

STUDY OF GRADE SEPERATED PEDESTRIAN CROSSING FACILITIES: A CASE STUDY OF PUNE MUNICIPAL CORPORATION

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Abstract - Grade separated pedestrian facilities are expensive infrastructure alternative over at-grade crossing, for the safety and convenience of pedestrians, but often they are not used. The study aims at finding parameters that could improve usability of such infrastructure. The study involves an assessment of existing grade separated pedestrian facilities considering parameters of engineering feasibility, safety, location, aesthetics to say a few. The objective of study is to assess existing grade separated crossing facility. The study area selected is Pune city.

Key Words: Grade Separated Pedestrian Crossing Facilities, Foot over Bridges, Foot under Bridge, Indian Road Congress, Unified Traffic and Transportation Infrastructure Centre

1. INTRODUCTION

1.1 Background

Pune has evolved gradually and dangerously into a state of traffic chaos. Along with the increasing volume of traffic in Pune rises the conflict between various road users. Pedestrians, the most vulnerable road users in this process need more importance. Grade separated pedestrian facilities (GSPF) serve many users, including bicyclists, walkers, joggers and pedestrians with wheelchair users etc. These facilities can signify one of the most important elements of a community's non-motorized transportation network. GSPF provide critical links in the bicycle/pedestrian system by joining areas separated by a variety of barriers. GSPF might also be suitable in locations where large numbers of schoolchildren cross busy roads, or where high volumes of seniors or mobility-impaired users need to cross a major roadway.

1.2 Study Area Profile

Pune, ranked as the seventh largest city in India and second largest city in Maharashtra after Mumbai. Pune Municipal Corporation (PMC) jurisdiction extends up to an area of 243.84 sq. km. housing 2.54 million populace within 144 wards. Pune as a rapidly growing contemporary industrial center after independence, and today identified as a growing metropolis. Pune, also known as an "Oxford of India", houses 6 Universities with about 600 efficient higher education centers providing to an estimated 5 lakh student population. PMC has a population of 3 million (census 2011) Migration has increased from 3.7 Lakhs in 2001 to 6.6 Lakhs in 2011.

The population density has increased from 10405.28 person per Sq.km in 2001 to 12,770.25 person per Sq.km. Population density especially in the core areas are very high. With increase in traffic and urbanization, the risk of pedestrians crossing at grade has increased tremendously. To reduce the fatalities caused by conflict between pedestrians crossing at grade and vehicles, GSPF have been provided in Pune. (Wilbur Smith, 2008)

1.3 Earlier Planning Efforts in Pune

➤ **Town Planning Schemes:** Immediately after the introduction of the Bombay Town Planning Act of 1915, the then Poona City Municipality took steps to control the development of the growing town on the west and the north of the City by undertaking a Town Planning Schemes. T.P.S.No.1. Bhamburda, which finalized in the year 1931. It had followed by three more schemes, viz. Town Planning Scheme No. III of Parvati and Gultekdi, Town Planning Scheme No. II of Somwar-Mangalwar Peth and T.P.S. Sangamwadi which was lately undertaken by P.M.C. Prior to the merger of suburban Municipality in PMC, the then suburban Municipality undertook T.P.S. Pune suburban No.1 which was finalized in 1930. These Schemes included most of the remaining areas on the southern and eastern parts of the City, which were open. In addition to these Town Planning Schemes, subsequently 2 T.P.S. mainly for industrial development were taken in the eastern part of the city viz. in Hadapsar area.

➤ Other planning schemes undertaken and developed by PMC In addition to all the TPS

- 1) Scheme of Tilak road running from Swargate to Lakdi Bridge (Sambhaji Bridge)
- 2) Scheme of Laxmi road running from Lakdi Bridge to Quarter Gate through the heart of the town. This was an east-west road.
- 3) Ganesh Road Scheme, which joined the Jijamata Baug to the Phadke Howd.
- 4) Phule Market Road from Phule Market to the Govind Halwai Chowk.
- 5) Bajirao Road from Parvati Naka to Vishrambaug Wada.
- 6) Mankeshwar Road from Ram baug to Omkareshwar.
- 7) In addition, the PMC also undertook work of shifting of Timber market from Gultekadi to presently located timber market in Bhavani Peth. This is an ambitious scheme implemented in the outer area. The present timber market is

an area planned for building material business. The Pune Municipality had thus not only controlled the development of the out-laying open areas but also provided new avenues for traffic and development in the city. This development had proceeded on the systematic lines of urban development. The old city of Pune was however very congested and despite the developments of new roads and road widening schemes, it was realized that the town proper could not be improved to the standards laid down in the Town Planning norms or to those standards which were followed in the schemes of Town Planning which were in hand at that time. The Municipality had prescribed regular lines of streets for practically all the roads in old city. This partially regulated the construction of buildings.

2. LITERATURE STUDY

2.1 Terminology

As per the **IRC: SP: 90-2010** basic concepts regarding the GSPF are explained as below,

- **Grade Separator:** Grade separator is a form of intersection in which one or more conflicting movements on intersecting ground transport facility such as road, rail, pedestrian way or cycle path is segregated in space. Flyover, Railway over bridges, under bridges, subways and under passes both for vehicular and pedestrian traffic are all grade separators. (IRC: SP: 90-2010, 2010)
- **Bridge:** It is a structure for carrying the road traffic or other moving loads over a depression or obstacle such as channel, river, road or railway. (IRC: SP: 90-2010, 2010)
- **Foot Over Bridge:** The foot over bridge is a bridge exclusively used for carrying pedestrians, cycles and animals. (IRC: SP: 90-2010, 2010)
- **Under Pass, Subway:** Underpass is a structure allowing movement of traffic beneath a roadway. An underpass is sub classified as cattle underpass, pedestrian underpass and vehicular underpass depending on the principal user. Subway is usually for pedestrian crossing below roadway. (IRC: SP: 90-2010, 2010)
- **Clearance:** Clearance is the minimum vertical or horizontal distance between boundaries at a specified position of a bridge structure/grade separator available for passage of vehicles. (IRC: SP: 90-2010, 2010)
- **Lateral Clearance:** Lateral clearance is the distance between the extreme edges of the carriageway to the face of the nearest support whether it is a solid abutment, pier or column. (IRC: SP: 90-2010, 2010)

- **Vertical Clearance:** Vertical clearance stands for the height above the highest point of the traveled way, i.e., the carriageway and part of the shoulders meant for vehicular use, to the lowest point of the overhead structure. (IRC: SP: 90-2010, 2010)

2.2 Literature Review

GSPF dedicated to the safety of the pedestrians, are highly expensive. Hence without need assessment and fulfillment of conditions of safety, convenience and universal accessibility it might not serve the purpose for what they are constructed. Modern cities provide pedestrian friendly streets in which walking is a transportation choice for efficient and healthy social and economic urban interaction. Modern cities provide pedestrian friendly streets in which walking is a meaningful transportation choice for efficient and healthy social and economic urban interaction (Pedestrian Policy of Calgary). Nowadays the principle of "human-oriented" has been implemented in the transportation planning, but the implementation is always opposite. The phenomenon of "car-oriented" is becoming seriously. As an important part of urban traffic, pedestrian traffic cannot be ignored equally (Juan Lia, 2013) Directorate of Urban Land Transport of Government of Karnataka suggests Accessibility of Subways and Foot-Over-Bridges can be improvised considering parameters such as FUB and FOBs should have elevators in addition to stairs. Elevators are essential at all grade-separated pedestrian crossings for mobility of disabled on wheel chair. Escalators may be provided along with stairs to increase comfort, but it cannot be a replacement to elevators, as escalators cannot safely accommodate pedestrians on wheel chair. Elevators should have enough space to accommodate at least one wheel chair and a pedestrian to stand. Opening to subways and FOBs should have sufficient width at least to allow two people to comfortably cross each other. (Guidelines for planning & implementation of Pedestrian infrastructure, 2014). The design specifications in WISDOT publications serve as mandatory standards for Pedestrian/bicycle facilities on State highways, serve as guidelines for local communities. It explains the in which pedestrian facilities should designed (The Washington State Department of Transportation's Design Manual, 2006) New Jersey Bicycle and Pedestrian Resource Center in their report „Bicycle and Pedestrian Safety Needs at Grade-Separated Interchanges" Summarizes common challenges to pedestrian and bicycle mobility through grade-separated interchanges and to document best practices. (New Jersey Department of Transportation, 2008)

Author Rory Renfro in his report „ Pedestrian/Bicycle Overcrossings: Lessons Learned" examines location, design and other parameters of pedestrian/bicycle overcrossings, based on detailed field assessments of 29 diverse bridges in terms of age, length, access provisions etc. „Case Study of Pedestrian Risk Behavior and Survival Analysis" is a research paper by authors Udit Gupta, Niladri Chatterjee. Geetam Tiwari, Joseph Fazio. This is a study of Signal-free, grade-

separated intersections in Delhi that have often replaced signalized intersections. The study evaluates the impact of signal free intersections on pedestrians (Udit Gupta, 2009) Parisar is an NGO in Pune which had extensively worked on the Pune's GSPF and have framed a report, Searching High and Low: Study of Pune's Pedestrian Crossing Facilities. This report presents the results of a survey of pedestrians using Foot Overbridges (FOB) and Foot Underbridges (FUB), as well as the findings of a usability analysis of these facilities in Pune. This study was triggered by the controversy surrounding the construction of the FUB at Goodluck chowk in Deccan Gymkhana area in late 2009 (Parisar NGO, 2010) Guidelines for planning & implementation of Pedestrian infrastructure have been prepared by the Directorate of Urban Land Transport (Karnataka Gov.) These guidelines are targeted for use by all local bodies and municipalities in Karnataka dealing with pedestrian or roadway infrastructure. (Guidelines for planning & implementation of Pedestrian infrastructure, 2014)

3. LOCATIONS SELECTED FOR STUDY

Selection of GSPF for study has been carried out based on initial pilot surveys. The radius of 10 km from the city center has been decided for the study area. The nonfunctioning GSPF and those on railway tracks were eliminated later from study since the study objective was to study pedestrians and road safety.

- **Location 1: Shaniwar Wada**

This study location is situated in the core area where both the density and the traffic volume is high. The bridge on the mula river connecting shivajinagar to swargate is further extended till shaniwar wada and below this bridge the underpass is provided. This GSPF location contains residential, commercial and public semi public facilities for which pedestrians have to travel from one end of the FUB to other, hence this infrastructure serves the entire vicinity. This GSPF have government offices under bridge which supports the concept of „eyes on the streets“. The basic criteria of the construction are fulfilled only the antisocial activities taking place in the night are major concern. The location of the FUB is most suitable to facilitate pedestrians visiting Shaniwar Wada.

- **Location 2: Railway Station**

Railway station FUB is provided under the humped junction. This is the most used GSPF in the Pune. The excessive usage of the junction is due to the availability of railway station, bus depot and the S.T. Stand. This junction is constructed with consideration of the regulations given by the central public development department. The shops provided under the bridge ensures safety of pedestrians. Machinery for the water

evacuation and the ventilation system adds to the value of the infrastructure. The FUB has many CCTV cameras, which patrol the whole GSPF round the clock.

- **Location 3: Kirloskar Company, Karvenagar**

This GSPF are meant to assure safety of the pedestrians. This FOB is built considering the CPWD guidelines. It is made of the rust proof material and can be reassembled and be shifted in future. This FOB is not used because of unavailability of the mid-block obstacles and easily accessible infrastructure. The surrounding area and density of the vicinity are major reasons for its usage

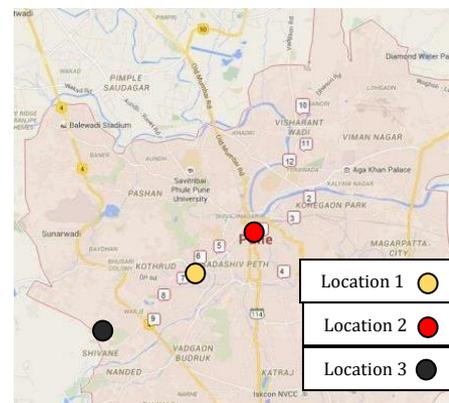


Fig -1: Location of Selected GSPF

4. SURVEY FINDINGS

4.1 Possibility of at-grade crossing:

The first and obvious factor is the possibility of at-grade crossing. A high wall (as seen at karve Road) or a fence hinders people from crossing the street. To cross they have to use the given foot over-bridge. At that location, we could almost watch the same number of people crossing at-grade as those using the foot over-bridge.

4.2 Traffic Volume:

When the traffic allows, people tend to cross the street at-grade level, which is more convenient, but at the same time more dangerous. E.g., Traffic volume on Karve Road increased a lot during our observation. Initially, there were enough gaps to cross the road at-grade and many people were crossing at grade. However, later the traffic increased and hence crossing at-grade became difficult and people tended to use the over-bridge.



Fig -2: Comparison of Foot-over Bridge fulfilling design criteria, Karvenagar

4.3 The Humped Bridge:

Foot under-bridges under uplifted roads are more pedestrian friendly than foot over-bridge and this is also proven by the pedestrian survey. A heavily used foot under-bridge at Pune Station is contradictory to the abandoned, unwelcoming foot under-bridge at Shaniwar Wada. Furthermore, the location of the facility is decisive. On the contrary, the FOB bridging Gulmohar Path next to Karve Road is an example of a badly designed and located pedestrian structure. People on Karve Road who want to pass Gulmohar Path have first to turn onto Gulmohar Path and walk to the FOB located in front of SNDT College, before climbing about 80 steps in total only to cross a two-lane road. Because of that, inconvenience people preferred to cross at-grade as the counting showed us.



Fig -3: Comparison of usage of Foot-under Bridge at Shaniwar Wada and Railway Station

4.4 The maintenance of facility:

It is also is a crucial factor in determining whether a pedestrian facility continues to be used or not. Attributes that determine this include how well lit a FUB/FOB is, how cleanly it is maintained, how secure it is etc. Thus, Shaniwar wada FUB, which is not clean or secure, is not a preferred choice of the pedestrian.

4.5 The visibility of FOB/FUB:

The entry must be easily recognizable. This is particularly true of FUBs since they are underground. Visitors coming straight out of the main building at Pune railway station have

difficulty in finding the station subway. The pedestrian facility is hard to find and no sign indicates its existence. Much worse is the situation at Shaniwar wada subway.

5. SURVEY ANALYSIS

The survey has been carried out on locations namely Shaniwar wada, Railway station, Kirloskar company, karve nagar. The analysis consist of two parts namely General observations on site and personal interview.

5.1 Survey Part I- General Observations on site:

The above stated locations were assessed based on need criteria, usability, Quality and type of construction, aesthetics, location criteria, Ease of accessibility and engineering feasibility.

5.1.1 Need Criteria:

No foot over bridge on the selected locations is more than 80m. For road width between 30-80m, the strong desire line has to be within 100 m of the landing.

Table -1: Fulfillment of need criteria of GSPF In Pune

Location		Shaniwar wada	Railway station	Kirloskar company, karve nagar	
FOB /FUB		FUB	FUB	FOB	
Need Criteria	> 80m roads	A) FOB at mid-block			
		B) FOB at t junction			
	> 30 up to 80m roads without t BRT	A) Strong desire line exists within 150m of the landing of an		Yes	No
		B) Is at-grade not possible due to severe physical site constraints?	Yes		No
< 30m roads	FOB not permitted unless it's not possible due to severe physical				

5.1.2 Location criteria:

It includes clauses of pedestrian attractor, neighboring building entries, mid-block bus stop at the GSPF. From the

analysis, only 1 out of 3 locations have pedestrian attractors i.e. railway station FUB have building entries nearby.

Table -2: Fulfillment of location criteria of GSPF In Pune

Location		Shaniwar wada	Railway station	Kirloskar company, karve nagar
Location criteria	Pedestrian attractors with mid-block entries (shopping areas, schools, key civic areas, residential areas, etc.)	No	Yes	Yes
	Neighboring building entries and destinations etc.	No	Yes	No
	FOB should not be placed within 80 m of the nearest intersection. Is it??	No	No	No
	Mid-block Transit/bus stops.	No	No	No

5.1.3 Ease of accessibility:

For the infrastructure to be more usable the usability criteria is to be followed. Here the provision of barrier to stop at-grade pedestrian was important and observed very useful to promote usage of GSPF. In addition, it was observed that the provision of tactile paving, Elevators promote usage of infrastructure. The criterion of unobstructed pavement of min. 1.8m was followed by all locations excluding Shaniwar wada FUB.

Table -3: Fulfillment of Ease of accessibility criteria of GSPF In Pune

Location			Shaniwar wada	Railway station	Kirloskar company, karve nagar
Ease of Accessibility	Reaching the FOB	Encroachment free pavements leading to the FOB.	Yes	Yes	Yes
Universal accessibility		A) staircase + ramp	Yes	Yes	No
		b) staircase + elevator	No	No	Yes
		C) color contrast tiles	No	Yes	No

	D) tactile paving	No	Yes	No
	Is there an unobstructed pavement of min. 1.8m left clear	No	Yes	Yes
	Is there barriers to prevent pedestrians crossing at grade	Yes	Yes	Yes

5.1.4 Engineering feasibility:

These aspects determine whether the construction is as per prescribed criteria to serve designed population efficiently. The consideration of min width of staircase and walkway are mostly fulfilled on contrary elevator size criteria are least fulfilled. Also the slope considerations are fulfilled only in one GSPF. The criterion of vertical clearance is followed on all FOB locations.

Table -4: Fulfillment of engineering feasibility criteria of GSPF In Pune

Location		Shaniwar wada	Railway station	Kirloskar company, karve nagar
Engineering feasibility	Min width walkway pedestrians+cyclist : 3.50m	Yes (4m)	No	No
	Min width of FOB walkway pedestrians: 2.50 - 3.00m		Yes	Yes
	Min width of staircase: 2.5m	No	No	Yes
	Min slope of 8% (1 in 12) for ramps		Yes	No
	Vertical clearance of 5.5 m above roadways			Yes
	Pedestrian only elevator is 1.4 x 1.4 m	-	-	Yes
	Cycle+pedestrian elevators 1.4 x 2 m	-	-	No

5.1.5 Usability of GSPF:

To conclude pedestrians crossing at-grade and those using GSPF this ratio is important. With this figures it can be concluded that railway station is running efficiently. Also, Railway station's GSPF is widely used owing to the fulfillment of most of the design criteria. The at-grade crossing at Kirloskar Company are to be considered.

Table -5: Fulfillment of Usability criteria of GSPF In Pune

Location		Shaniwar wada	Railway station	Kirloskar company, karve nagar
All year round weather protection	Partial shelter at least along one edge of the bridge.	Yes	Yes	Yes
Lighting for safety and visibility	Lighting within subway/ FOB ?	No	Yes	Yes
	Adequate lighting at both access points?	Yes	Yes	Yes
Seating	Resting places at minimum two locations	Yes	No	No
Garbage disposal	Garbage bins adjacent to both access Points.	No	Yes	No
Machinery for	Water logging clearance	No	Yes	—
	Air vent/ central open court	Yes	Yes	
Watchmen		No	Yes	Yes
Way finding/information maps	Information on maps must be provided	No	Yes	No

5.1.6 Quality and type of Construction: To conclude pedestrians crossing at-grade and those using GSPF this ratio is important. With this figures it can be concluded that railway station is running efficiently. Also, Railway station’s GSPF is widely used owing to the fulfillment of most of the design criteria. The at-grade crossing at Kirloskar Company are to be considered.

Table -6: Fulfillment of Quality and type of Construction of GSPF In Pune

Location		Shaniwar wada	Railway station	Kirloskar company, karve nagar	
Quality and type of construction	Structural system	Structures which can be dismantled in future	No	No	Yes
		Light weight/ space Efficient structure	No	No	Yes
	Quality	Robust and vandalism- proof materials and fixtures?	Yes	Yes	Yes

5.1.7 Aesthetical Parameters:

To conclude pedestrians crossing at-grade and those using GSPF this ratio is important. With this figures it can be concluded that railway station is running efficiently. Also Railway station’s GSPF are widely used owing to the fulfillment of most of the design criteria. The at-grade crossing at Kirloskar Company are to be considered

Table -7: Fulfillment of Aesthetical criteria of GSPF In Pune

Location		Shaniwar wada	Railway station	Kirloskar company, karve nagar
Aesthetics	Advertisements distract drivers	No	No	No
	Adverse impact on surrounding aesthetics?	Low	Low	Low

5.2 Survey Part II- Personal Interview:

Interviewing infrastructure users was to obtain their perspective of usability of GSPF. To study the factors affecting usability the economic group, Age group, Frequency of usage, special physical considerations were considered. Further, the interrelation between these factors can be acknowledged. With person-to-person interview, we could conclude that people prefer the mode, which is relatively safe followed by convenience. About half the pedestrian would still like to cross at grade and then by foot over bridge the list preferred was foot under bridge. People’s choices also differ with age and disability.

5.2.1 Age Group:

The usability of any GSPF differs with age group of users. The usability will vary according to the age of user. Aged people and kids“ population would be uncomfortable with climbing excessive steps at FOB. So determination of age group was done in 4 groups viz. Kids (i.e. up to 10), Adults (i.e. 10-40), Aged (i.e. 40-60) and those Above 60. Number of steps in GSPF could restrict kids and aged pedestrians to access the GSPF

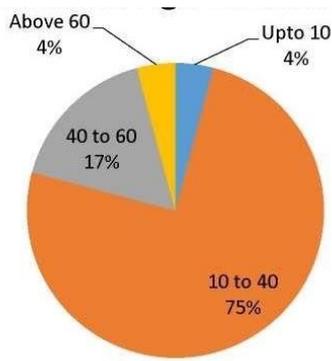


Chart -1: Pedestrian Age distribution

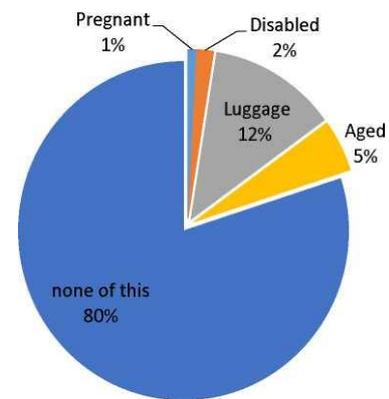


Chart -3: Pedestrian Special Character

5.2.2 Income Group:

Economic status of pedestrians was considered to find out relation between the usage of GSPF and economic condition of users. Economic condition of the pedestrians is also necessary to know before implementation of any design. The observation survey have showed that the facilities maintenance increases at GSPF surrounded by slums In the 120 samples collected during survey majority users were MIG followed by LIG users. Only few EWS and HIG users were observed. From the figures obtained in survey, it could be concluded that, measures to promote GSPF usage are to be more focused on EWS population.

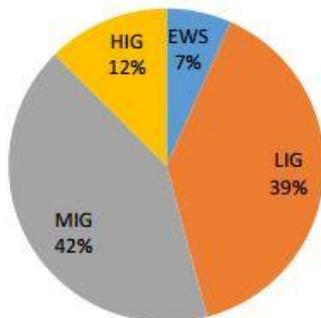


Chart -2: Pedestrian Income distribution

5.2.3 Special Character:

Four special characters were observed during survey namely pregnant women, disabled and aged and those other than this (which includes a person with no disability and restriction to use GSPF). This study has resulted into a conclusion that amongst Pune"s GSPF users most of the users (almost 80%) are without any disability or any obstacle to use the GSPF. Amongst the surveyed special character people with luggage were observed on large number, to cater these pedestrians with luggage to cross the road ease of accessibility criteria with proper importance on the provision of Lifts and ramps is to be given.

5.2.4 Mode Choice:

Amongst 120 samples taken at three different GSPF locations, pedestrians were asked which mode of transport they would shift to. The results have shown almost half of the pedestrians were going to shift to bus after getting off from the GSPF. This suggests that most of the GSPF are to be provided near to the transit stops to serve the purpose. The future GSPF should be constructed near the transit stops. Also, the 2 wheeler users are almost more than 37%, which means two wheeler parking provision is to be fulfilled near future GSPF.

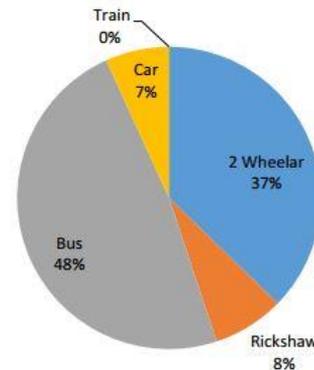


Chart -4: Mode of transport Pedestrians will Shift to

5.2.5 Pedestrians GSPF Preference reasons:

Pedestrians crossing behavior is dependent on the parameters like safety, cleanliness, convenience and time saving factors. The extent of the consideration of following criteria was surveyed and it states that safety is most considered parameter (47%) followed by convenience. The same parameters have been observed instrumental in making Railway station GSPF useful. The most preferred parameter was numbered as 1 and the least preferred as 4, Therefore the parameter with least weightage is most preferred parameter and vice versa.

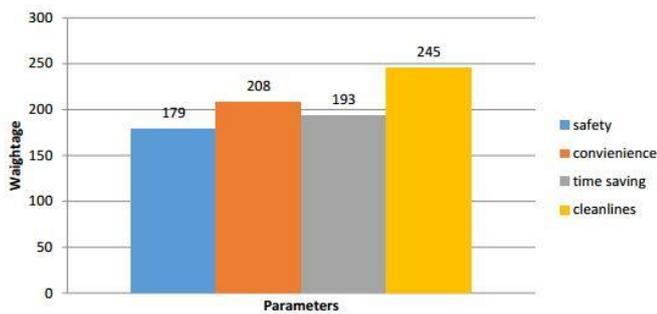


Chart -5: Pedestrians GSPF Preferences

5.2.6 Pedestrians GSPF Preference reasons:

The Pedestrian facilities preference of 120 pedestrians concludes that more than half of the pedestrian would prefer at-grade crossing followed by the FOB. This indicates after at-grade crossing pedestrians preferably opt for the FUB. This analysis states that pedestrian shall always prefer at grade crossing whenever possible and FUB more than FOB. However, the IRC codes for pedestrian facilities states that FUB are to be only provided if no FOB is not feasible at given location.

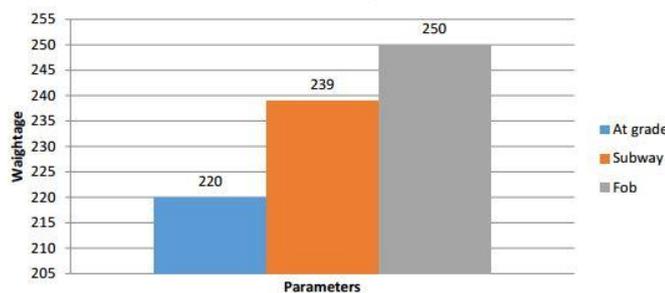


Chart -6: Pedestrians crossing Preferences

4. PROPOSALS

4.1 Location 1: Shaniwar Wada

This study location is located in the core area where both the density and the traffic volume is high. The bridge on the Mula River connecting shivajinagar to swargate is further extended until shaniwar wada and below this bridge, the underpass is provided. This GSPF location contains residential, commercial and public semipublic facilities for which pedestrians have to travel from one end of the FUB to other; hence, this infrastructure serves the entire vicinity. This GSPF have government offices under bridge, which supports the concept of “eyes on the streets”. The basic criteria of the construction is fulfilled only the antisocial activities taking place in the night are major concern. The location of the FUB is most suitable to facilitate pedestrians visiting Shaniwar Wada.

• SWOT Analysis

Strengths: Seating and resting place inside the foot under bridge improves usability. Offices overlooking the FUB upholds “eyes on street” concept.

Weakness: The entrance of the FUB is neither visible from the main road nor the signage is provided for the same. Less visibility of entrance decreases the users. The Darkness in the subway leads to the antisocial activities.

Opportunity: This subway can be connected to shaniwar wada for ease of pedestrian movement. The current propose served by the FUB is to allow pedestrians to cross the humped road in front of shaniwar wada if the present FUB is connected to the shaniwar wada premises there are probabilities that more pedestrians would use it.

Threats: Anti-social behavior of users is a threat for other users and the usage might be hampered, further reducing the number of the users and which might degrade the situations further.

• Proposals

Based on the analysis at the location and the pedestrians interviews following recommendations are to be considered for improvement of existing GSPF. Installation of adequate lighting fixtures as per the norms by UTTIPEC, it is suggested that the light fixtures produce at least the FOB. Lighting level on and around the FOB must be minimum 20 lux. Thus, the fixtures need to be provided. Providing Signage for more entrance visibility shall improve the usage. The signage as provided in the Pune Station FUB can be referred. The signage are shown in figures as below:



Fig -4: Signage at Pune Station

4.2 Location 2: Railway Station

Railway station FUB is provided under the humped junction. This is the most used GSPF in the Pune. The excessive usage of the junction is due to the availability of railway station, bus depot and the S.T. Stand. This junction is constructed with consideration of the the regulations given by the central public development department. The shops provided under the bridge ensures safety of pedestrians. Machinery for the water evacuation and the ventilation system adds to the value

of the infrastructure. The FUB has many CCTV cameras, which petrol the whole GSPF round the clock.

- **SWOT Analysis**

Strengths: This foot under bridge is located in the periphery of Railway station; also, it connects railway station to the PMT bus depot and the other side of the railway station, so it is continuously operational. The humped junction constrains the pedestrians to cross at grade and since it is a very safe junction with the provision of ramps and universal accessibility provisions.

Weakness: The water logging prevention system towards ST stand gate is not functional which leads to unhygienic conditions.

Opportunity: The GSPF is widely used which results in pedestrian conflicts. These conflicts can be reduced with proper utilization of the GSPF.

Threats: Excessive pedestrian might reduce the lifespan of the structure. The channelizing of the pedestrian could be a difficult task to manage.

- **Proposals**

Based on the analysis at the location and the pedestrians interviews following recommendations are to be considered for improvement of existing GSPF.

Hygienic measures are to be taken to increase the usability the daily cleaning has to be taken up. In addition, awareness drives regarding public hygiene and health could be promoted with the provision of the slogans on the subway walls and by the provision of the dustbins too.

The ramps on station side needs improved design. This ramp is obstructed with bollards as shown in the figure 18 shown below, where the bollard restrains the movement of the disabled person with a wheelchair cannot enter foot under bridge through the ramp. The ramp which is solely made for the universal accessibility needs no bollards. The steep slope of more than 8 percent is not desirable and thus a proper slope of less than 8 percent.



Fig -5: Model of Slope for disables

4.3 Location 4: Kirloskar Company, Karvenagar

This GSPF is meant to assure safety of the pedestrians. This FOB is built considering the CPWD guidelines. It is made of the rust proof material and can be reassembled and be shifted in future. This FOB is not used because of unavailability of the mid-block obstacles and easily accessible infrastructure. The surrounding area and density of the vicinity are major reasons for its usage.

- **SWOT Analysis**

Strengths: seating and resting place. Elevators available.

Weakness: no median obstacle.

Opportunity: The present facility could be used for company workers and the median obstacle might add to its usability. . The users of the fob could be increased or the present FOB could be dismantled as well.

Threats: The present investment might also be seen as Dead investment for the less number of users.

- **Proposals**

Proposing median at junction in the form of Barricades is recommended. Barricades are intended to provide containment without significant deflection or deformation under impact and to redirect errant vehicles along the barrier. They are designed to be easily relocated and have four specific functions to: 1) prevent traffic from entering work areas, such as excavations or material storage sites; II) provide protection to workers; III) separate two-way traffic; and IV) protect construction such as false work for culverts and other exposed objects. Barricades can be portable or permanent. Portable barricades should be stable under adverse weather conditions and appear substantial but not so much as to cause excessive damage to the vehicle if they are struck.

3. CONCLUSIONS

Direct and indirect factors determine the behavior of pedestrians at FOB and FUB and have an impact on the choice between crossing at-grade and using the FOB /FUB. Direct determining factors are related with the design and construction of the pedestrian facilities. Indirect determining factors deal with circumstances like the volume of traffic or road conditions. Each determining factor has an influence on the pedestrian's decision, and each factor should be considered to find out if FOBs and FUBs fulfill their purpose or not. A crowded FOB /FUB alone are not significant; it can just be due to a lack of pedestrian friendly alternatives. The usability analysis of GSPF found that many of these facilities are poorly designed, particularly for the children and the elderly. However, the surveys also showed that if GSPF are

well designed, it would be more preferable to pedestrians as they are more convenient and safe to use for all. Nevertheless, even at such pedestrian infrastructure, pedestrian's preference was to cross the road at-grade if safe crossings were possible.

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BIOGRAPHIES



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