Ministry of Education and Science of the Russian Federation
Federal State Budgetary Educational Institution of Higher Education
«Nizhny Novgorod State University of Architecture and Civil Engineering»

D. I. Ivanov, A. A. Khudin

PARKING GARAGE FOR 250 CARS

Educational-Methodological Manual
on the Performance of the course project

for Students in the direction of training 07.03.01 «Architecture»,
Profile «Architecture»

FOR INTERNATIONAL STUDENTS IN ENGLISH

Nizhny Novgorod
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CONTENTS:

1. Placement of parking garage

The placement of the parking garage building on the allotted lot and the design of the master plan are based on the following objectives: -maximum utilization of the plot within the land allotment;

- taking into account the urban planning situation of the construction area;
- rational organization of entrances and exits to the territory taking into account the traffic pattern of city transport on adjacent streets and passages;
- Consideration of planning restrictions and sanitary-hygienic gaps; - Organization of the site relief, contributing to the collection and treatment of surface runoff;
- improvement and landscaping of the allocated territory.

When locating a parking garage building (in accordance with SP 42.13330.2011) distances from above-ground and surface-underground garages, open parking lots, intended for permanent and temporary storage of cars, and service stations to residential buildings and public buildings, as well as to the sites of schools, kindergartens and medical institutions of stationary type, located in residential areas should be taken not less than those given in the table:

Buildings to which the distance is determined	Distance, m					
	from garages and open parking lots with the number of passenger cars				from service stations at the number of stations	
	10 и less	11 - 50	51 - 100	101 - 300	10 и less	11 - 30
Residential buildings	10	15	25	35	15	25
Residential building ends without windows	10	10	15	25	15	25
Public buildings	10	10	15	25	15	20
Comprehensive schools and preschools (to the precincts)	15	25	25	50	50	
Medical institutions with Inpatient (up to sites)	25	50			50	

In order to improve control, it is recommended that the entrance is placed next to the exit. The total number of entry and exit lanes is recommended to be at least two.

The strips shall be at least 3 m wide. On curvilinear sections the width of the strip shall be increased to 3.5 m.

2. Volume planning solutions

Above-ground parking garages may be provided with a maximum height of 9 stories.

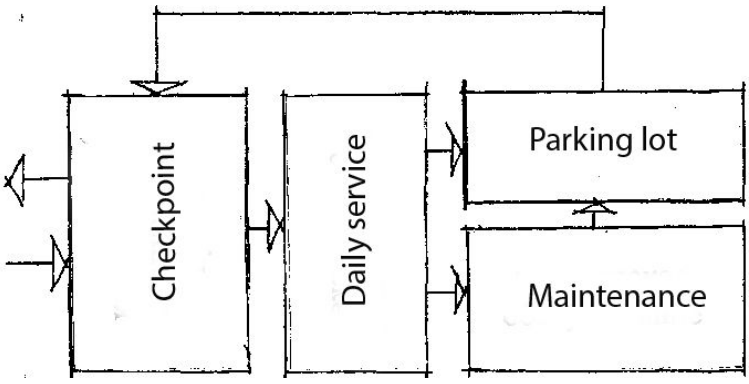
The garage includes:

- vehicle storage facilities;
- facilities for day-to-day maintenance;
- maintenance facilities;
- ancillary facilities.

The basis for the design of the garage should be expedient and clear organization of the technological process with the observance of a strict sequence of operations according to the functional relationships shown in Fig. 1.

Fig. 1

1. Checkpoint
2. Daily service
3. Maintenance
4. Parking lot

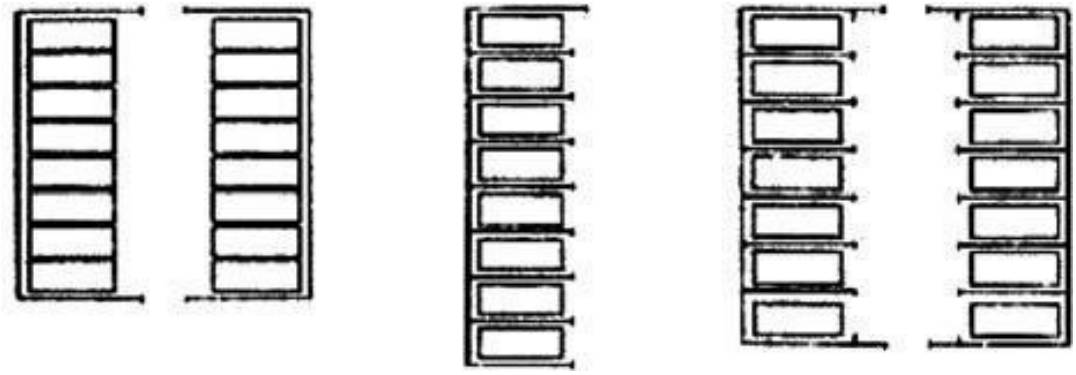


The production building of the garage is designed for the 2nd climatic region. The group of auxiliary premises can be located in a separate or attached volume.

Planning types of parking lots

a - manege; b - boxing; c - boxing in a closed room

a **b** **c**



A medium-sized vehicle with dimensions of a medium-sized class is taken as the design vehicle:

- length 4950 mm;
- width 1800 mm;
- minimum turning radius 6200 mm;
- height 1500 mm.

In addition to the dimensions of the horizontal projection of the vehicle, the parameters of the protective zones shown in the table below must be taken into account in order to determine the minimum required parking space:

Parameters of protection zones

Protection zones	Distance, m
From the longitudinal side of the vehicle to the wall	0,5
From the end of the vehicle to the wall	0,5
Between the car and the convoy	0,3
From the end of the vehicle to the gate	0,5
Between the longitudinal sides of the cars	0,6

Parameters of storage locations

Vehicle class	Vehicle dimensions, mm	Dimensions of the parking space, mm			
		Box storage	Mannequin storage		
			Corner location	Row arrangement	Row positioning at the column
Medium class					

There are two known methods of parking a car in a storage space dead-end, involving entering in reverse and exiting in front, (or vice versa),

and straight-through, in which entry and exit to the storage site is done in a forward direction (Fig. 21).

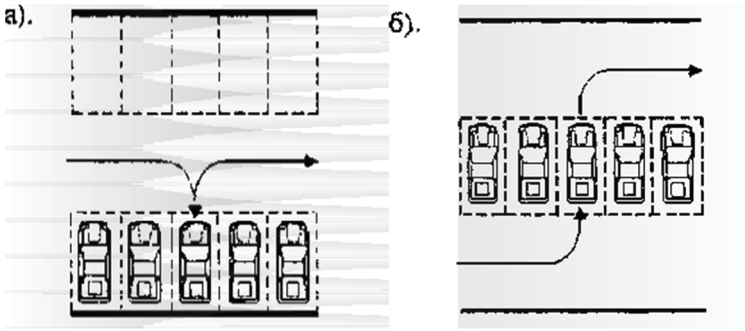
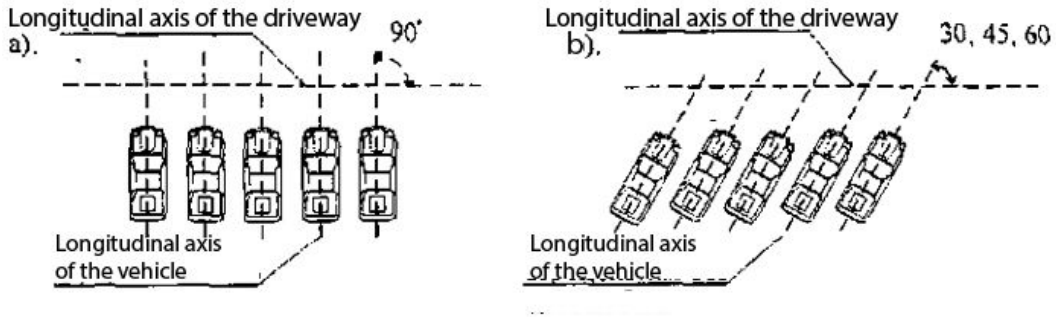


Fig. 21 Methods of parking cars a) dead-end, b) straight-through.

According to the angle between the longitudinal axes of the car and the roadway, rectangular and oblique schemes are used in the organization of *the* storage area (Fig. 22).

Fig. 22. Schemes of car arrangement in the storage area a) rectangular b) oblique- angular



When designing parking garages with box storage, a rectangular arrangement of storage spaces is used. Any arrangement scheme can be used for manege storage in accordance with the specific design solution. The minimum permissible width of the garage driveway depends on the application of this or that scheme (Table 3).

Width of the garage driveway

Table 3

Types vehicles, class	Width of garage driveway, m					
	When parking in the forward direction			When parking in reverse		
	of the executive maneur		with maneuver	Without additional maneuvering		
	Angle of the vehicle to the driveway axis					
	45°	60°	90°	45°		
Cars middle class	3,7	5,4	7,7	4,7	4,8	6,1

Parking can be carried out: with the participation of drivers - on ramps (ramps) or using freight elevators; without the participation of drivers - by mechanized devices.

3. Garages with ramps

Ramps can be built-in or attached. Attached ramps allow for rapid occupancy or clearance and eliminate transit traffic on the floors, especially if there is a separate ramp for each floor. The floor level of such a garage is limited by the length and number of attached ramps. Separate ramps are associated with a significant increase in the amount of land available for construction

A more economical solution in this respect is the half ramp solution (halved ramps), in which the offset of adjacent floors is provided.

There are several types of ramp garages. The garage with attached ramps is shown in Fig. 2.

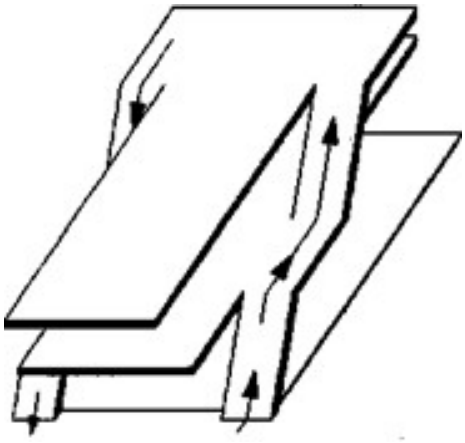


Fig. 2

The ramp is one-way and transit traffic on the ramp is not hindered by maneuvering the vehicle in the parking space. A comparatively short route for access to the floors. The organization of traffic inside the garage is simple and relatively safe.

A garage with integrated ramps is shown in Fig. 3

They provide for separate upward and downward movement of vehicles. Each floor has two lanes for vehicle traffic. The traffic organization is relatively simple and easy to understand even for an inexperienced driver, but there is no differentiation between transit and maneuvering at the parking place in each floor. The route to the upper floors is long and uncomfortable due to the large number of turns.

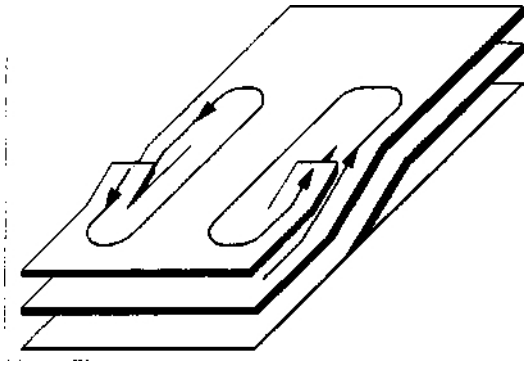


Fig. 3

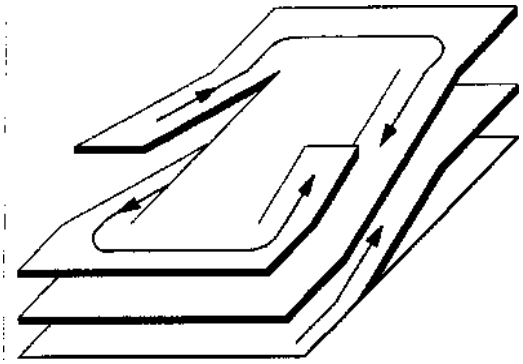


Fig. 4

The double integrated ramps (Fig.4) provide separate up and down movement both on the ramp and in any floor.

Garages with sloping slabs (Fig. 5) are of interest, where both storage and vehicle movement uphill or downhill is carried out. The slope of the slopes should be no more than 0.04, which requires a large length of each sloping section. Safe traffic can be ensured in such a garage, although parking is not convenient as the vehicles must be parked on the brakes.

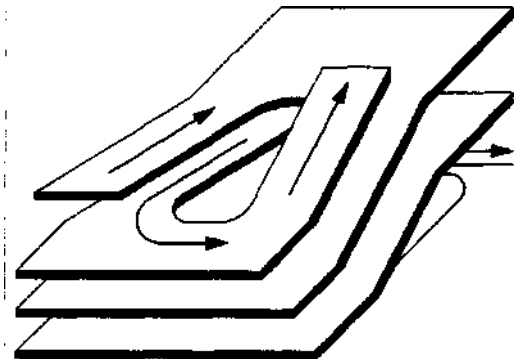


Fig. 5

Half-ramp garages, i.e. half ramps, are more economical in terms of land plot - they provide for the displacement of neighboring floors by half a storey in height. There are varieties of such garages.

Half frames with two-way traffic are shown in Fig. 6. From the point of view of traffic safety, this solution has major disadvantages due to oncoming traffic on the ramp, complication of vehicle traffic on the internal passages in the parking lot, frequent and abrupt changes in directions and gradients.

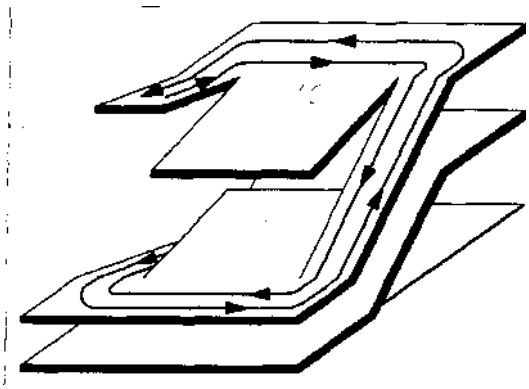


Fig. 6

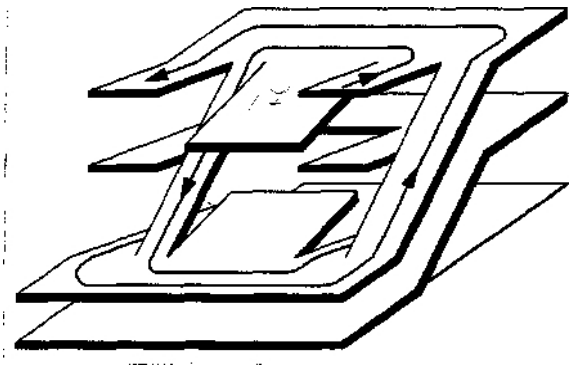
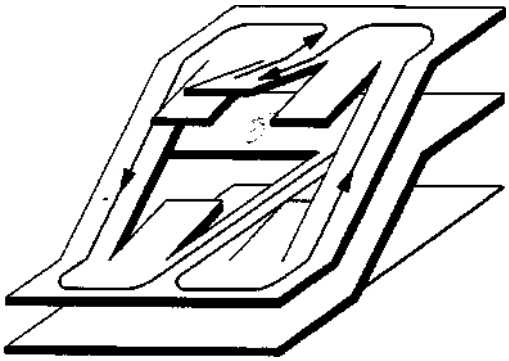


Fig. 7

An improved version of the half-frame garage is shown in Fig. 7. 7. Here, oncoming car traffic is only in the inner driveways. The installation of additional ramps in the middle of the garage allows to reduce the length of transit traffic during the ascent or descent of cars or to eliminate it altogether.

oncoming traffic (Figure 8).

The most compact solution for ramp garages is achieved with spiral ramps. Such ramps can be used only for lifting or only for lowering vehicles. (Fig. 9). In this case, the garage should have two



detached ramps. Another variant involves storing cars on a spiral surface and the gar

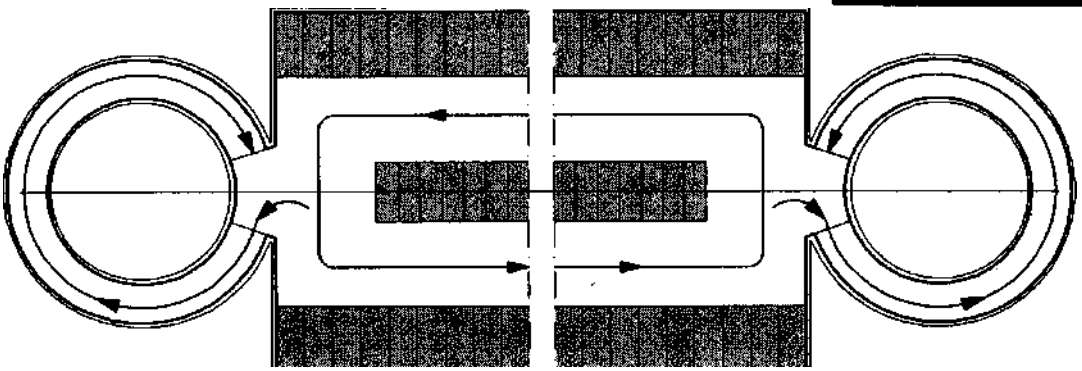


Fig. 9

The most compact solution of ramp garages is achieved with spiral ramps. Such ramps can be used only for ascending or only for descending the car (Fig. 9). In this case, the garage should have two separate ramps. Another option is to store the cars on a spiral top, and the garage becomes circular inplan.

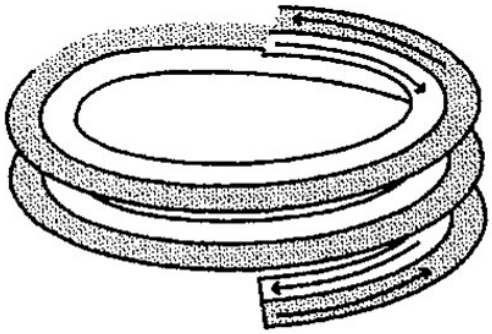


Figure 10

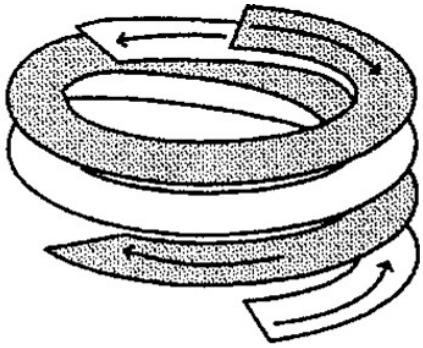


Figure 11

Figure 10 shows a spiral ramp. The inbound and outbound lanes are next to each other.

A two-way ramp is shown in Figure 11. The entrance and exit lanes are on top of each other.

Figures 12, 13 show the minimum horizontal projections of ramps, most often used in the practice of designing parking garages. Horizontal projections of ramps are built for medium class cars taking into account all current regulatory requirements. The values of the parameters indicated by symbols a) and b) are given in the table below

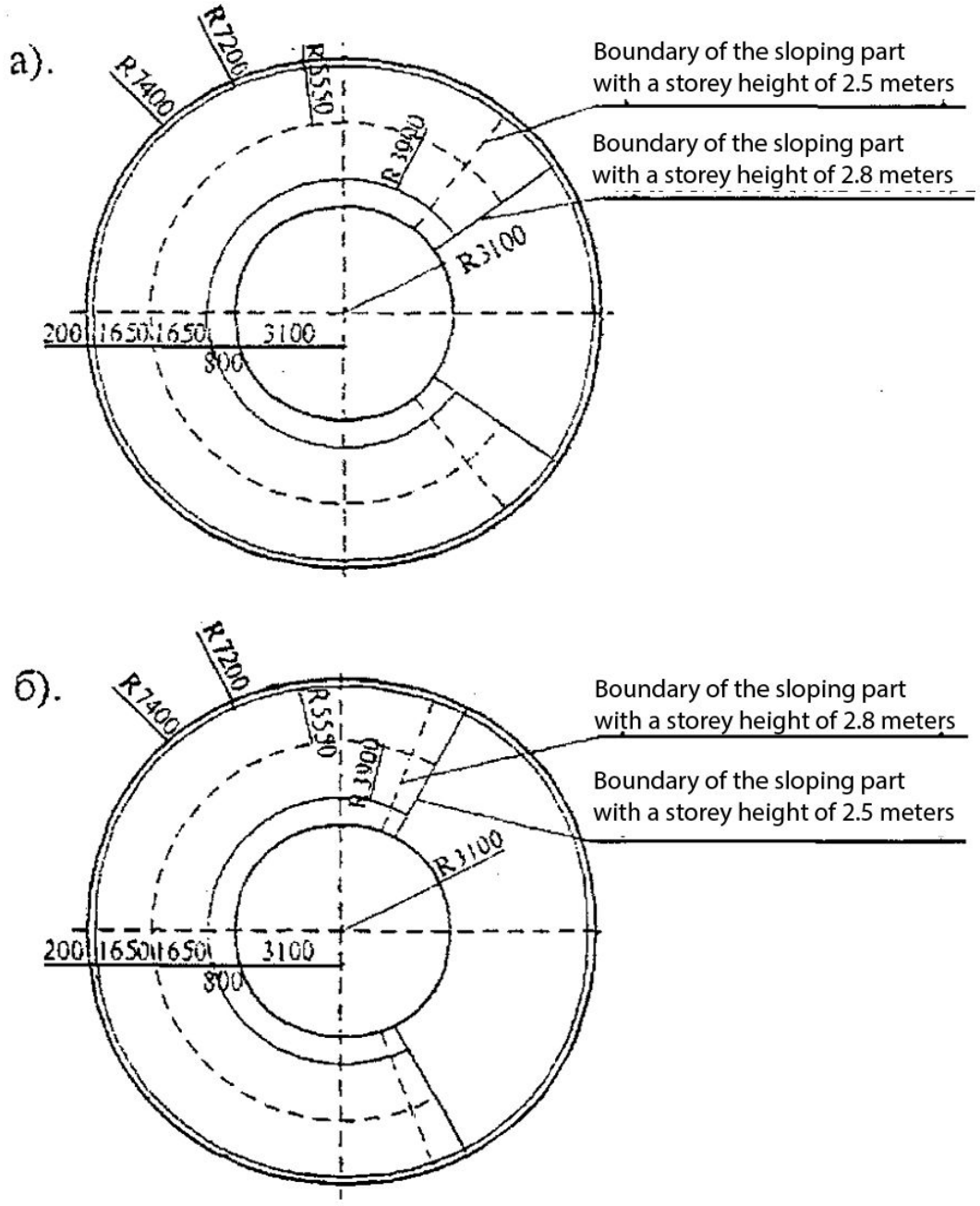
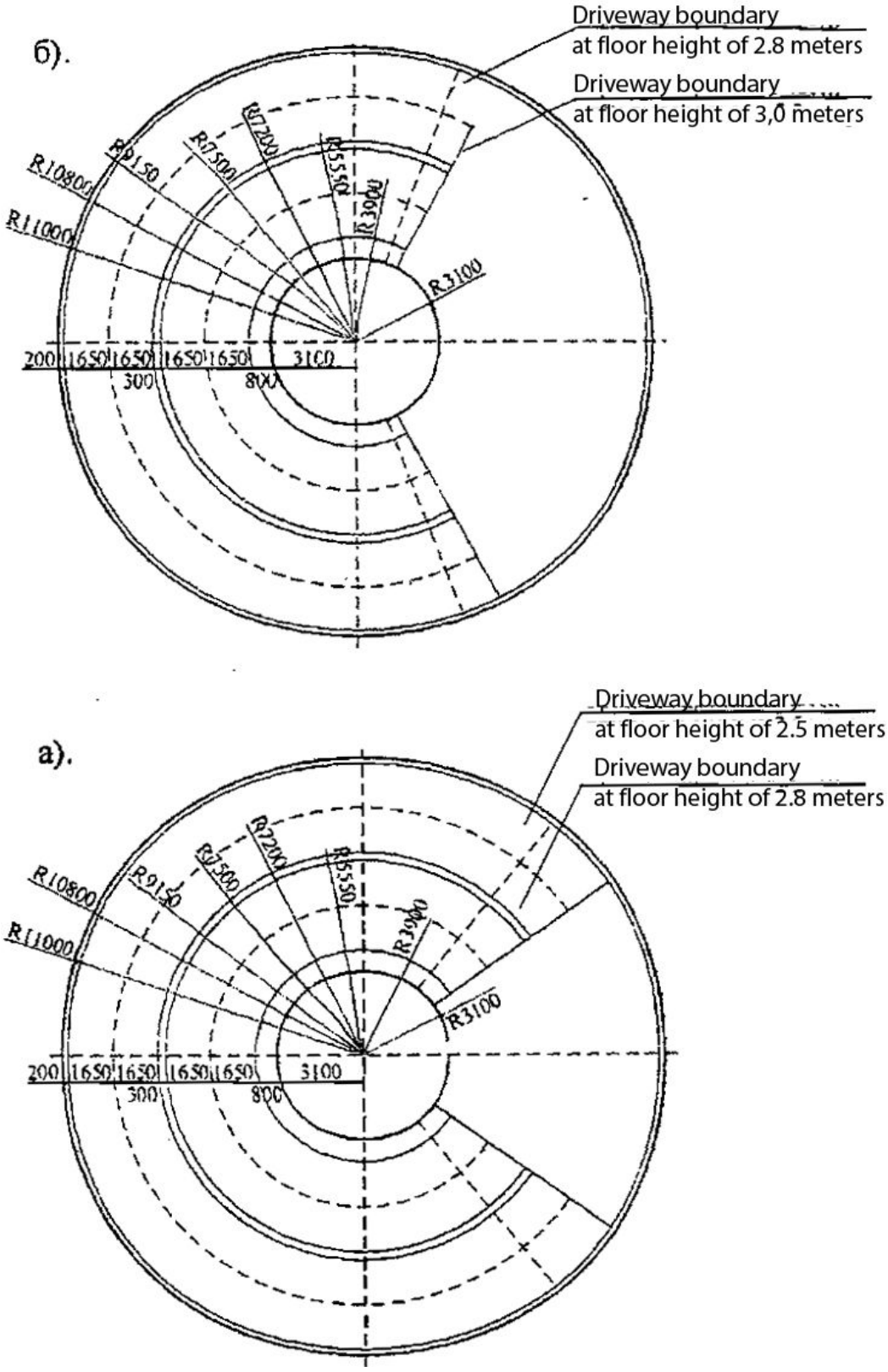


Fig.12. Minimum horizontal projection of curvilinear single-track ramp a) slope -10 %; b) slope -13 %



Minimum horizontal projection of a two-track curvilinear ramp.
a) slope 10 %; b) slope 13%

Table 1 shows the minimum areas and horizontal projection parameters of the most frequently used ramps.

Table 1

Ramp parameters

Ramp type	Slope	floor height, m	Carriage way width parts, m	Outer radius in gate, m	Length of inclined parts (a), m	Overall width, m	Overall length, (b), m	area, m2
Single-track straight single-run single march	10%	2,5	3,3	7,2	25,0	7,4	39,8	178,4
		2,8	*3,3*	7,2	28,0	7,4	42,8	191,3
	18%	2,8	3,3	7,2	15,6	7,4	30,4	138,0
		3,0	3,3	7,2	16,7	7,4	31,5	142,7
Single-track straight two-step track	10%	2,5	3,3	7,2	12,5	14,8	27,3	357,0
		2,8	3,3	7,2	14,0	14,8	28,8	379,2
	18%	2,8	3,3	7,2	7,8	14,8	22,6	287,5
		3,0	3,3	*7,2*	8,35	14,8	23,1	294,9
Two-track straight two-staircase	10%	2,5	6,9	10,8	12,5	22,0	34,5	655,0
		2,8	6,9	10,8	14,0	22,0	36,0	688,0
	18%	2,8	6,9	10,8	7,8	22,0	29,8	551,6
		3,0	6,9	10,8	8,35	*22,0*	30,3	562,6
I'm crooked	10%	2,5	3,3	7,2	-	14,8	14,8	172,0
		2,8	3,3	7,2	-	14,8	14.8	172,0
	13%	2,8	3,3	7,2	-	14,8	14,8	172,0
		3,0	3,3	7,2	-	14,8	14,8	172,0
Two-track curvilinear	10%	2,5	6,9	10,8	-	22,0	22,0	380,1
		2.8	6,9	10,8		22,0	22,0	380,1
	13%	2,8	6.9	10,8	-	22,0	22,0	380,1
		3,0	6,9	10,8	-	22,0	22,0	380,1
single-track ramps	10%	2,5	3,3	-	-	8,6	12,5	107,5
		2,8	3,3	-	-	8,6	14,0	120,4
		3,0	3,3	-	-	8,6	15,0	129,0
double-track ramps	10%	2,5	6,9	-	-	15,8	12,5	197,5
		2.8	6,9	-	-	15,8	14,0	221,2
		3,0	6,9	-	-	15,8	15,0	237,0

The number of ramps and, accordingly, the number of required exits and entrances in the garages are determined according to the number of cars located on all floors except the ground floor. In this task, one double-track ramp or two single-track ramps are assumed.

4. Mechanized garages

Multi-storey semi-mechanized garages - the vehicle is lifted using various lifting devices and parked onits own.

This type of garage includes the Bowser system, which uses an elevator to transport cars. It can move both vertically and along the main axis of the building (Fig. 14). The garage has a shaft-corridor, which is located along the main axis and is intended for moving the elevator-tower, and multistory rooms on both sides of the elevator - for storage. The car is parked on the parking place by the service personnel. The number of elevators depends on the number of parking spaces. The garage provides information on the availability of free spaces, cashier's office, and rooms for waiting customers. Negative side of this type of garage

- complex machinery handling equipment and the need for ventilation devices, as the vehicle moves on its own after lifting.

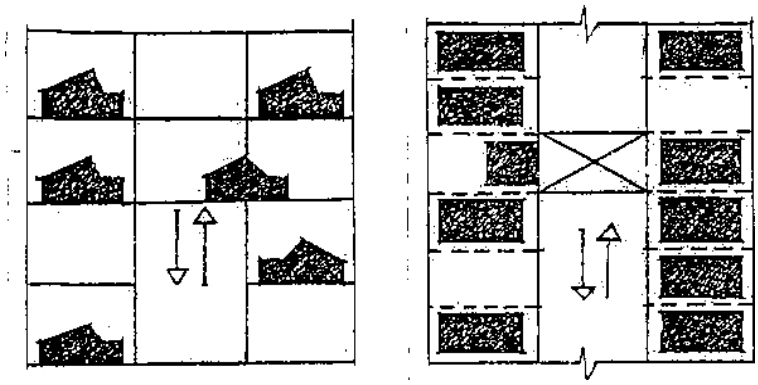


Fig. 14

Another variant of a semi-mechanized garage is a garage with rotating platforms, which can be arranged on slope-screw ramps (Fig. 15). Each floor on the ramp has a horizontal section with a turning platform. With its help, the car is turned at an angle convenient for entering the parking space.

100. The method allows reducing the volume of the garage building at the expense of the area required for maneuvering the car in the parking area.

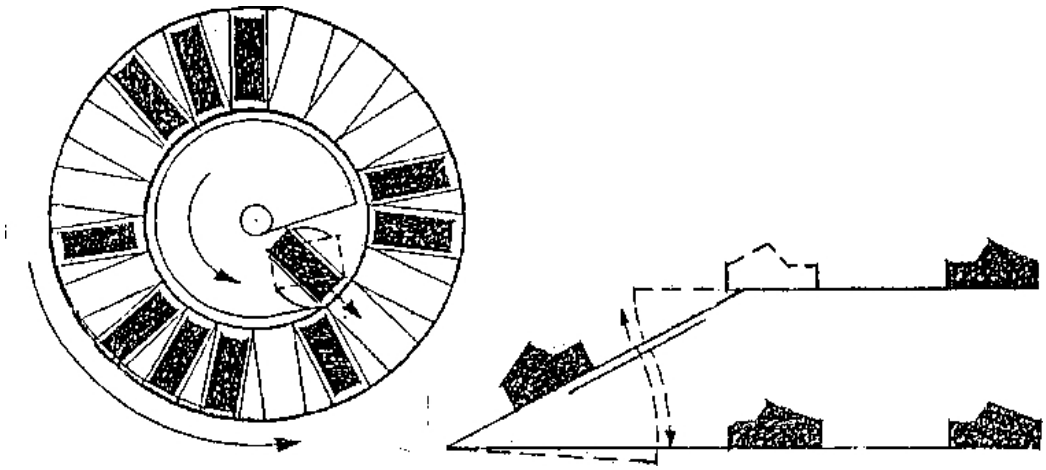


Fig. 15

Multi-storey, fully mechanized garages - the vehicle is transported to its place by machinery. This system eliminates the need for ventilation devices. There are several types of fully mechanized garages:

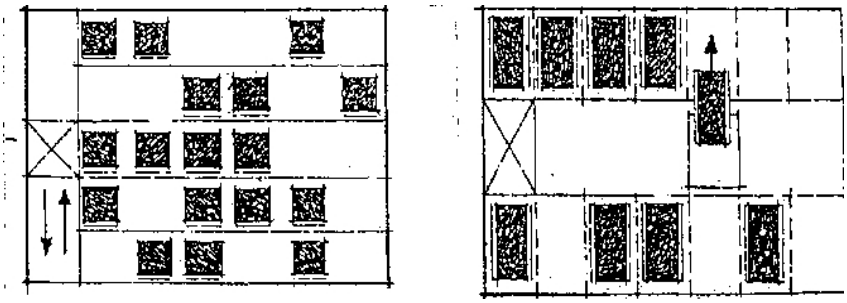


Fig. 16

Garages with horizontal-vertical distribution - equipped with a system of car distribution to free parking boxes (Fig. 16*)*. The garages have several shafts with elevators, and the boxes are located on 4 sides of each shaft. A frame equipped with pushing hydraulic cylinders is installed on the elevator platform. On the frame guides the carriage with the car can move to any of the 4 sides towards a free box.

Another option is a tower elevator, which can also move horizontally in a shaft located along the main axis of the garage (Fig. 17).

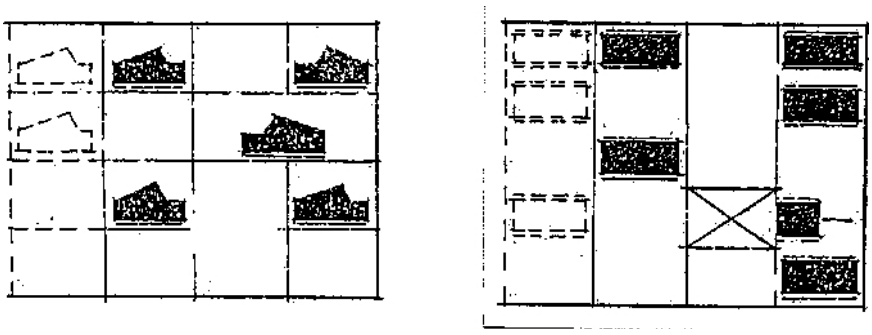
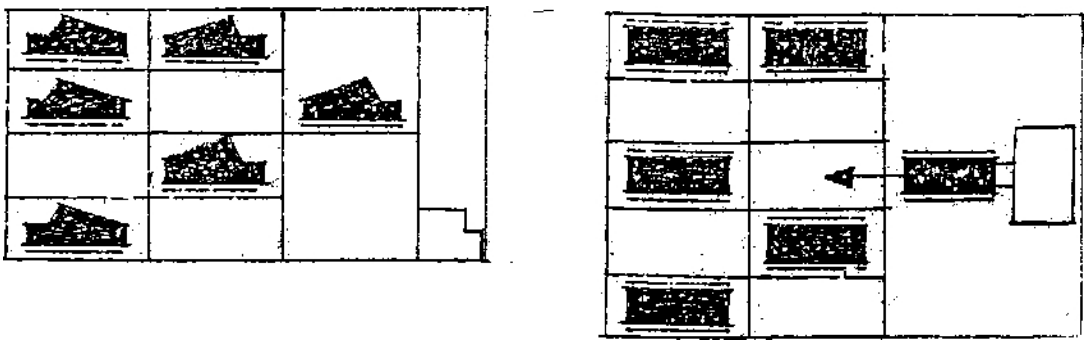


Fig. 17

Using this principle, in the central districts of densely built-up cities it is possible to build open garages - shelves (Fig. 18), where lifting and distribution of cars to parking places is carried out by a special forklift.

Fig. 18



Rotary garages are cylindrical buildings with an elevator in the center. Such garages can be equipped with rotating elevators (Fig. 19), which is a rotating wheel of frame construction, which is supported by axle trunnions on bearings fixed in sockets. There are cross beams along the perimeter of the frame wheel, the ends of which with bearings move along circular guides. The cross beams are hinged to the supporting plates on which the vehicles are placed when they are delivered to the parking place.

Fig.19

It is possible to transport a car in a multi-tier garage to any tier by means of a lifting platform. The car is moved to the parking place by synchronously rotating conveyors of the platform and the box (Fig. 20). the garage is a parallelepiped-shaped room, in which an endless two-chain conveyor is placed. Platforms with cars attached to them can be installed on its upper branches, which are interconnected by tractors. Platforms with cars are installed and removed from the conveyor by means of a vertical hoist, which ensures lifting and lowering of the mold.

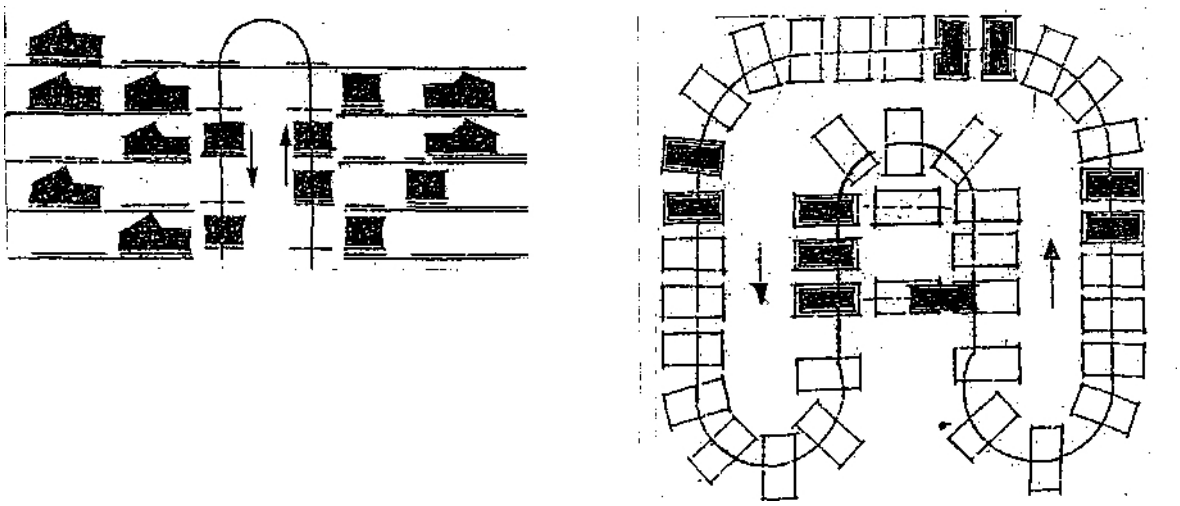


Fig. 20

Daily vehicle maintenance

The maintenance includes control inspection and cleaning and washing operations. In this project we use two types of automatic washers.

The conveyor wash (capacity - 60 cars per hour) is a series of washing arches arranged along the washing room in a line, each of which is separately controlled by a computer according to a selected program. Up to 4 cars can be washed at the same time and the next car enters every minute. Washing hall dimensions: length -30 m, width -5.3 m, height -30 m.
3.6 м.

Automatic gantry-type car wash (capacity - 12 cars per hour). The car is stationary, the gantry moves.
Dimensions of the washing hall: length - 12 m, width - 4.6, height - 3.6 m.

Technical rooms are used to house pumping equipment and equipment of the closed-cycle water treatment system.

Vehicle maintenance

To perform maintenance work, lifting stations with a set of technological equipment and stands for diagnostics and component-by-component service are provided.

5.Design solutions

Bearing structures of the building: columns, transoms, slabs, coverings, walls. When designing multi-storey parking garages, both metal columns of I-beam or closed profile and reinforced concrete columns of rectangular or circular cross-section can be used. If metal columns are used, additional fire protection measures are required. The most reasonable use of metal columns in the design of cold garages - parking lots of low storey, large-span multi-storey open or closed manege type. Depending on the structural system, the frames can be beam or beamless, with reinforced or prefabricated reinforced concrete slabs.

Steel or reinforced concrete beams (ledgers) are used in beam-type slabs. Reinforced concrete beams are rationally used in frame buildings with reinforced concrete columns and small spans (up to nine meters). Metal beams allow to cover the span up to 18 meters and are used in frame buildings with both reinforced concrete and metal columns. Overlaps on steel beams are carried out with large-size and small-size reinforced concrete slabs. The use of the latter allows to reduce the thickness of the slab, as well as to reduce the cost of construction and installation works. The use of reinforced concrete floor slabs is a traditional solution for both frame and semi-frame buildings of parking garages.

Monolithic slabs are less thick than prefabricated slabs and make it possible to cover buildings with a complex configuration in plan. Monolithic slabs are effectively used in removable or fixed formwork made of

steel profiled decking. The main type of covering used in the design of parking garage buildings is a combined covering. Vo- The walls of parking garages are made of non-combustible or, in rare cases, difficult-to- combust materials: monolithic reinforced concrete, prefabricated reinforced concrete panels. The walls of parking garages are made of non-combustible or, in rare cases, hard- to-combust materials: monolithic reinforced concrete, prefabricated reinforced concrete panels, large and small concrete or ceramic blocks, bricks, multilayer panels, sheet materials. The walls can be designed as load-bearing, self-supporting or curtain walls.

The load-bearing structures in panelized buildings are made of reinforced concrete panels of different series. The load-bearing envelope structures can be prefabricated reinforced concrete with the use of panels of different series, reinforced concrete monolithic or made of small blocks and bricks. Self-supporting envelope structures are made of single-, double- and multilayer panels, small blocks of cellular concrete, foam concrete, expanded clay concrete, gas-silicate or arbalite blocks and bricks. The following structural solutions of stairs are used: prefabricated reinforced concrete flights and platforms; prefabricated reinforced concrete steps on steel or reinforced concrete rungs; monolithic reinforced concrete flights and platforms; steel rungs, treads and platforms.

A specific element of the volume-planning structure of the parking garage is the ramps, the peculiarity of which is the need to organize a sloping floor. The structural solution of the ramp is determined by its type and the general structural solution of the building. Ramps, as well as the main volume of the building, can be designed in a frame version or with load-bearing walls. The frame can be metal, reinforced concrete monolithic or reinforced concrete prefabricated. Bearing walls are made of monolithic reinforced concrete, small blocks or bricks. Slabs in rectilinear ramps are prefabricated or monolithic, in curvilinear ramps, as a rule, monolithic.

The column grid of multi-storey garages is usually selected with different spacing for each direction. In the transverse direction, the largest spacing is determined by the width of the driveway, taking into account the radius, turn, and in the longitudinal direction, the possibility of installing the maximum number of cars between the columns.

by us.

Recommended steps (taking into account economic feasibility) in transverse direction 6.0-8.1-6.0, in longitudinal direction 6.0 - 6.0.

Floor height in the car storage area 2.5 - 2.7 m at minimum

2.2 m between the floor and the bottom of protruding structures. Floor height in the service area for maintenance and repair vehicles - 3.6 m from the floor to the bottom of protruding structures.

In places of passage and storage of cars, the height of premises and gates from the floor to the bottom of protruding structures and suspended equipment must be at least 0.2 m higher than the highest height of the car and be at least 2.2 m; on the ramp is allowed to reduce it to 2.0 m.

6.Volume-planning solutions of household premises

Let's focus on two variants of planning solutions:

a. Rooms that house only checkroom equipment or only washroom and shower facilities.

б. Rooms that can be conventionally called complex rooms, as they house all necessary equipment (checkroom facilities, showers and washbasins).

Checkrooms occupy the largest area of the domestic premises and are used for storing three types of clothing - street, home and work clothes. There are three ways of storing clothes in closets: closed (in closets), open (on hangers and in open closets) and mixed (clothes are stored on hangers and in closed closets depending on the type). Most of the clothes are stored in closets in a closed way. Checkrooms (Fig. 23) provide for the placement of closets without benches, with benches located at the ends of rows of closets, and with folding benches at each closet.

Washrooms are located in separate rooms adjacent to checkrooms or in checkroom rooms. Some washbasins (up to 20% of the estimated number) can be located in free areas of the production area near workplaces.

Showers (Fig. 24) should be located in rooms adjacent to the checkrooms,

as a rule, between the dressing rooms for work and home clothes. There must be a vestibule between the shower room with more than 6 shower nets and the checkroom. The number of shower nets is determined by the number of people per shower net working in the largest shift, depending on the production process group.

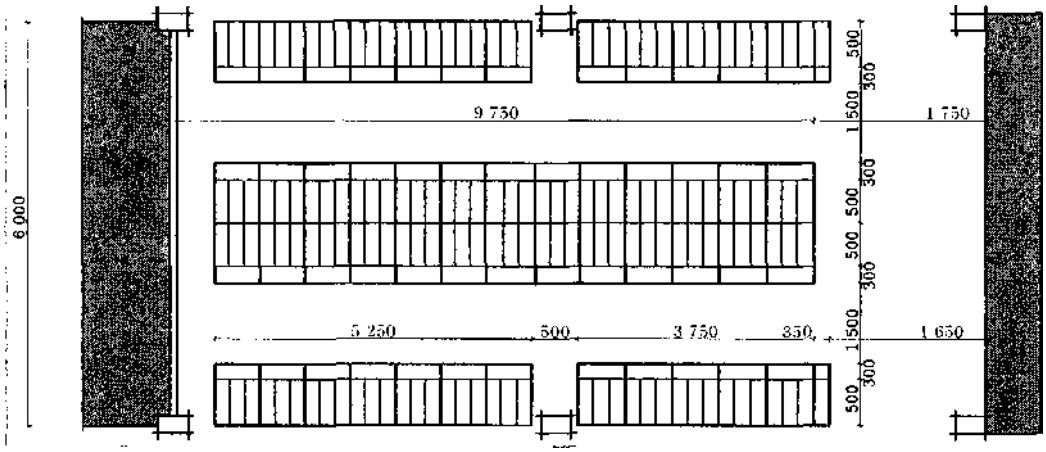


Fig. 23

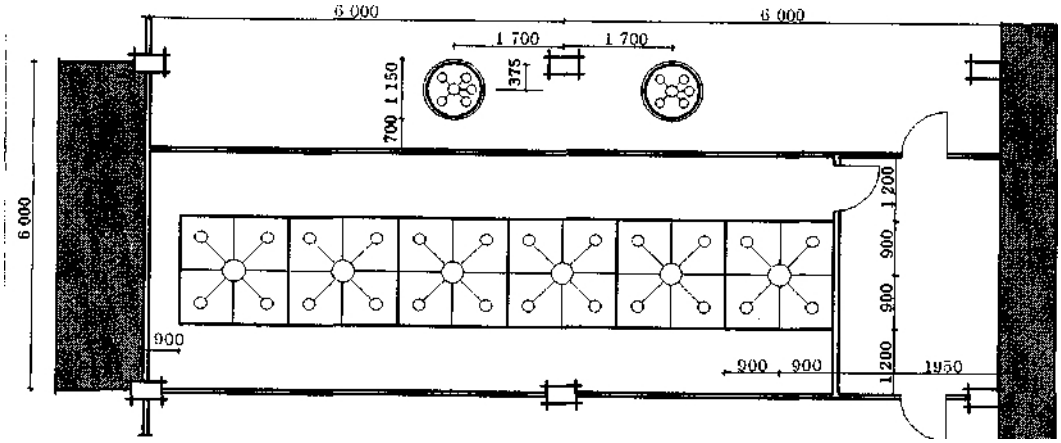


Fig. 24

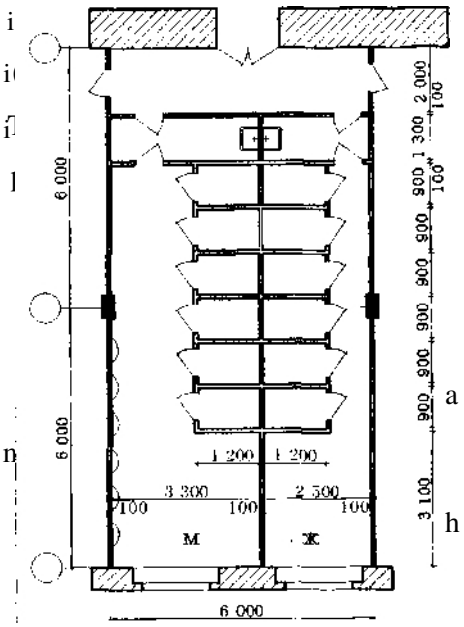
Washrooms shall be located at a distance not exceeding 100 m from the most remote workplace; in multi-storey buildings, they should be arranged on each floor for men and women.

The restrooms are equipped with ceramic floor bowls or toilets. Floor bowls and toilets are placed in separate cubicles. Cabins should be separated by partitions not reaching

0.2 m to the floor, not less than 1.75 m high. The size of the cabin in the axes of partitions is

1.2 x 0.9 m (Fig. *25. The* width of the passage between

the rows of restroom stalls and the opposite wall
or partition of the room is at least 1.3 meters.
When urinals are located against the cubicles,
the aisle width should be increased by 0.7 m.
The width of the passage between two fronts
of cubicles should be at least 1.5 m.
An important condition for the organization of the cloakroom-shower block
is the choice of the most appropriate mutual system. the most expedient system of mutual arrangement of dressing rooms for working
and household clothes and showers



Let's analyze the different layouts of the wardrobe-shower unit used in practice. In production processes of the first group, when all clothes are allowed to be stored in one common room, usually scheme 1 is used (Fig. 26). In this case, dressing rooms for home and work clothes are located parallel to the shower room with a passage between them.

The layout has a significant disadvantage in terms of meeting and overlapping "clean" and "dirty" human flows, and difficulty in redesigning when changing the ratio of men and women. A significant disadvantage of the layout is that the "clean" and "dirty" flows of people meet and intersect, and it is difficult to redesign the layout if the ratio of men and women changes.

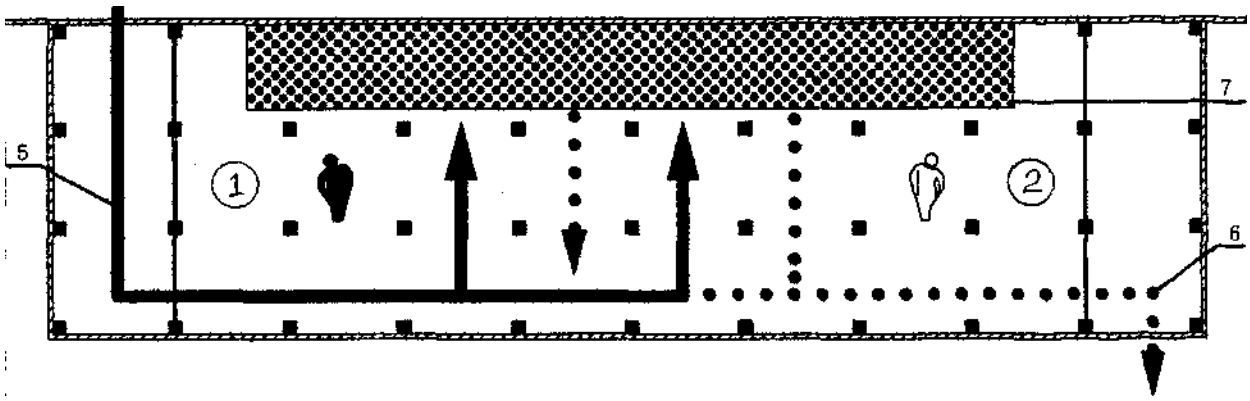


Figure 26.

When work clothes closets and outdoor and home clothes closets need to be located in separate rooms, the shower room is most often located between them. This is the basis for scheme 2 (Fig. 27).

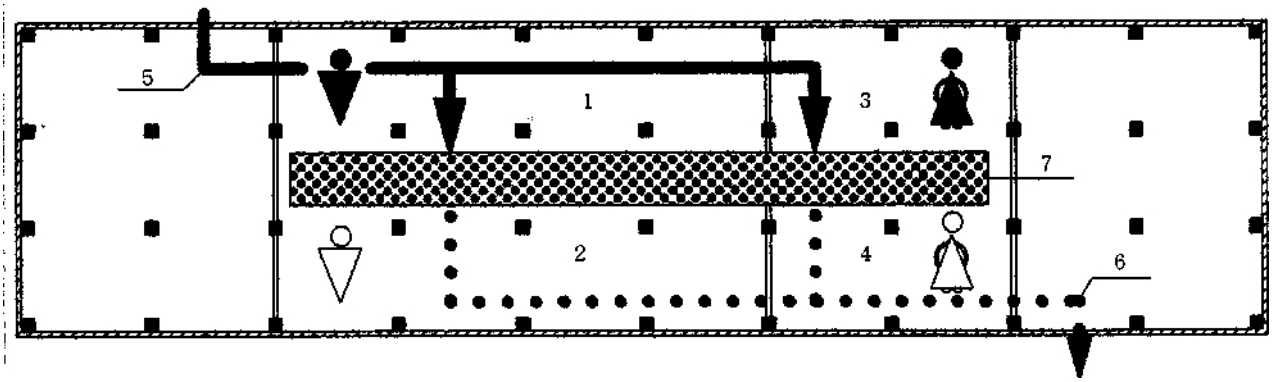


Fig. 27

Scheme 2 provides a clear organization of the movement of workers, provides for the location of dressing rooms for work and home clothes in the outermost well-lit aisles, and showers - in the central part of the building.

- men's workwear closet
- men's dressing room for outerwear and home clothes
- ladies' workwear closet
- women's dressing room for outerwear and home clothes
- "dirty" human flows
- "clean" human flows
- shower room

7. Composition and areas of the garage premises

№	Name of premises	Area, m^2

checkpoint

1	Control room	30
2	Room for issuing and receiving travel documents	30
3	Room for drivers on duty	40

Total 100

Daily service area (DSA)

4	Accumulator	200
5	Conveyor washing area	140
6	Gantry washing area	60
7	Operator's room	10
8	Technical rooms	60
9	Ventilation chamber	12
10	Pump room	12
11	Compressor room	24

Maintenance area (TOl, TO2) Total 518

12	3 diagnostic stations	150
13	5 stations for maintenance-1 and maintenance-2	250
14	Electrical Department	20
15	Fuel Equipment Department	30
16	Battery	60
17	Lubricant warehouse	30
18	tire fitting department	50
19	Rubber warehouse	40
20	Spare parts and aggregates warehouse	70
21	Pump room	20
22	Compressor room	30
23	Ventilation chamber	20
24	Electrical room	20

25	Parking lot	By calculation

Auxiliary premises

26	Dressing rooms: men's women's	90
		90
27	Showers	36
28	Toilets	36
29	Administrative offices	120
30	Nurses' station	60
31	Buffet with utility rooms	90

Notes: depending on the type of garage, provide for the placement of parking ventilation equipment.

The above garage floor areas may be changed within 10%.

Height of auxiliary rooms > 3.3 m.

8.Technical and economic indicators

Site area Building area

Building area, including area for each floor Construction volume of the building total

9.Project composition

1. General plan M 1:1000
2. Facades M 1:200
3. Floor plans M 1:200, 400
4. Sections (longitudinal and transverse) M :200
5. Perspective images
6. Technical and economic indicators

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PARKING GARAGE FOR 250 CARS

Educational-Methodological Manual
on the Performance of the course project

for Students in the direction of training 07.03.01 «Architecture»,
Profile «Architecture»

FOR INTERNATIONAL STUDENTS IN ENGLISH

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