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Design, Estimation, Costing and Valuation of Multilevel Parking System

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ABSTRACT:

The increase in private vehicle ownership, fast urbanisation, and poor parking infrastructure have made parking a major urban issue in Indian cities. The design and assessment of a multilevel parking system near the Dhule Bus Stand in Maharashtra is how this study tackles the problem. To evaluate current conditions, such as parking demand, illegal on-street parking, and traffic congestion, a site reconnaissance survey and a thorough parking volume study were carried out. To guide the planning process, important performance indicators like parking accumulation, turnover, and index were computed. Structural modelling for reinforced concrete components was done during the design phase using STAAD Pro. The Maharashtra Public Works Department then conducted a comprehensive estimation and costing process based on the Standard Schedule of Rates (SSR 2022–23). It was determined that the project would cost ₹4.96 crores in total. Taking into account fair market rates, a subsequent valuation of the land and built infrastructure calculated the total property value to be ₹11.58 crores. Benefit-cost analysis and parking revenue were used to evaluate economic viability. The average daily revenue from parking was ₹8,858 per week, which translates to an annual income of about ₹4.74 lakhs. The results lend credence to multilevel parking systems' viability and sustainability as a long-term fix for urban parking issues. The study emphasises how important data-driven planning and infrastructure development are to reducing urban traffic and improving mobility in high-density areas.

Key words: Estimation, Quantity, Parking, Costing

1. INTRODUCTION:

In India, the fast rise in private vehicle ownership, increasing urbanization, and the lack of regulated parking space development have made parking a major urban infrastructure challenge. Due to inadequate infrastructure and regulation, illegal and negligent parking has become widespread in Indian cities, increasing traffic congestion and safety issues, especially for pedestrians. (Vantagudia, Rishabh, et al). Unregulated planning methods and lax regulatory frameworks are the main causes of the increasing strain on parking infrastructure in both large and small cities, leading to chaotic and dangerous parking behaviours. (Trushko, O. V. et al).

Given the growing number of vehicles in Indian cities and the scarcity of available space, effective parking design has become crucial to resolving these urban issues. On already congested streets, poorly managed on-street parking frequently leads to major inefficiencies and unused road capacity, which exacerbates traffic. (Plasencia-Lozano & Méndez-Manjón, 2023). These problems especially affect parking for two-wheelers. Even though two-wheelers make up a significant amount of urban transportation, they are frequently disregarded in city design, which results in a lack of adequate and badly maintained parking spaces that cause chaos, worsen roadside encroachment, and jeopardize pedestrian safety. (M. M. Charde et. al.).

In commercial and high-density residential neighbourhoods, where demand for parking greatly outpaces supply, the situation is even more dire. These land restrictions can be addressed by multilevel parking structures. These solutions reduce the demand for roadside parking and search-time congestion by increasing vehicle capacity without increasing the physical footprint by stacking parking spaces vertically. Furthermore, multilevel systems reduce car emissions brought on by extended traffic circles looking for parking spots while promoting more efficient traffic flow in crowded areas like business districts and transportation hubs.(Reuben Jacob Chacko et al.).

Parking is an essential part of urban planning and mobility management, not only a practical issue. Beyond just causing traffic jams, inadequate parking infrastructure has an impact on road safety, air quality, and general urban operation. Research shows that common sidewalk encroachment due to a lack of defined parking spots puts vulnerable road users, such as children and the elderly, in danger and increases user conflict on shared road spaces (Kirschner, F. 2021). Due to restricted accessibility and frequent road closures, the lack of structured parking in business areas, where heavy traffic volumes are common, exacerbates congestion and hinders economic activity. (Mayyada A. Kattanh et al. 2023).

Parking system efficiency and environmental sustainability are related. Lack of parking forces drivers to circle or idle for longer periods of time in an effort to find empty spots, which increases emissions and wastes fuel. Unplanned parking patterns worsen the environmental effects of urban transportation, which is why this topic has drawn attention in discussions on mitigating climate change.(Can Biyik et al. 2021).

Furthermore, as parking is a prerequisite for the majority of transit trips, parking has an impact on the everyday routines of urban living. Therefore, a well-functioning parking system is essential for both the general economic and social well-being of cities as well as for the comfort of individuals. Cities need innovative approaches to solve the supply and demand imbalance as a result of the growing need for parking, particularly in high-density regions. The intricacy of urban parking management has led academics and planners to assess the ways in which site-specific characteristics, user behaviour, and price policies influence parking preferences and usage trends. (Dr. Manisha Lande et al. 2020).

Multilevel parking systems are being investigated as a long-term solution to urban parking problems in light of these realities. To guarantee scalable and effective designs, these systems can be planned using empirical traffic data, user movement analytics, and demand predictions. Such data-driven parking solutions must be incorporated into city development plans as India continues to industrialize and urbanize in order to guarantee sustainable urban growth and enhanced mobility.

2. METHODOLOGY:

2.1 SITE RECONSSAINCE SURVEY

A site reconnaissance survey is essential to comprehending the nature of the place. To assess the viability, a reconnaissance survey is carried out, and parking facilities are developed on the property. It is the initial stage of parking infrastructure planning and aids in identifying important problems and openings prior to more thorough research. Near the Dhule bus stop in Dhule city, a reconnaissance study is conducted. Along with other pertinent site-related issues including unlawful parking, on-street parking, clogged traffic, etc., car accumulation and accessibility were also discovered. The site's parking demand and its effects on neighbourhood traffic congestion and circulation patterns are determined by this survey.

2.2 PARKING VOLUME STUDY:

The number of parking spots needed to satisfy the demand for parking in a particular area or institution is ascertained via a parking volume study. This study helps determine the parking demands of a certain region by looking at the number and kind of cars that visit a site, how long they stay there, and the times of day when parking demand is highest. The results of the survey provide developers, architects, and urban planners with crucial information for designing parking facilities that meet the demands of the community.

Parking volume studies allow us to obtain precise data for multilevel parking system planning based on a number of parameters, including vehicle type, vehicle load, vehicle dimension, etc. The Dhule bus station, which is located in Dhule city, is the site of a parking volume survey. The terms listed below are associated with parking volume studies:

- Parking accumulation: The quantity of cars parked at a specific moment in time is known as parking accumulation. This is typically represented by an accumulation curve. Plotting the number of bays occupied against time yields a graph known as the accumulation curve
- Parking volume: The total number of cars parked for a specific amount of time is known as the parking volume. Vehicle repetition is not taken into consideration here. It is noted how many cars really entered the region
- Parking load: The area under the accumulation curve is provided by parking load. Another way to get it is to just increase the number of cars using the parking lot at each time interval by the period itself. It is stated as a vehicle. Three hours
- Average parking duration: It is the ratio of the number of parked cars to the total number of vehicle hours is known as Average parking duration

$$\text{Parking duration:} \quad \frac{\text{parking load}}{\text{Parking volume}}$$

- Parking turnover: It is the proportion of cars parked in a certain amount of time to the total number of parking spaces. This can be stated as the quantity of cars in each bay during a given period of time.

$$\text{Parking turnover:} \quad \frac{\text{parking volume}}{\text{Number of bays available}}$$

- Parking index: Another name for the parking index is occupancy or efficiency. It is defined as the proportion of available space to the number of bays occupied in a certain period of time. It provides a total indicator of how well the parking space is being used. The parking index is available as follows:

$$\text{Parking index:} \quad \frac{\text{parking load}}{\text{Parking capacity}} \times 100$$

2.3 DESIGNING:

In order to support loads and withstand different stresses, a structural plan utilizing steel reinforcement and concrete is created while designing an R. C. C. structure. To guarantee structural stability, safety, and durability, it includes structural analysis, individual element design, and reinforcement detailing

The multileveled parking system's R. C. C. structural plan is created during the design process using Stadd-pro software. Concrete design, slab design, footing design, beam structural design, column structural design, etc. are all completed in Stadd-pro.

2.4 ESTIMATION:

The process of estimating the approximate cost and amount of labour, materials, and resources needed for a building project is known as estimation. Calculating the number of materials, etc., is how a multilevel parking building is estimated. Quantity estimation is one of the most crucial steps in the estimation process. It involves calculating the exact quantities of foundation materials, bricks, concrete, steel reinforcement, and finishing touches, among other building supplies. These figures are computed using common thumb rules and exact measurement methods.

Rate analysis is another crucial part of estimation. It involves calculating the cost per unit of each labour and material component. This method includes examining labour pay, material costs, transportation costs, and overhead charges. Finding the most cost-effective alternative among multiple cost options is made easier with the help of an accurate rate analysis. Overheads and contingencies must be included in the estimate to cover additional expenses beyond the direct cost of construction. Overheads include things like administrative costs, project management fees, and supervision fees.

2.5 COSTING:

The act of assigning a monetary value to each project component in order to determine the project's total cost is known as costing. It helps with cost-effectiveness, financial planning, and expense control. During the costing process, a variety of factors are considered, including staff, materials, machinery, and other overheads, which ultimately decide the project's final budget.

Multilevel parking is priced according to quantity, and the standard schedule rate of the Maharashtra public works department is used to quote the fee. This SSR was released in 2022–2023. SSR includes the item's description, the material rate per unit (without CGST and SGST), and the total labour rate (without CGST and SGST). Following the computation of all amounts, IS 1200 is followed to account for a specific percentage for overhead, contingencies, sanitary expenses, water supply charges, etc. The project's overall cost is determined by summing the costs of labour, materials, and overhead. The multilevel parking building will cost Rs. 4,96,37,702 in total.

2.6 VALUATION:

Valuation is the process of determining the current or future worth of a property or infrastructure by taking into account factors including construction cost, depreciation, market trends, and revenue potential. The Multilevel Parking System project's actual value can be ascertained with the help of valuation, which examines construction costs, depreciation, and potential parking charge revenue. It ensures financial viability by assessing the return on investment (ROI) and guiding decisions on the facility's expansion, sale, or leasing. Accurate evaluation also makes insurance coverage, taxation, and loan approvals easier, which guarantees the project's long-term financial sustainability. It supports loan approvals, resale value estimation, investment decisions, and project profitability analysis.

3. RESULT AND DISCUSSION:

3.1: ABSTRACT SHEET

Table 1: Abstract Sheet

Item no	Description/particulars	SSR item no	Qty	Completed rate	Labour rate	Total amount
1	Site Clearance	….	1225 Sq.	…..	20	24500
2	Soiling	21.39	21.23 Cu. m.	2160	120	48404.4
3	Excavation from ground level	21.08	662.116	284	159	293317.388

			Cu. m			
4	PCC in Foundation	24.15	53.075 Cu. m.	6721	1778	451084.425
5	Soil filling up to plinth level	21.39	505.992 Cu. m.	2160	120	1153661.76
6	RCC in foundation	25.15	75.08 Cu. m.	7471	2110	719341.48
7	CC in column	25.33	148.24 Cu. m.	13967	5252	2849024.56
8	RCC in beam	25.52	133.76 Cu. m.	12452	5085	2345749.12
9	RCC in slab	26.6	319.05675 Cu. m.	15277	7149	7155166.676
10	Autoclaved aerated concrete block	27.15	347.6505 Cu. m.	7340	2080	3274867.71
11	RCC in lintel	25.52	0.98325 Cu. m.	12452	5085	24486.858
12	Plastering	32.11	7509.82933 Sq. m.	639	412	7892830.626
13	RCC in staircase	26.26	14.2871 Cu. m.	12244	5219	249495.6273
14	RCC in Ramp	26.26	63.6 Cu. m.	12244	5219	1110646.8
15	Concreting in parking driveways	26.26	3 Cu. m.	12244	5219	52389
16	colouring	36.21	7478.76937 Sq. m.	275	136	3073774.21
17	Flooring (ceramic tile)	33.24	504.03 Sq. m.	1182	355	774694.11
18	Flooring (cement concrete)	33.14	1874.975 Cu. m.	568	308	1642478.1
19	Aluminium windows shutter	…..	93 Sq. m.	700	…..	65,100
20	D. P. C. at plinth beam	31.01	1091.11 Sq. m.	432	98	578288.3
21	Railing for staircase	40.08	28.5 Rmt.	3545	476	114598.5
22	RAILING FOR RAMP	40.08	51.5	3545	476	207081.5

			Rmt			
23	SLIDING WINDOW	…...	21.6 Sq. m.	8152	…...	176083.2
24	FIRE EXTINGUISHER	…...	20 No.	1500	…...	30000
25	GI ROOF	38.53	530.585 Sq. m.	3371	399	2000305.45
26	LIFT	…...	2 No.	700,000	…...	1,400,000
27	STEEL	…...	51.623 tonne	45000	…...	2,323,035
TOTAL(in Rs.)						40,005,905
• WATER SUPPLY AND SANITATION CHARGES (8% OF TOTAL)						3200472.384
• ELECTRIFICATION CHARGES (8% OF TOTAL)						3200472.4
• CONTINGENCIES (3 % OF TOTAL)						1200177.15
• ANOTHER SERVIES (5% OF TOTAL)						2000295.25
GRAND TOTAL (IN RS.)						4,96,37,702

3.2: VALUATION:

Table 2: Valuation of land

Part A: Valuation of land			
Sr. No.	Particulars	Govt. Circle/ Guideline Value	Prospective Fair Market Value
1	Prevailing Market Raterange	3500 per Sq. ft.	4500 per Sq. ft.
2	Rate adopted considering all characteristics of the property	3500 per Sq. ft.	5000 per Sq. ft.
3	Total Land Area considered (documents vs site survey whichever is less)	13185.79 Sq. ft.	13185.79 Sq. ft.
4	Total Value of land (A) (In Rs.)	4,61,50,265	6,59,28,950

Table 3: Valuation of constructed building

Part B: Valuation of building construction			
Particulars		Govt. Circle/ Guideline Value	Depreciated Replacement Value
Structure Construction Value	Rate range	91000/- (per Sq. m)	90000-92000/- (per Sq. m.)
	Rate adopted	91000/- (per Sq. m)	91500/- (per Sq. m)
	Covered Area	545.555 Sq. m	545.555 Sq. m
	Valuation Calculation (in Rs.)	4,96,45,505/-	4,99,18,282/-
	Total Value (in Rs.)	4,96,45,505/-	4,99,18,282/-
Depreciation percentage (assuming salvage value % per year)		NA	NA

Table 4: Consolidated value

Part 4: Consolidated value			
	Particulars	Govt. Circle/ Guideline Value	Prospective Fair Market Value
1)	Land (A)	4,61,50,265/-	6,59,28,950/-
2)	Constructed building (B)	4,96,45,505/-	4,99,18,282/-
3)	Total Add (A+B)	9,57,95,770/-	11,58,47,232/-
4)	Rounded Off	9,58,00,000/-	11,58,50,000/-

3.3: PARKING TURNOVER AND REVENUE FOR A TYPICAL WEEK

Table 5: Parking turnover and revenue for a typical week

Days	Turnover	Revenue (In Rs.)
Monday	361	10830
Tuesday	272	8160
Wednesday	249	7470
Thursday	310	9300
Friday	225	6750
Saturday	311	9330
Sunday	339	10170
Average (per day)	295	8858

3.4: ECONOMIC VIABILITY

- Economic viability for the new proposal is calculated using benefit cost ratio. Including rent revenue.
- Total revenue return expected in 10 years and 6 months

Table 6: Economic Viability

Duration	Turnover	Revenue (in Rs.)
1 month	8850	395000
1 year	106200	474000

4. CONCLUSION:

Innovative, data-driven solutions are needed to address the growing problem of unregulated and subpar parking infrastructure in Indian cities in order to promote sustainable urban growth. Through the planning, design, and economic analysis of a multilevel parking system close to the Dhule Bus Stand, this study aimed to address the severe parking issues in Dhule city. Critical factors affecting parking demand and behaviour were found by means of a thorough parking volume study and site reconnaissance. In addition to highlighting inefficiencies in the current system and providing empirical data for infrastructure planning, the study was successful in quantifying the parking need. To maximise space utilisation and accommodate high vehicle turnover, a reinforced concrete multilevel parking structure was designed using structural modelling tools like STAAD Pro. While valuation showed significant asset appreciation over time, accurate estimation and costing based on standard rates guaranteed financial transparency. The economic analysis, which included benefit-cost ratio computations and weekly revenue assessment, validated the proposed system's financial feasibility and predicted a sizable return on investment over the following ten years.All things considered, the project emphasises how crucial it is to combine engineering, planning, and economic analysis when developing urban infrastructure. When placed and planned according to local needs, multilevel parking structures not only reduce traffic but also enhance pedestrian safety, environmental sustainability, and traffic flow. This study supports the implementation of multilevel parking as a progressive urban mobility solution and offers a replicable framework for other Indian cities dealing with comparable parking issues.

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