated Systems

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Puzzle Lift (Lift & Slide)

WHY?

- Simple independent access allow no valet

WHY NOT?

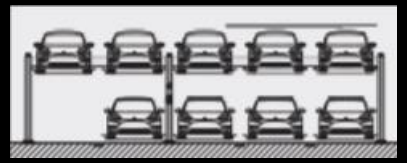
- Structural column placement
- Larger system depth
- More costly than traditional stackers
- Heavier than traditional stackers

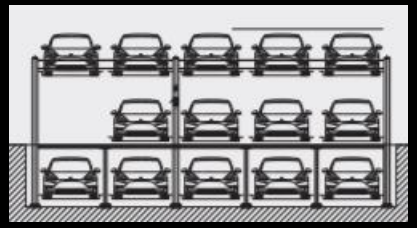
GOOD FOR

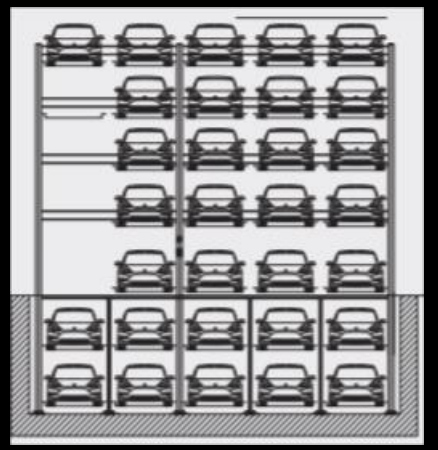
- Residential
- Small office buildings with assigned parking

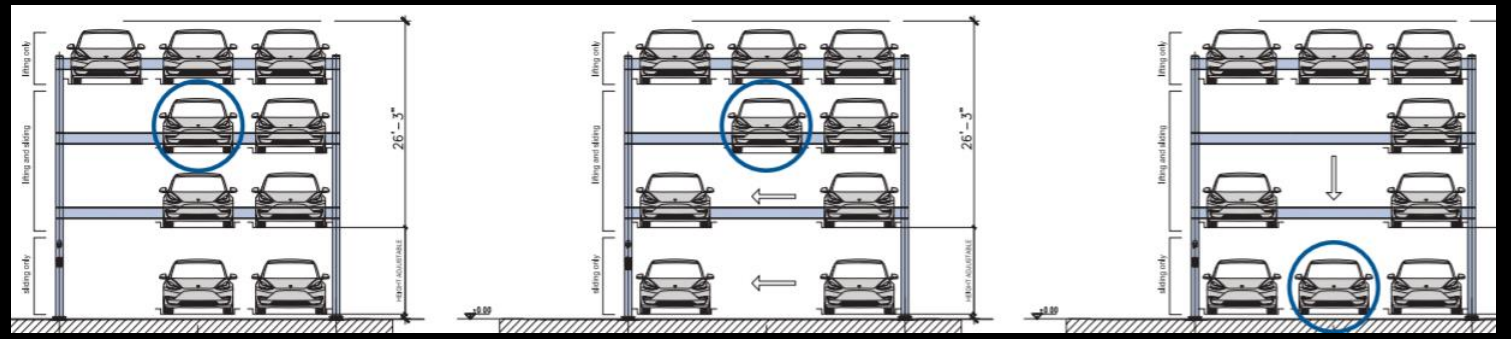
NOTES:

- Electric
- With or without Pits

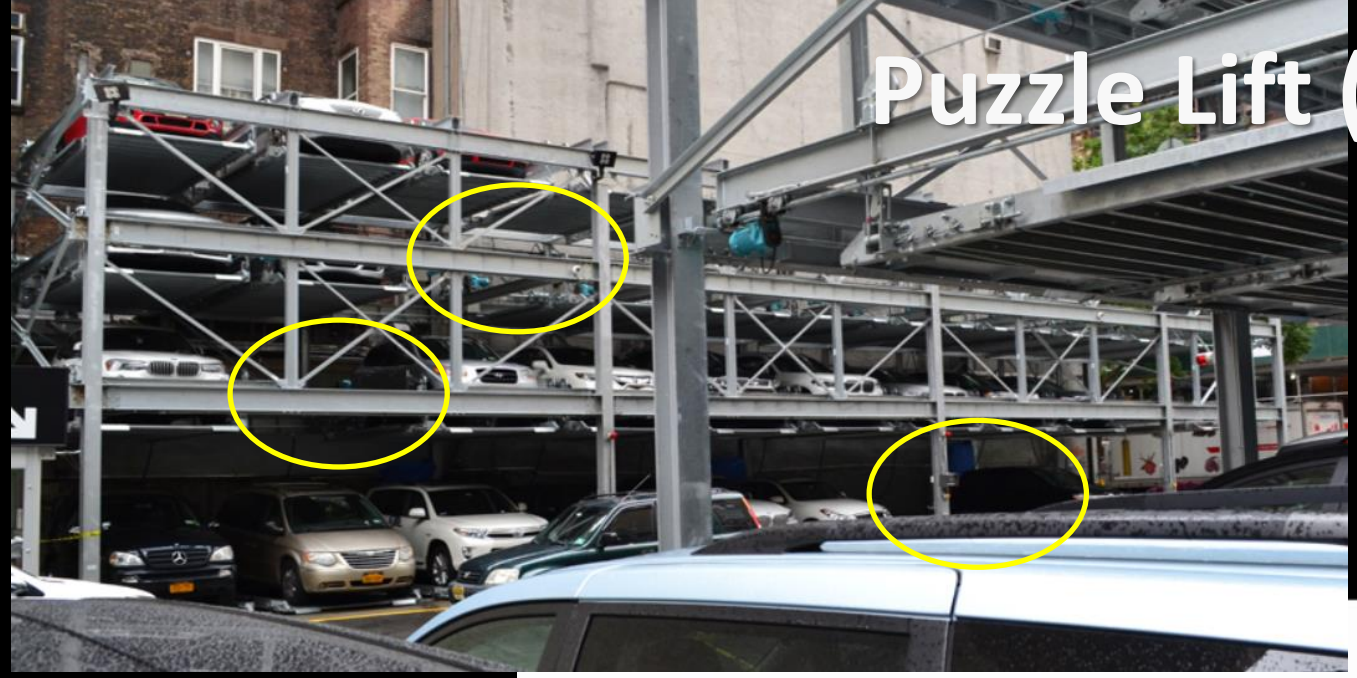








Puzzle Lift (Lift & Slide)



Carousel

WHY?

- High density
- Use of vertical space

WHY NOT?

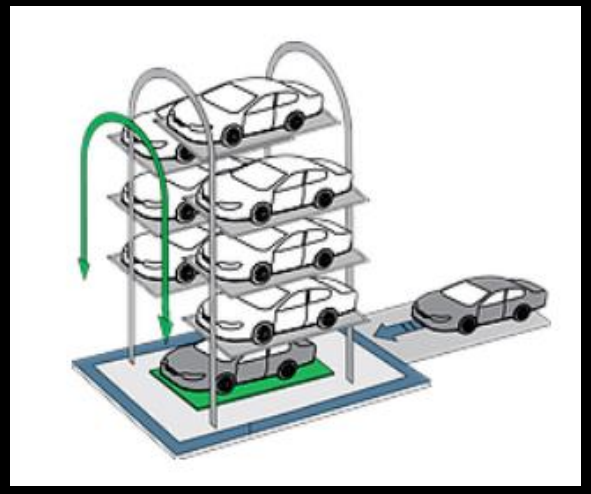
- Height requirement
- Aesthetics

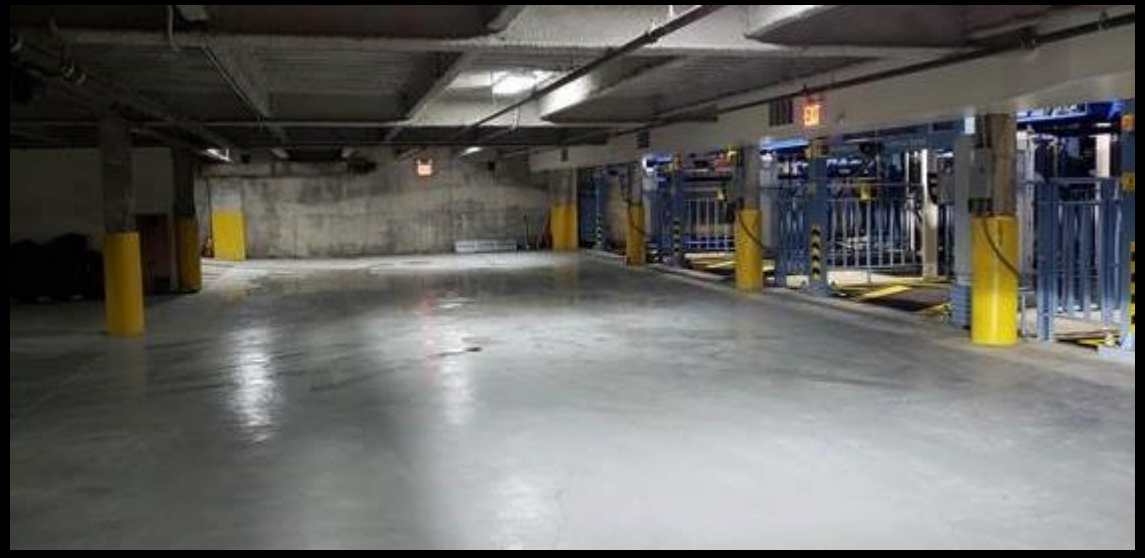
GOOD FOR:

- Residential
- Office

NOTES:

- Electric





A Closer Look at

Fully Automated Systems

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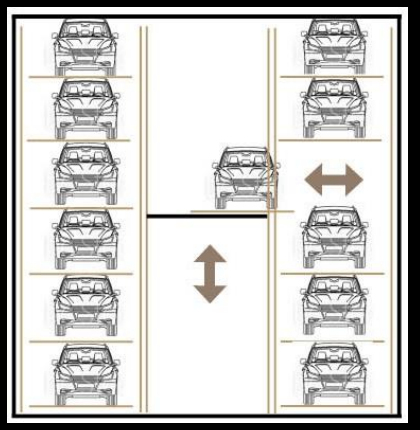
Transfer Cabin


WELCOME TO
park
+garden
AUTOMATED
PARKING GARAGE
Please proceed to the bay
with the green arrow and
follow directions on screen
4
2
1



Fully Automated Rack and Rail (central shaft)

This system divides the vertical and horizontal movement of vehicles between a Lift and a Shuttle. The Lift lowers or lifts the vehicle to its parking level and then the resident Shuttle moves horizontally to align with the parking space. The Dolly then parks the car and returns to the Shuttle which then returns to the Lift.

WHY?

- High capacity
- High density

WHY NOT?

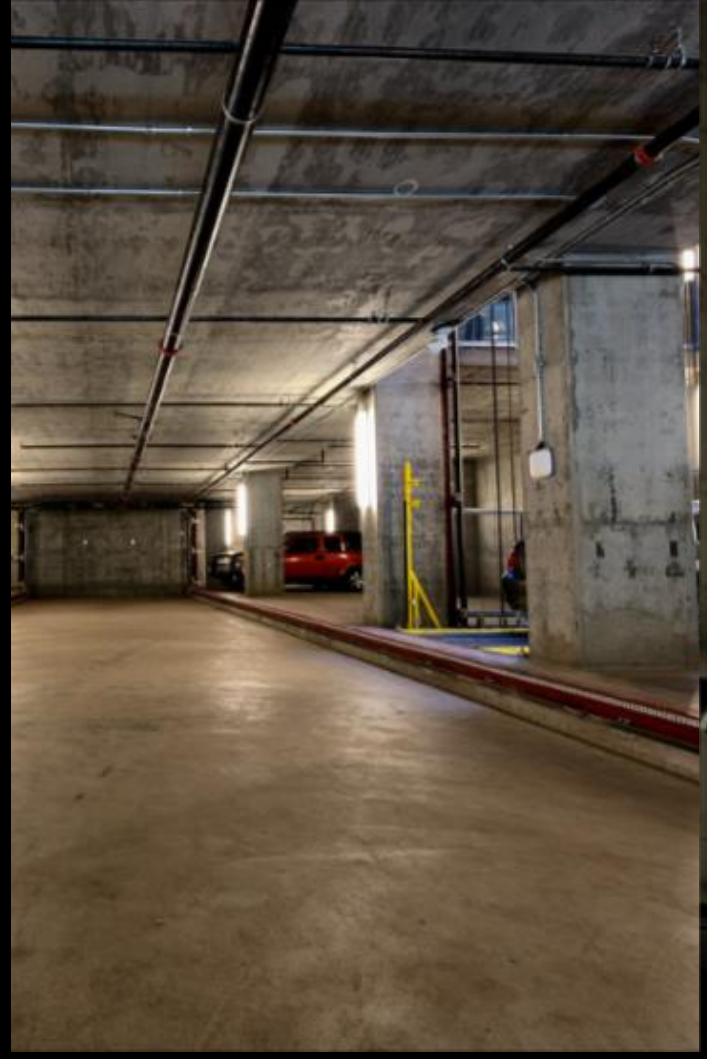
- Expensive

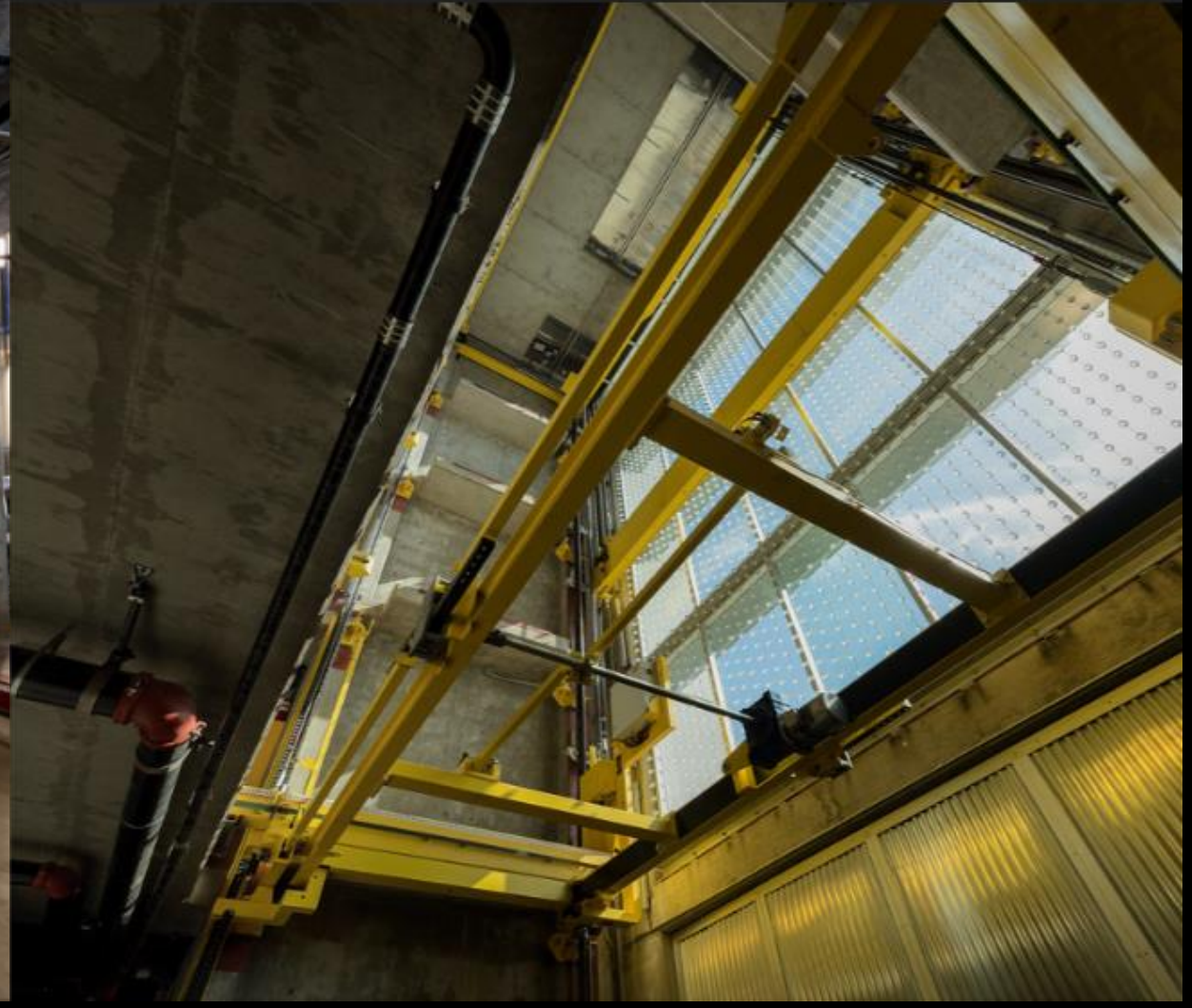
GOOD FOR:

- Residential
- Office
- Public Parking

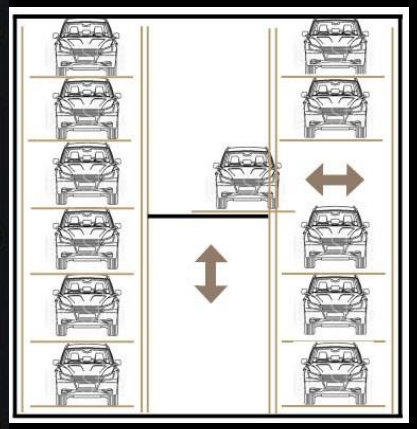
NOTES:

- With or without central shaft
- With or without pallets





Fully Automated
Rack and Rail (slabs at central shaft)



Fully Automated Traveling Tower

A traveling tower moves vehicles up and down and sideways to reach the correct parking level and align with the parking space; both motions occur simultaneously, maximizing throughput. Once the vehicle is positioned in front of its parking space, the resident Dolly transports the vehicle to its parking space, deposits it and then returns to the Traveling Tower.

WHY?

- High capacity
- High density

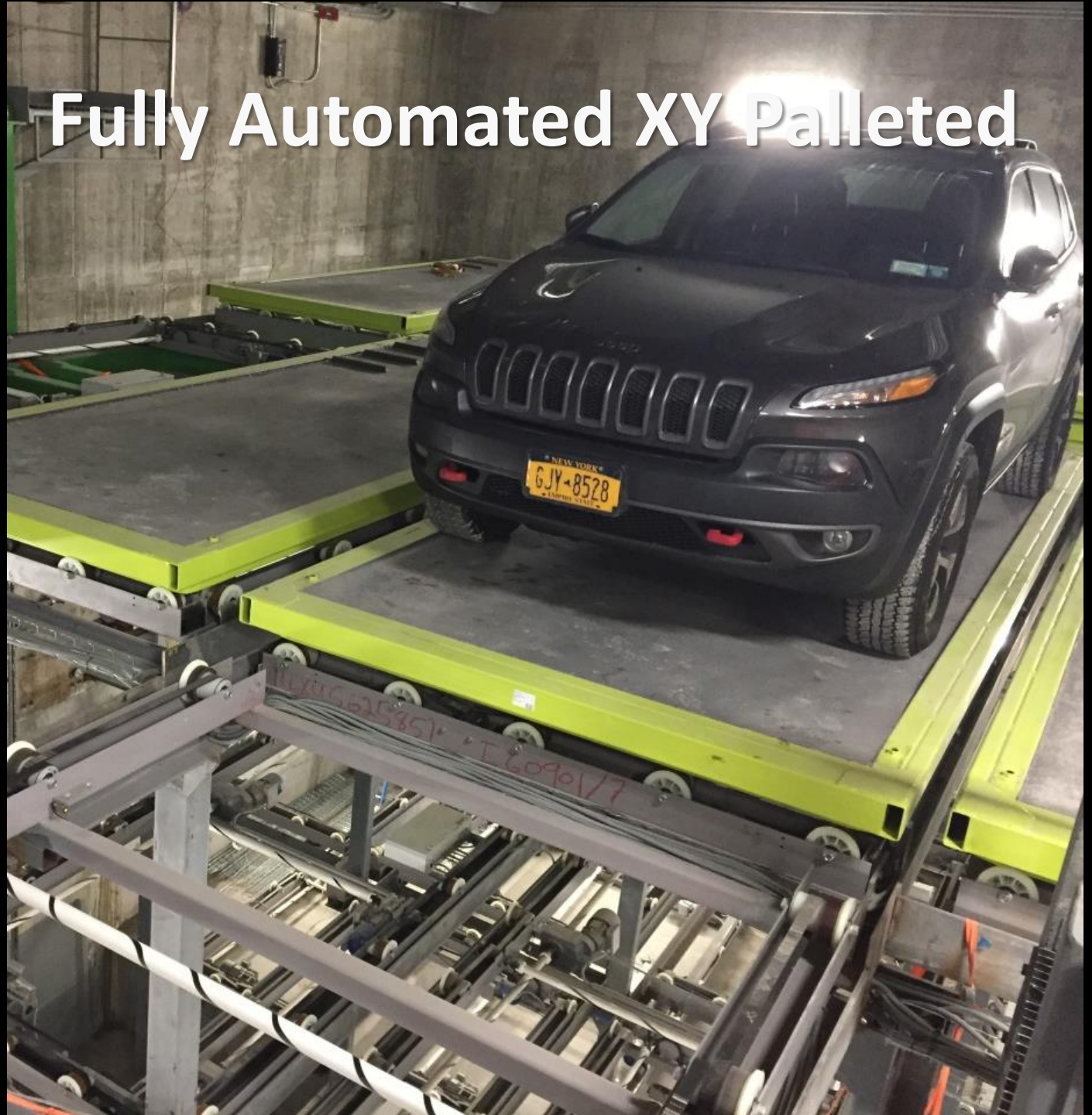
WHY NOT?

- Expensive
- Requires open shaft which is hard to implement with cities & fire depts. and has structural implications

GOOD FOR:

- Residential
- Office
- Public Parking

Fully Automated XY Palleted



WHY?

- High capacity
- High density
- No unused space

WHY NOT?

- Expensive
- Can be limiting to different sized vehicles, depending on design
- Slower retrieval times

GOOD FOR:

- Residential
- Office
- Public

An XY Palleted system has a series of castors that allow the pallet to move horizontally in the X and Y coordinate when looking at it in plan. Lifts are also located in certain locations that allow the pallets to move vertically to different tiers. Only a few empty spaces are required in the entire system for the shifting, making it a very dense system.

AGV (Automated Guided Vehicle)

WHY?

- Park in irregular and unusual shapes
- High density

WHY NOT?

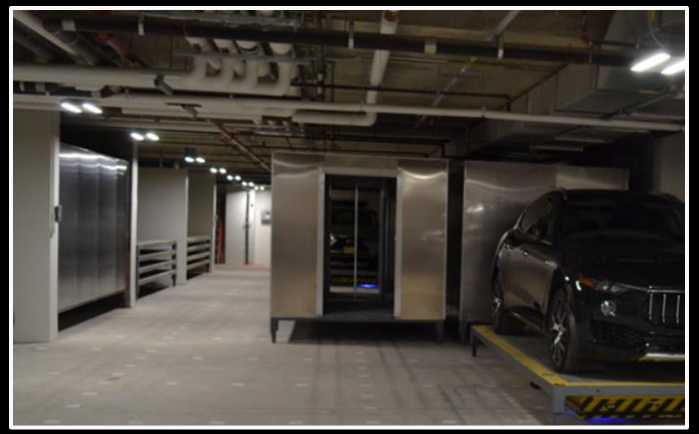
- Expensive – based on throughput & robot count
- May not have any reduction to floor heights

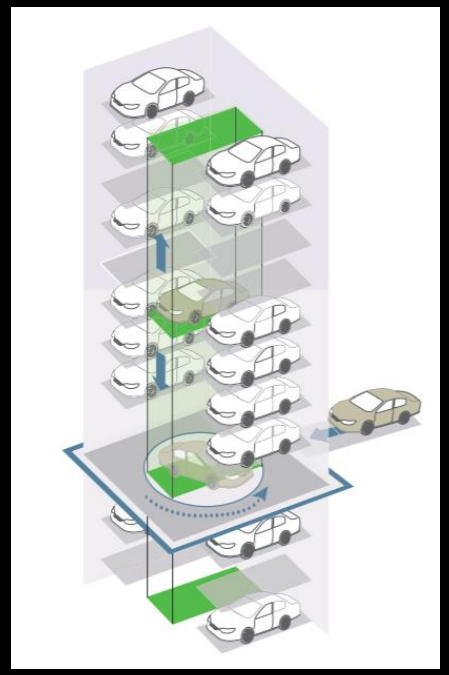
GOOD FOR:

- Residential
- Office

NOTES:

- Can also add storage pods into a project
- Allows users to access through a transfer cabin from a hallway





Modular Tower

WHY?

- High density

WHY NOT?

- Only 1 transfer cabin – throughput limits
- No redundancy unless multiple systems used
- Requires central shaft, structurally more complicated

GOOD FOR:

- Residential
- Office
- Public

Unique Considerations

For Mechanical/Automated Systems

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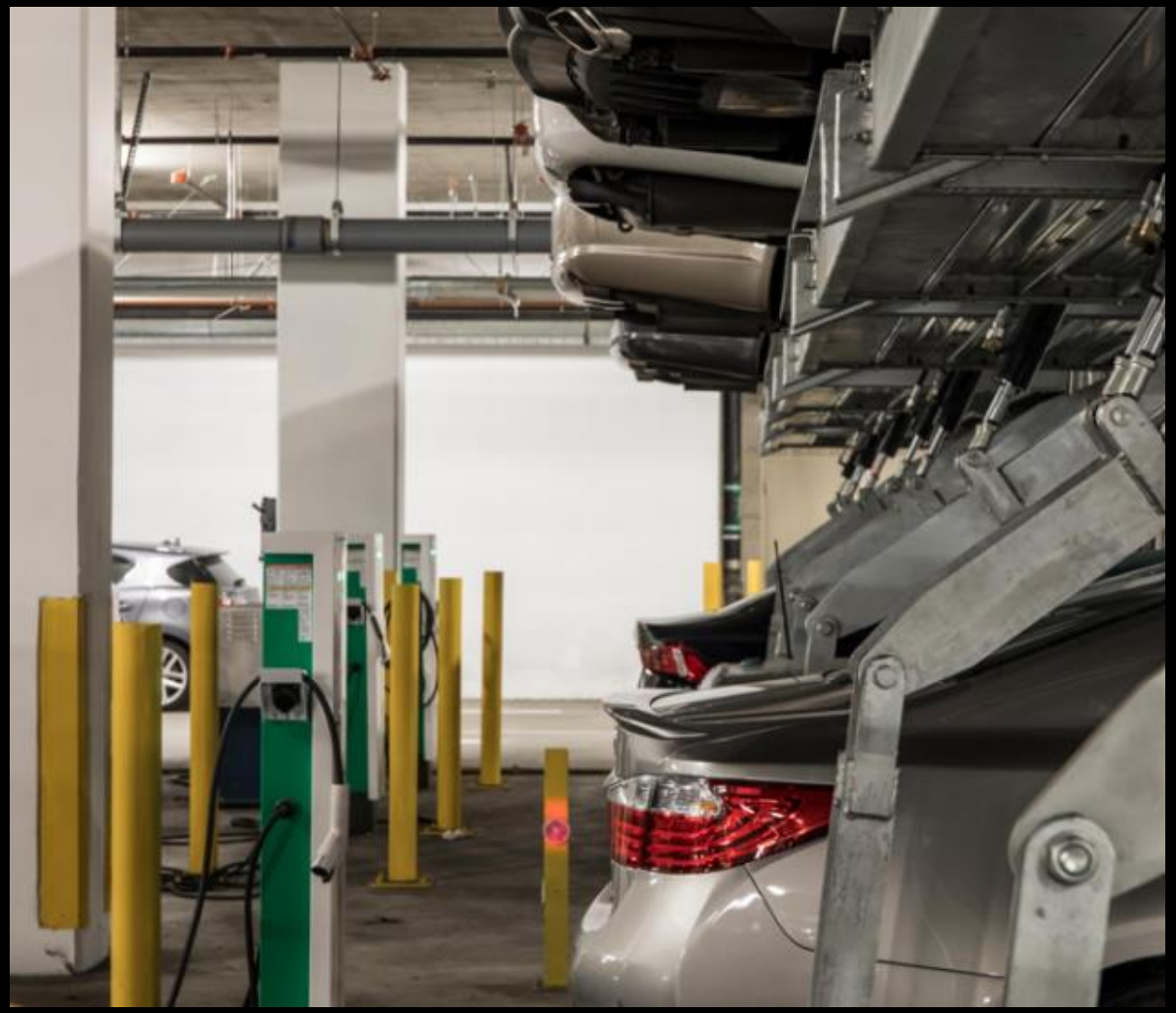
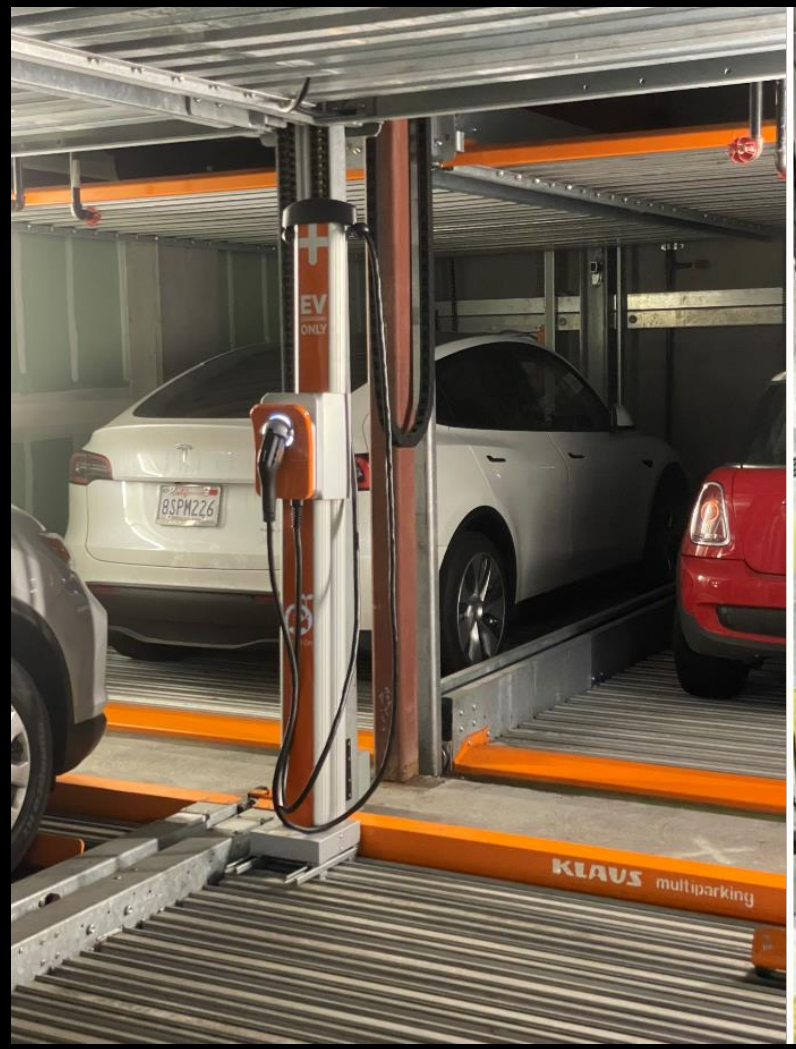
EV Charging

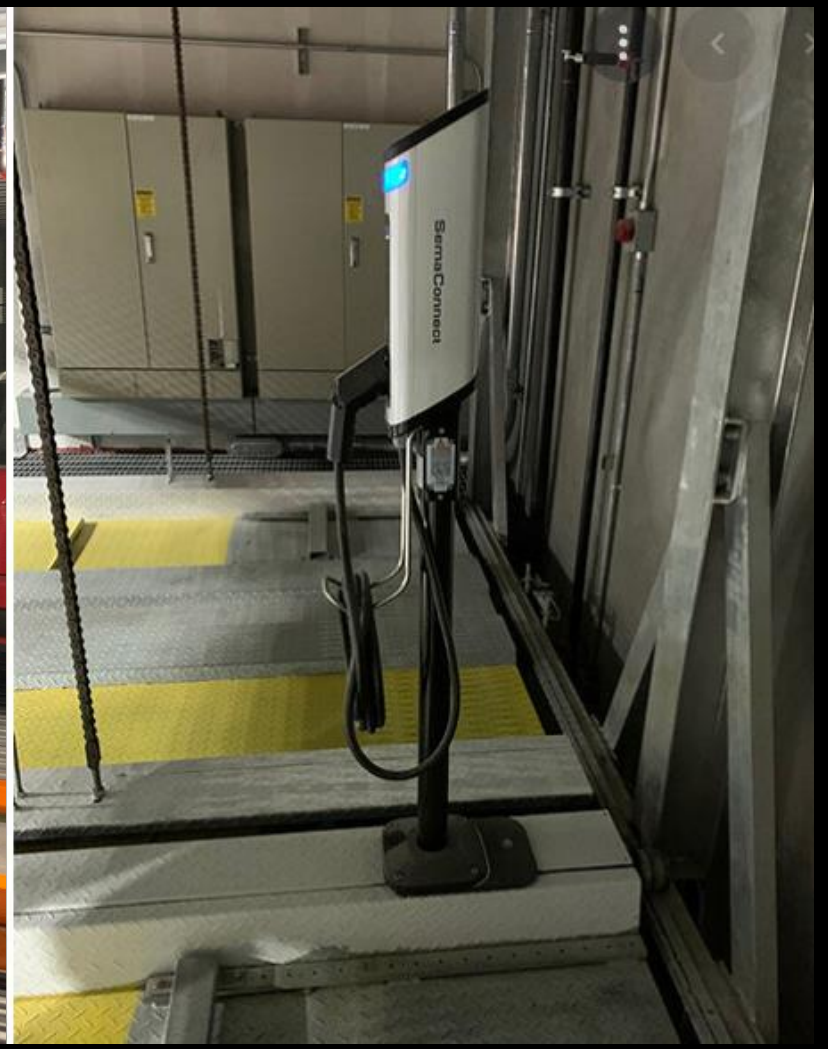
- Stackers
  - Traditional chargers can be located at the back of the stall and manually plugged in by the parker
  - Charger can be mounted to each pallet and move with the system



EV Charging

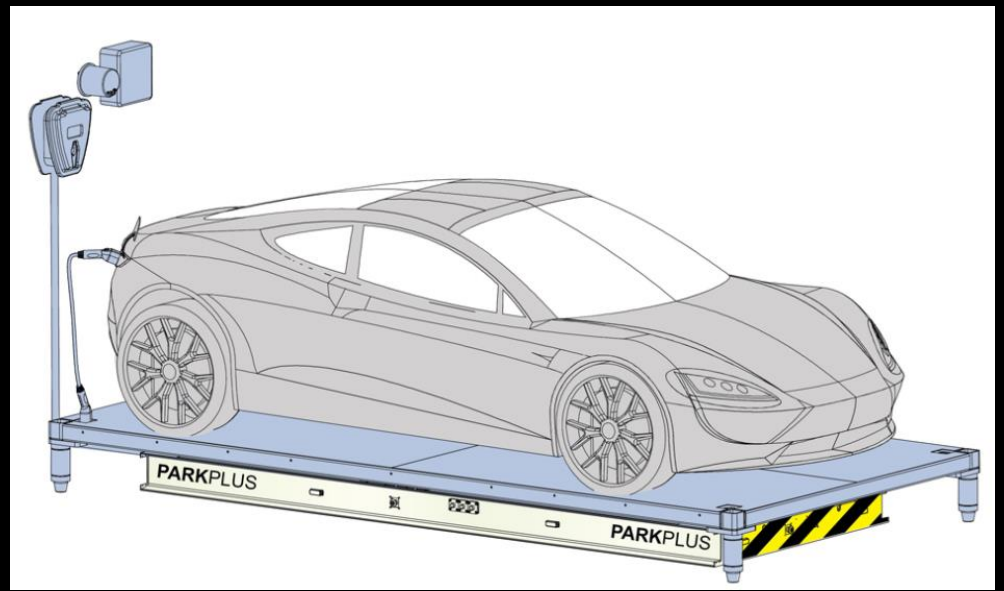
- Puzzle Lifts
  - Traditional chargers can be located at the back of the stall and manually plugged in by the parker
  - Charger can be mounted to each pallet and move with the system

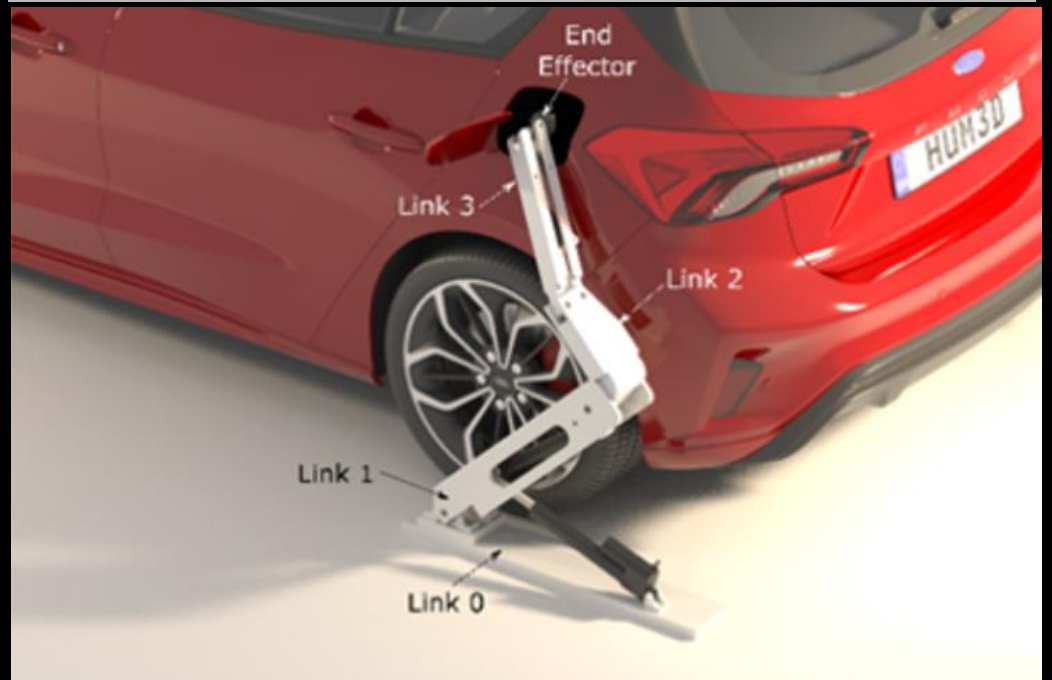




EV Charging

- Fully Automated Systems
  - Pallet systems can have a plug on the pallet
  - Robotic arm chargers
  - Manually taken out of the system and charged by attendants





Space Requirements

- Dedicated waiting areas for fully automated systems and valet parking operations
- Dedicated maintenance areas for some systems
- Automated systems may need loading areas outside of the transfer cabins

Service & Maintenance

- All mechanical parking systems require preventative maintenance and regular service for optimal performance
- Recommend a service contract with manufacturer or vendor
- Different companies handle service differently
  - In-house option only
  - 3rd party contracts
- Maintenance contracts usually a requirement for warranty
- Some jurisdictions may require a service/maintenance agreement as a condition of approval.

Plans for System Outages

- Routine Maintenance
- Repairs
- System Malfunction/Failures
- Power Outages
  - Hydraulic stackers can be lowered to the ground without power
  - Electric stackers can be lowered to the ground without power but more slowly, can be connected to a generator or a portable generator.
  - Semi-Automatic and Fully Automatic should be hooked up to emergency power.

What Affects Throughput and Capacity

- **Stackers:** number of valet attendants, number of tandem vehicles, number of maneuvers
- **Semi-Automated:** number of stalls in each system, number of spaces accessed from a single drive aisle
- **Fully Automated:** number of transfer cabins; number of tandem cars

System Speeds

- **Stackers:** 30 seconds to lift or lower
- **Semi-Automated:** 45 to 60 seconds (not including time for loading/unloading)
- **Fully Automated:** 1 to 10 minutes (not including time for loading/unloading – dwell time)
  - Can take several minute if loading and unloading in transfer cabin

Future of Parking

Adaptive Re-use

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Future-Proofing Parking Structures

How to go from this…

To this…

Challenges to Adaptive Reuse

- Being able to anticipate how to repurpose an existing building in 20-30 years, is difficult at best. There are a number of unknown factors:
  - What shifts will occur in the way we travel, live work and play?
  - Will funding be available for future conversion?
  - Does the added upfront cost justify the future goal?
  - What will building codes be like in the future?

Levels of Conversion

- Full Conversion – entirely new use for the garage
- Partial Conversion
  - Parking Remains Above
  - Ground floor takes on new use (s)
    - Retail, Data Center, Office space, Fitness Center
- Minimal Conversion – mobility hub / storage facility
  - Provide drop off lobbies for App Ride/TNC Transportation Network Companies
  - Add bike storage, showers and restrooms
  - Charging/waiting areas for driverless cars

Parking Structure Fundamental Differences

- Parking structures are fundamentally different from buildings designed for where people work and live.

  - Low floor to floor heights - 10’-6” to 11’-6”, with a clear height of 7’-0” to 8’-4”
  - Large floor plates with only the perimeter having access to daylighting.
  - Ramping system to circulate between floors
  - Sloping floors for drainage
  - Vertical circulation (stairs and elevators) typically located in the corners
  - Occupant loads for parking less than other uses (office, assembly).
  - Structural system design – Live load of 40 psf + 5 psf dead load
  - Vibration and Acoustics – not a big concern in a traditional parking facility

Floor to Floor Height Consideration

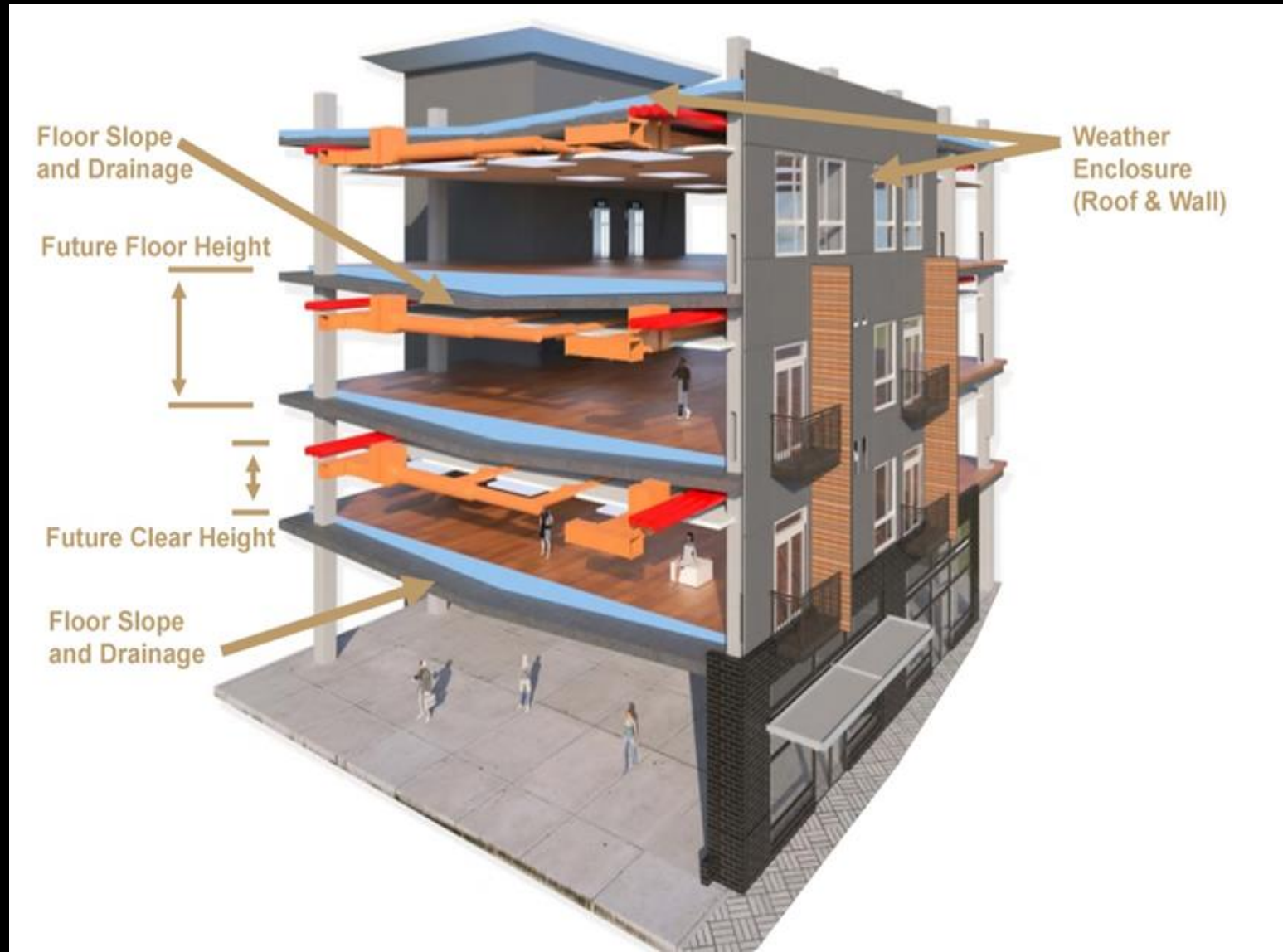
- Increase floor to floor height to correct sloping floors, allow for adequate MEP interstitial space and provide desired clear heights for future use.

- Clear Heights:

  Office: 10’ - 13’

  Retail/Restaurant: 15’- 18’

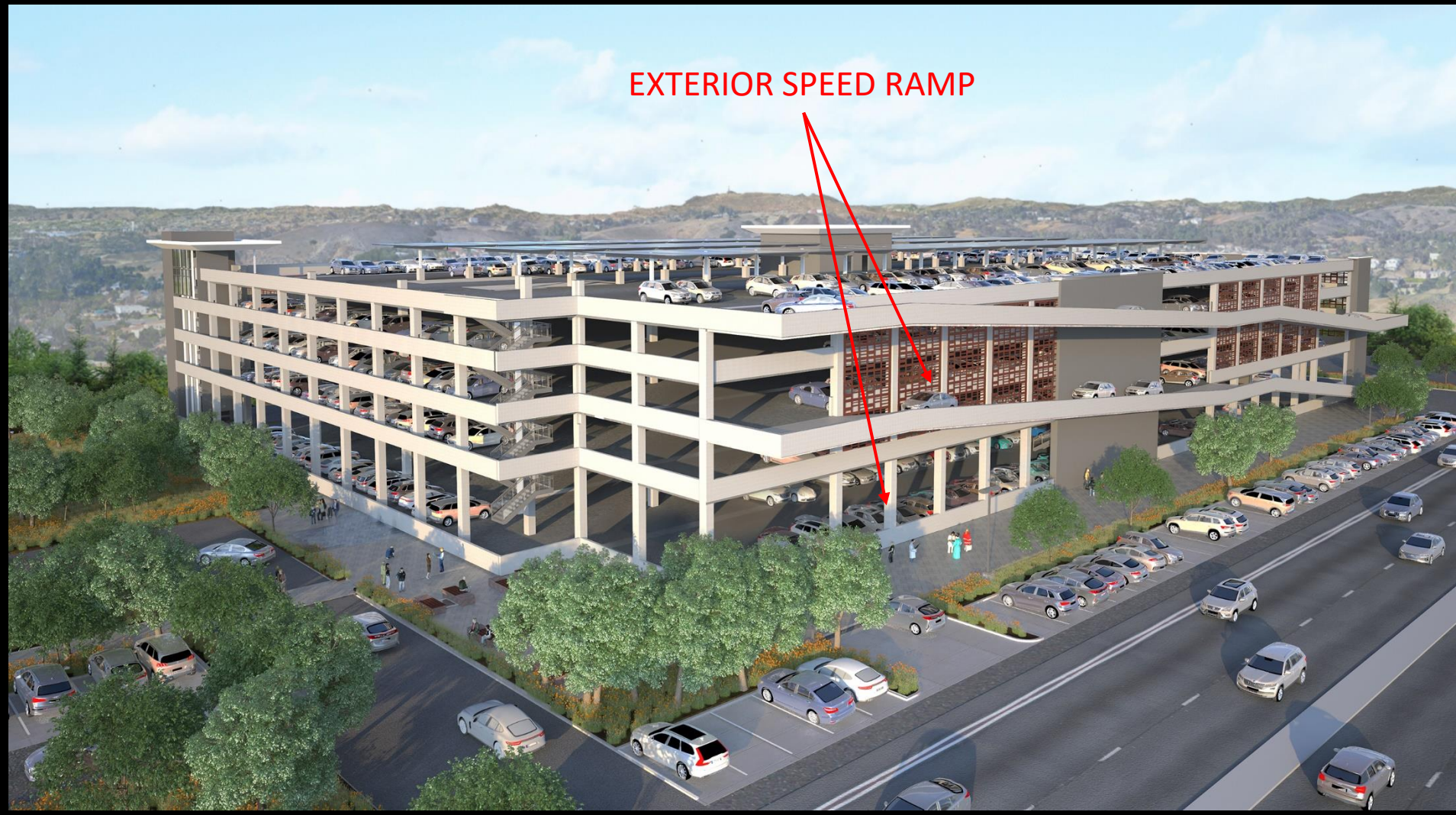
  Residential: 8’- 9’



Ramping System Consideration

- Ramp locations should offer a high level of service for the parking structure while not being a hindrance to the reconfiguration of a future use.

- Design ramps for ease of removal in the future



Conceptual Conversion to Retail/Residential

- 18’ Floor to Floor height for ground floor retail
- +/-13’ Floor to Floor for Residential
- Speed ramp removed

Ramping System Consideration

- Interior speed ramp designed with steel or precast support beams, can be easily removed.

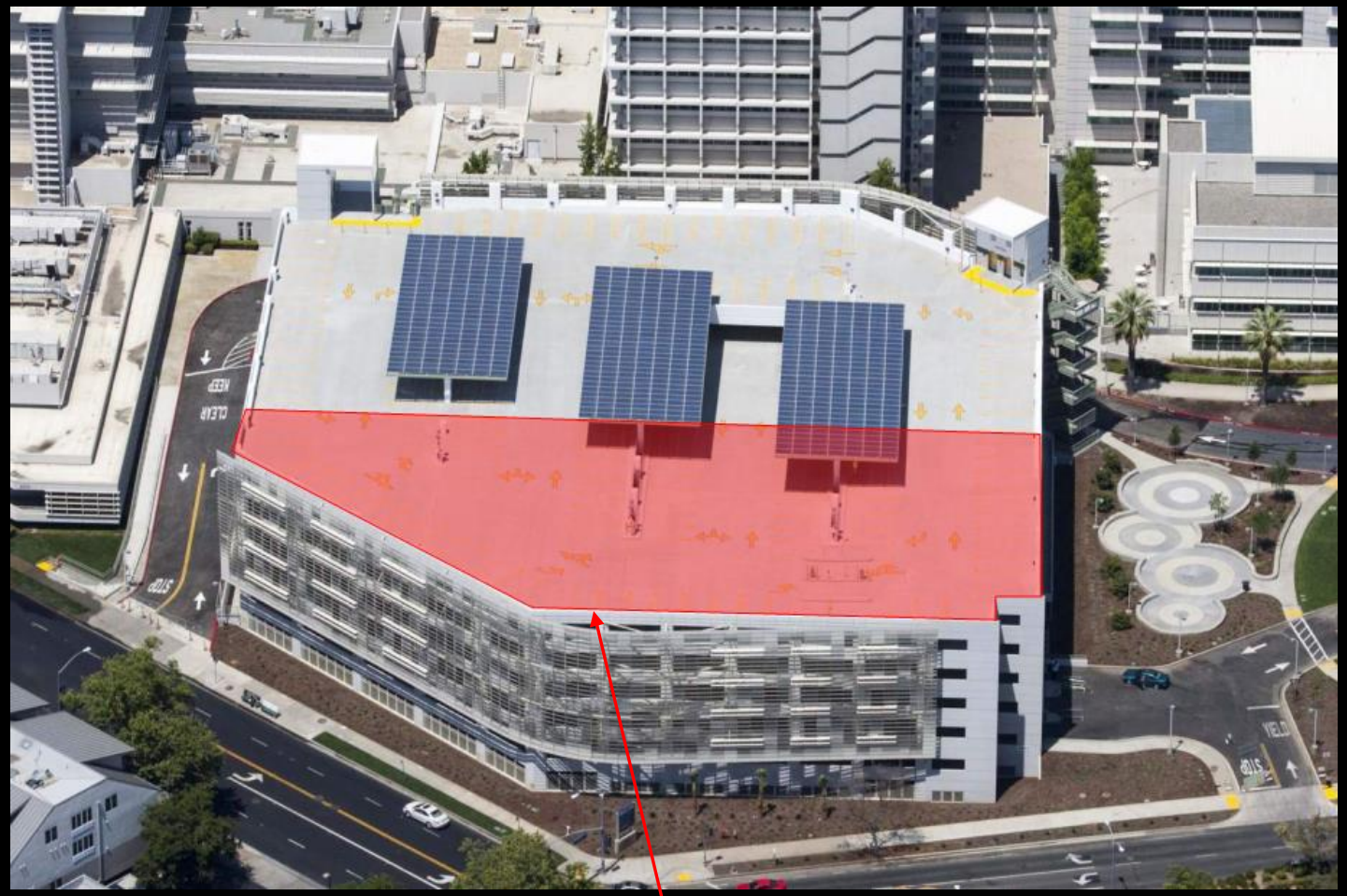
Ramping System Consideration

- Interior garden area/park for a conceptual residential conversion.
- Ground and second floor parking levels. 5 levels of residential
- Could add mechanical stackers at second level to pick up additional parking

SPEED RAMP REMOVED ON LEVELS 3 THRU 7

Footprint Size

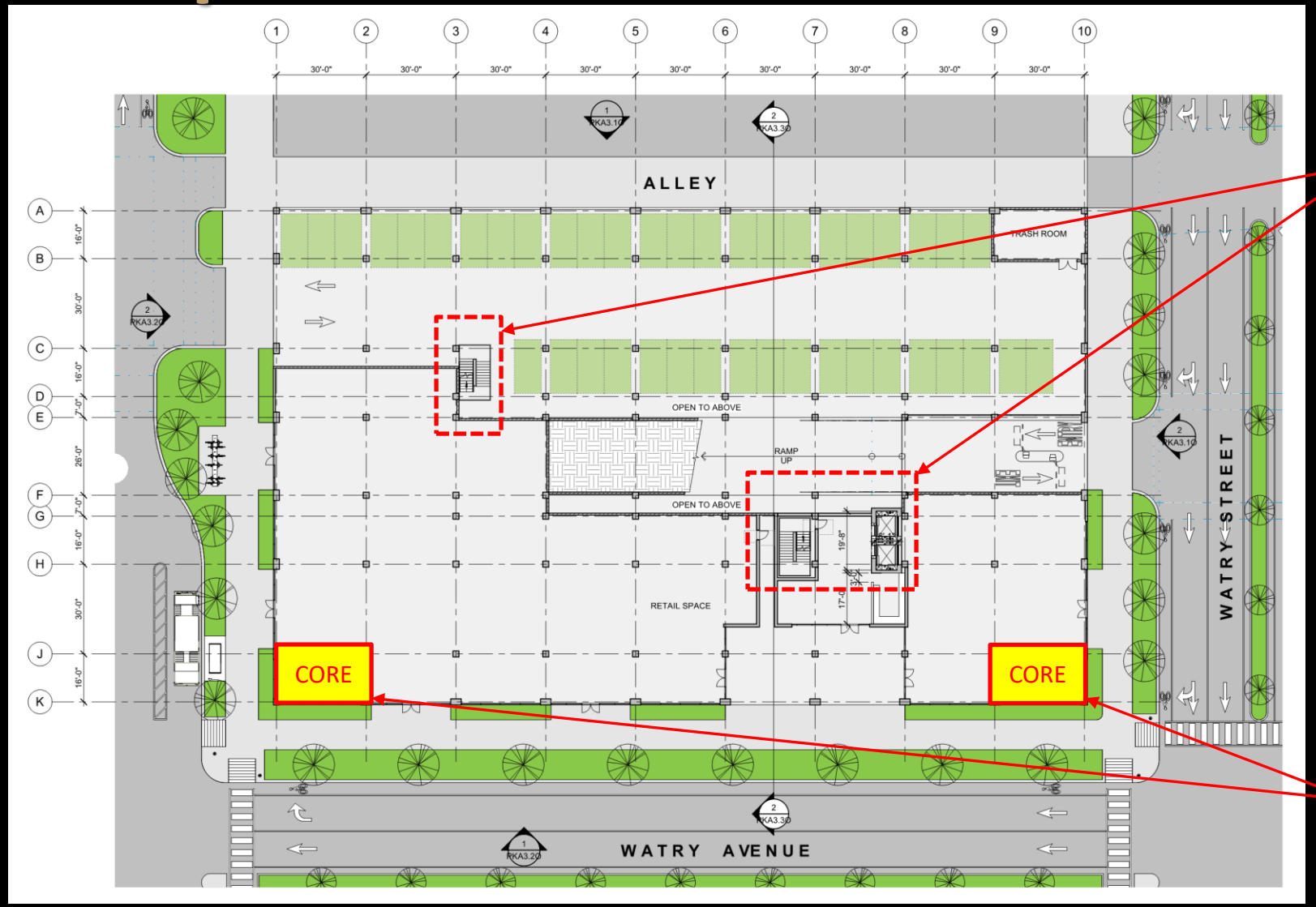
- Parking structures typically have large floor plates. The large floor plates may not correspond well to uses such as office, retail or residential.
- Designing the parking structure with seismically separated sections make it feasible to demolish an portion of the existing building to allow for the construction of another type of facility.
  - Not able to predict what use might do well on the site.
  - Don’t want to over spend on upfront costs



Egress, Pedestrian Pathways and Occupant Load

- Plan for future vertical circulation core locations.
  - For office use, cores are frequently more centralized in the building, whereas in parking structures, it is more efficient to locate cores at the outer corners.
  - Occupant loads for other uses can be much higher than for parking structures. Anticipate Office/Assembly use and size the stair width and travel distance for the future conversion.

Conceptual Office - Ground Level Plan

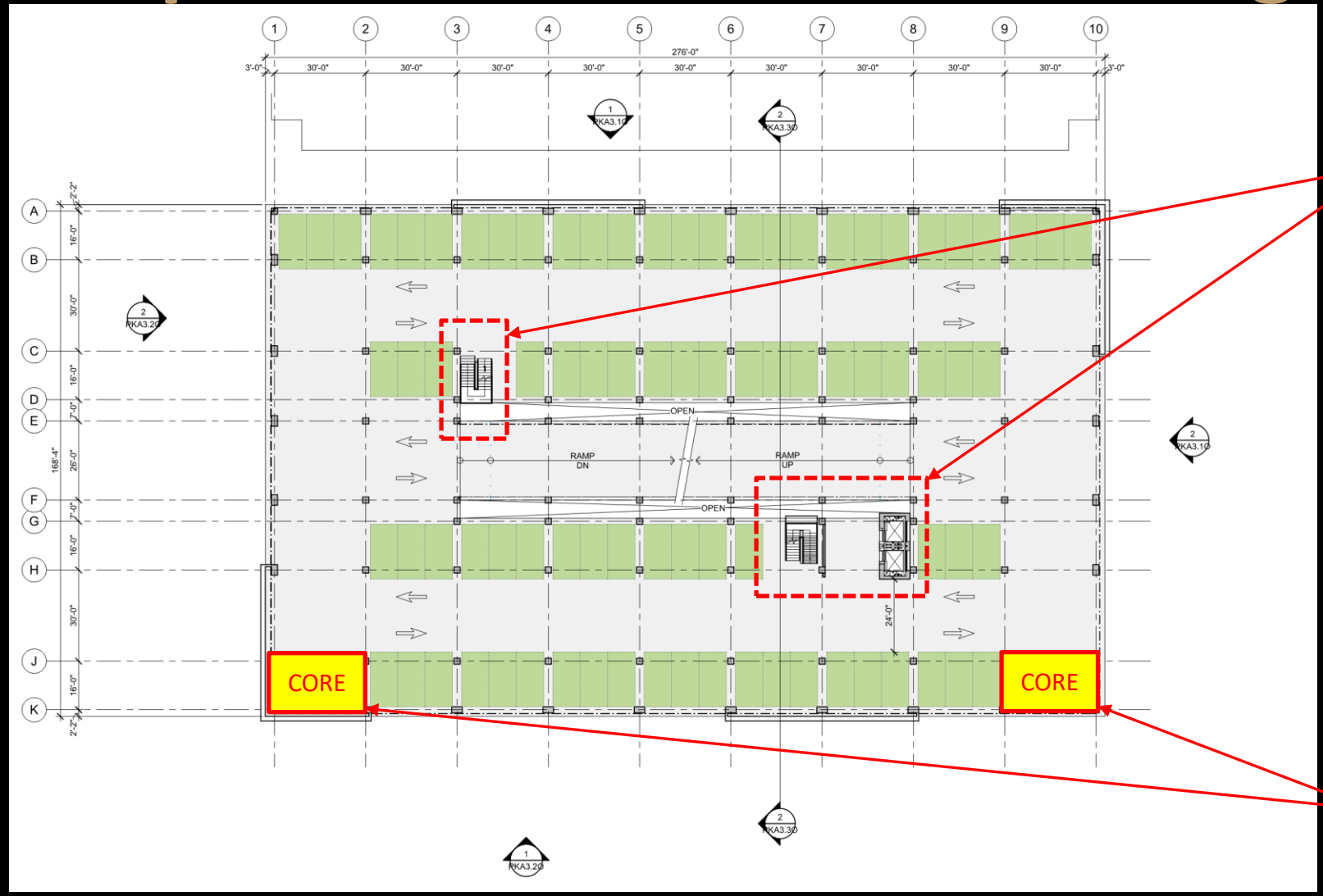


Traditional Core Locations

FORWARD THINKING CORE LOCATIONS

TRADITIONAL LOCATION FOR VERTICAL CIRCULATION

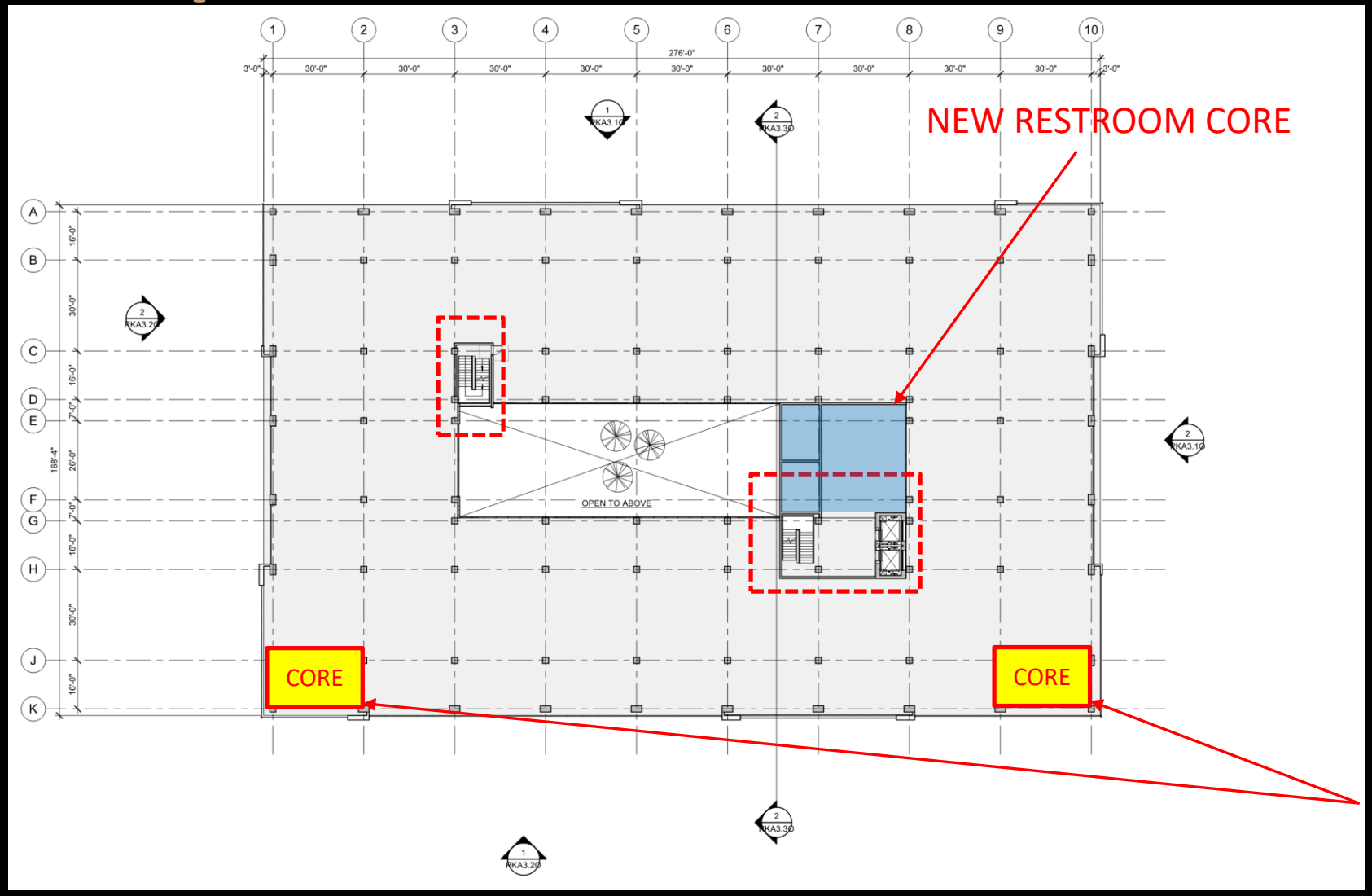
Conceptual Office - Level 2 Parking Plan



FORWARD THINKING CORE LOCATIONS

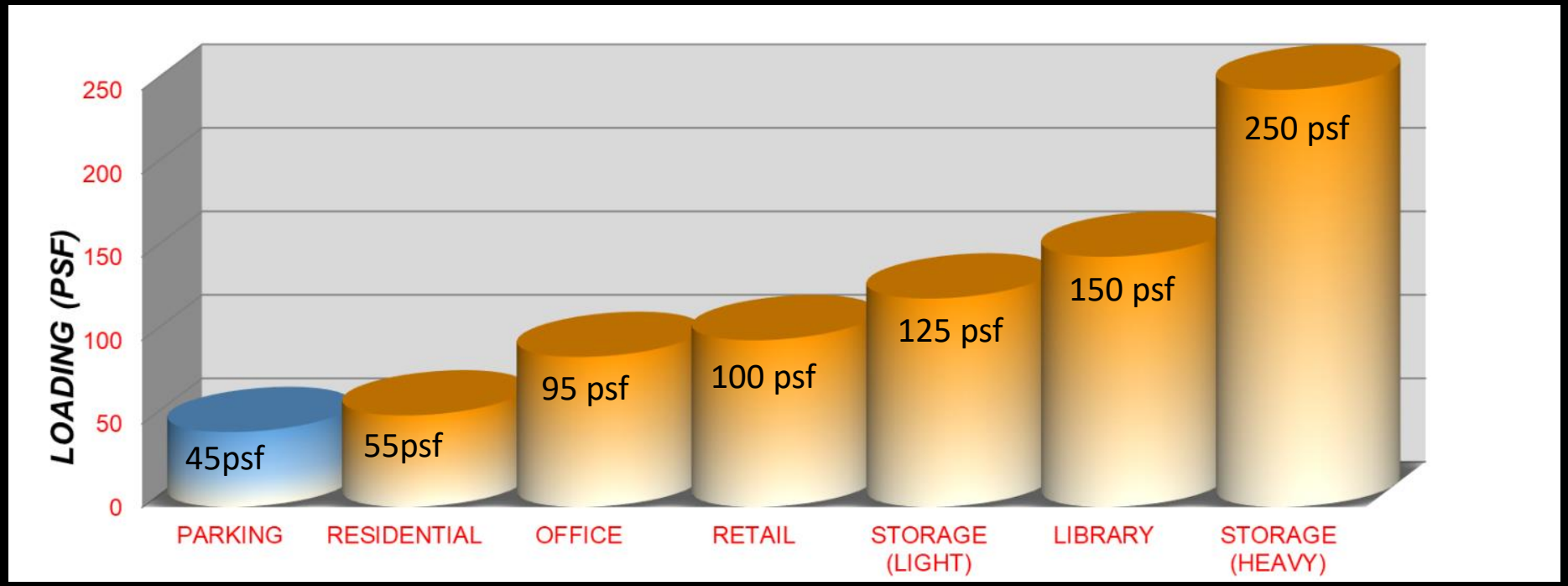
TRADITIONAL LOCATION FOR VERTICAL CIRCULATION

Conceptual Office - Level 4 Office Plan



Structural System and Floor Design

- Heavier Live and Dead Load Requirements for non-vehicle uses



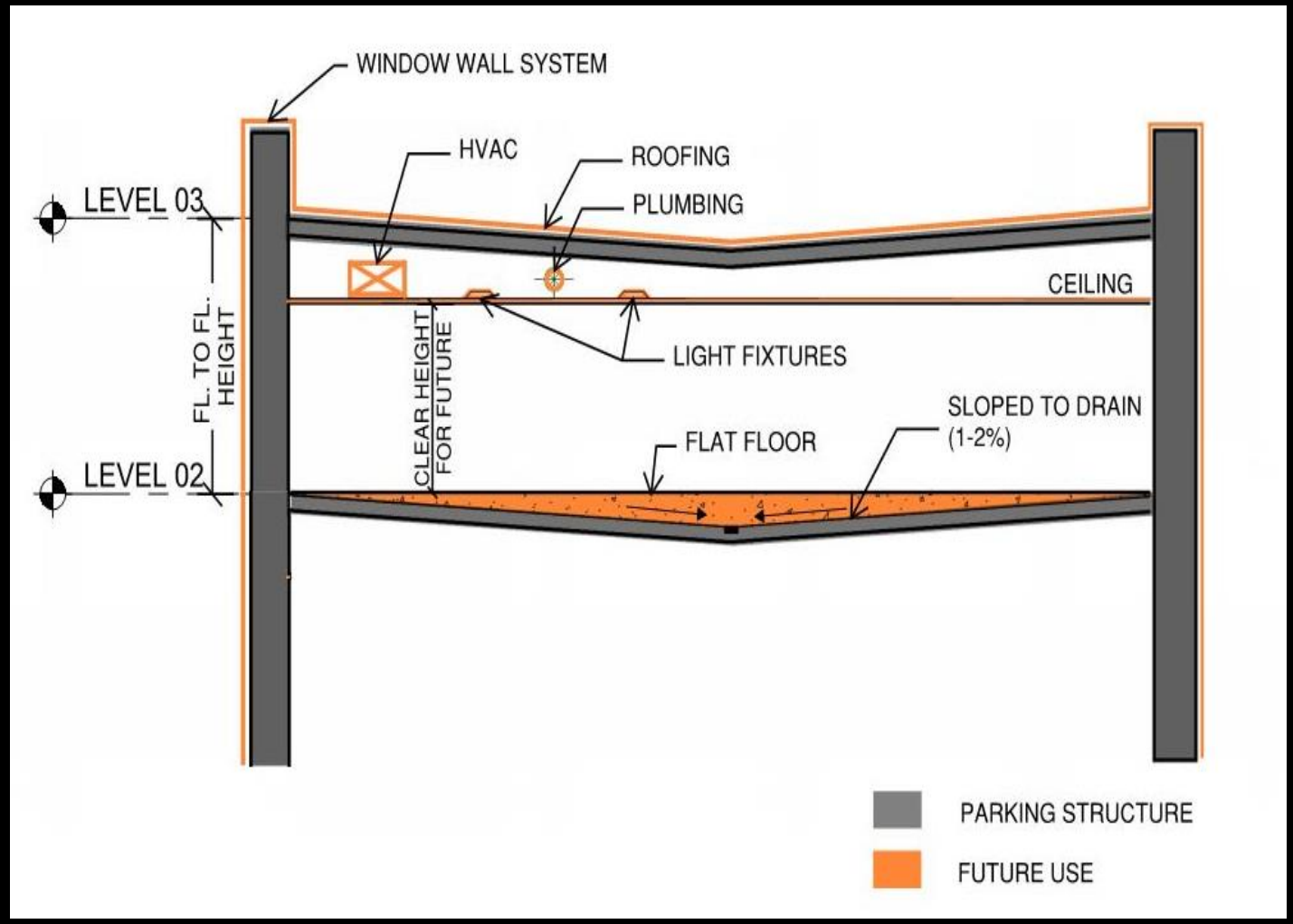
Structural System and Floor Design

- Parking structures typically have sloped floors
  - Positive drainage is required to deal with rainwater, water brought in on car tires, and water used for washing of parking decks.
  - Poor drainage can lead to water ponding, damage to elevators, and other problems.
  - A lack of drainage has also been associated with liability for slips and falls caused by puddling. Common practice is to incorporate 1.5% slope to drains on every floor.

Removable Mechanical Parking Solutions

Structural System and Floor Design

- Flatten floors for future use.
  - Lightweight concrete over high density foam (May add 40 psf)
  - Raised floor for office use. Under floor routing of utilities
  - Added loads require thicker slabs, bigger beams which also add weight to the building when designing the foundation and seismic resisting system.



Structural System and Floor Design

- Vibration and acoustics are not usually a concern in a traditional parking facility. However, noise and vibration are undesirable for other uses.
  - Design consideration for slab spans, column grids and concrete thickness are major cost considerations to build in up front.

Conceptual Garage

Conceptual Office Conversion

Conceptual Residential Conversion

Other Design Considerations

- Stair and Elevator enclosures – fire rated separation of uses
- Electrical Service – Size Main Electrical Room to accommodate the addition of switchgear for the higher loads for office, residential or retail use.
  - Provide extra conduits and pull boxes during initial design to make expansion easier.
- Plumbing - Plan for future connection to sewer and water – is current size adequate?, how would a new use tie into the existing system?
- Mechanical systems – Consider future added weight and locations for vertical chases.

Other Design Considerations

- Guardrails and exterior façade – added cost to remove these when changing to future use.
  - Precast and cable rail guardrails are more easily removable
- Avoid expensive materials to enclose/screen the parking structure that cannot be used later.

Summary

With the many factors and unique design goals for each project it is difficult to say with certainty what upfront costs will be for a conversion. Early consideration is key to facilitate a change in use 10 or 20 years in the future.

- Full Conversion: may add 40% or more in upfront costs
  - Taller floor to floor heights, larger foundations, future planning for utilities.
- Partial Conversion: may add 10-15% or more in upfront costs
- Taller ground floor, utilities prepped for future uses, planning for future infill of exterior and weather proofing.
- Minimal Conversion: may add 3-5% or more in upfront costs
  - No change in floor height, addition of power, sewer to accommodate future uses.

INSPIRED,

Have Questions,

OR WANT TO KNOW MORE?

WATRY DESIGN, INC.

Architects • Engineers • Parking Planners