

**Pedestrian Crosswalks
Integration with Pedestrian Sites**

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ABSTRACT

Developments and changes in transportation systems caused disharmony in urban patterns in general while they have resulted in rapid access opportunities, because both pedestrian and vehicle needs have equally been imposed on existing of urban patterns. Different countries have different approaches for designing the circulation system in the cities depending on their socio-economic structures and political systems. In the developed countries pedestrians are not neglected, on the contrary, they are considered as much as vehicles. Opposed to this, in the developing countries, the pedestrian needs are ignored with respect to security, comfort, convenience, aesthetic, and continuity aspects. Particularly, the disabled are effected heavily from this ignorance.

The aim of this study is to develop an optimisation of design criteria for safe pedestrian crossings that link pedestrian areas; and to test these criteria though made a design projects on Adana.

The methodology used in the study consists of three steps: Theoretical, analytical, and pragmatism. Theoretical step consists of literature survey, analytical step includes analysis of the selected problem areas as pedestrian crossing, and finally pragmatic step proposes a way of problem system for the pedestrian crossings on D-400 National road in Adana. In this respect, Türkkuşu Junction was selected which has the high volume both vehicle and pedestrian for design.

ÖZ

Ulaşım sistemlerindeki gelişim ve değişimler hızlı ulaşım olanaklarını sağlarken mevcut kent dokusuna eklemlenme sürecinde uyumsuzluklara neden olmuş, bununla birlikte, hem yaya hem de araçların ihtiyaçlarını eşit düzeyde dikkate almak yoluyla mevcut kentsel dokuya uyarlanmasını zorunlu kılmıştır. Ne var ki, şehirlerin dolaşım sistemlerini tasarlamada ülkeler gelişmişlik düzeylerine- sosyo ekonomik yapı ve politik sistem- göre farklı yaklaşımlar göstermişlerdir. Gelişmiş ülkelerde yayalar gözardı edilmemekte, araçlar kadar dikkate alınmaktadır. Bunun tersine gelişmekte olan ülkelerde, şehirlerin dolaşım sistemi tasarlanırken, yayalar araçlardan daha az dikkate alınmakta, sonuç olarak, yayaların ihtiyaçları güvenlik, rahatlık, uygunluk, estetik ve devamlılık bakımlarından ihmal edilmektedir. Özellikle engelliler bu ihmalden daha fazla etkilenmektedirler.

Bu çalışmanın amacı yaya mekanlarının bağlantılarını sağlayan herkes için güvenli yaya geçişlerinin tasarım ilkelerini ülke koşulları içinde optimum düzeyde geliştirmek ve bu ilkeleri Adana kenti için ortaya koyan bir tasarım projesi ile sınamaktır.

Çalışmada kullanılan yöntem teorik, analitik, ve pragmatik olmak üzere üç adımdan oluşmaktadır. Teorik adım geniş bir literatür araştırmasını gerektirmektedir, ve analitik adım yaya geçişleri olarak seçilmiş problem alanlarının analiz edilmesini içerir. Son olarak, pragmatik adım D-400 karayolunun Adana kent geçişi üzerinde yaya geçişleri için problem çözücü bir sistem önermektedir. Bunun için yaya ve araç yoğunluğunun en fazla olduğu Türkkuşu kavşağı tasarım için seçilmiştir.

TABLE OF CONTENTS

LIST OF FIGURES	VII
LIST OF TABLES.....	IX
Chapter 1 INTRODUCTION.....	1
1.1. Definition of the Problem	1
1.2. Content of the Study	2
1.3. Methodology	3
Chapter 2 RAPID URBANISATION, AND TRANSPORTATION	5
2.1. Rapid Urbanisation	5
2.1.1. Demographic and Economic Factors	5
2.1.2. Political Factors.....	6
2.2. Reflections on Urbanisation.....	7
2.2.1. Advantages of Urbanisation.....	7
2.2.2. Problems of Urbanisation.....	7
2.3. Transportation	8
2.3.1. Transportation and City in History	8
2.3.2. Transportation Policies and Effects	11
Chapter 3 CONCEPTUAL DEFINITIONS AND EXPLANATIONS	14
3.1. The Concept of Pedestrianism	14
3.1.1. Pedestrian Groups at Risk.....	14
3.1.1.1. Children	17
3.1.1.2. Elderly Persons.....	20
3.1.1.3. Disabled Persons	22
3.1.2. Social and Cultural Characteristics of Pedestrian	23
3.2. Characteristics of Pedestrian Movements.....	24
3.3. Characteristics of Pedestrian Accidents.....	26
3.3.1. Factors Causing Accidents.....	27
3.3.2. General Characteristics of Crash Sites.....	32
Chapter 4 ACCIDENT PREVENTION SYSTEMS	34
4.1. Pedestrian Crosswalks.....	34
4.1.1. Ground Level Crosswalks	36
4.1.1.1. Marked Crosswalks	36
4.1.1.2. Unmarked Crosswalks.....	40
4.1.2. Separated Level Crosswalks	40
4.2. Traffic Calming.....	42
4.2.1. Traffic Calming Devices	43
4.2.1.1. Speed Control Devices	44
4.2.1.2. Volume Control Devices	61

Chapter 5 DESIGN GUIDELINES AND STANDARDS OF CROSSWALKS.....	72
5.1. Quantitative Factors of Design	72
5.1.1. Dimensions.....	72
5.1.1.1. Basic Human Dimensions	72
5.1.1.2. Disabled People Dimensions.....	73
5.1.1.3. Clearances	74
5.1.2. Capacity and Density	77
5.2. Qualitative Factors of Design	87
5.2.1 Safety.....	88
5.2.1.1. Lighting	88
5.2.1.2. Sight Lines.....	89
5.2.1.3. Entrapment Spots	89
5.2.1.4. Mixed Use	90
5.2.1.5. Movement Predictors	90
5.2.2. Comfort	90
5.2.3. Continuity.....	91
5.2.4. Convenience.....	91
5.2.5. Aesthetic.....	91
5.3. Conclusion	92
Chapter 6:CASE STUDY; ADANA CITY CENTER.....	96
6.1. A short History	96
6.2. The Existing Structure of Adana.....	100
6.2.1. General Characteristics and Land Use.....	101
6.2.2. Transportation.....	102
6.3. Problems.....	106
6.4. Redesign of the problem areas.....	109
6.4.1. Atilla Altikat Crosswalk.....	111
6.4.1.1. Problem Definition	113
6.4.2. 5 Ocak Crosswalk.....	114
6.4.2.1. Problem Definition.....	116
6.4.3. Türkkuşu Junction.....	117
6.4.3.1. Existing Structure of Türkkusu Junction.....	117
6.4.3.2. Problem Definition.....	119
6.4.3.3. Proposed Solution.	120
Chapter 7 CONCLUSION	124
REFERENCES	126
APPENDIX	A

List of Figures

Figure 1: Pompeii (Italy), a Roman paved street, with sidewalks and stepping	9
Figure 2: Darting out to the road	17
Figure 3: Vision of child	18
Figure 4: Hidden by parked car	19
Figure 5: Distributions of crossing time by time-of-arrival measures	19
Figure 6: Total pedestrian fatalities among children 0-14 years old by age group	20
Figure 7: Annual average Victorian pedestrian casualty rates	21
Figure 8: Distributions of crossing time by time-of-arrival	22
Figure 9: Loss of energy in level ground crosswalk	34
Figure 10: Loss of energy in undercrosswalk	35
Figure 11: Loss of energy in overcrosswalk	35
Figure 12: The graphic on designation of the crosswalk type	37
Figure 13: Under crosswalk, “Design of Urban Spaces”	41
Figure 14: Crosswalk elevations	41
Figure 15: Speed Hump	46
Figure 16: Colored speed humps	45
Figure 17: Speed humps	45
Figure 18: Speed bumps	47
Figure 19: The graphic of speed bumps	47
Figure 20: Vertical Shifts: Humps, cushions and plateaux,	49
Figure 21: Raised crosswalk and it’s detail	50
Figure 22: Chicane	52
Figure 23: Chicane	52
Figure 24: Chicanes(lateral shifts)	53
Figure 25: Diagonal diverters	53
Figure 26: Semi diverters	54
Figure 27: Semi Diverter - Left Turn Restriction	55
Figure 28: (a)Diagonal Diverter, (b) Semi Diverter	55
Figure 29: Graphics of curb extension	56
Figure 30: Curb extension detail	56
Figure 31: Effects of corner radii on pedestrians and cyclists	58

Figure 32: Graphic of neckdawn	59
Figure 33: Graphic of choker	60
Figure 34: Choker	60
Figure 35: Examples of choker	61
Figure 36: Graphic of textpavement	61
Figure 37: Textured crosswalk	62
Figure 38: Roundabouts	63
Figure 39: Attractive traffic circles	63
Figure 40: Graphic of the central island	64
Figure 41: Pedestrian refuge - Half intersection	65
Figure 42: Pedestrian refuge - Full intersection	65
Figure 43: Pedestrian refuge details - centerline approach	65
Figure 44: Island	66
Figure 45: Midblock and intersect block	66
Figure 46: Fullclosure and half closure	69
Figure 47: Graphic of median barrier	70
Figure 48: Central islands in mixed and traffic priority areas	70
Figure 49: Body dimension of men and women & body dimension	72
Figure 50: (a) Man with a walker, and (b) man with a dog	73
Figure 51: Wheelchair dimensions	73
Figure 52: a) T shaped space for 180 ⁰ turns. b) 60-in diameter space	74
Figure 53: Clear ground space for forward and parallel approach	74
Figure 54: Sides of curb ramps	76
Figure 55: Curb ramps at marked crossings	76
Figure 56: Built-up curb ramp	76
Figure 57: Led by a few venturesome souls, the waiting platoon of	82
Figure 58: The platoons from both sides of the street start moving	83
Figure 53: The platoons meet and interpenetrate	83
Figure 60: The platoons begin to arrive at opposite sides of the street	83
Figure 61: The major platoon flow is over, but stragglers continue to walk	84
Figure 62: Pedestrian space in crosswalks. Unimpeded	86
Figure 63: Pedestrian space in crosswalks. Constrained	86
Figure 64: The absence of pedestrian reservoir space on narrow sidewalks	87

Figure 65: Development of Adana City	98
Figure 66: Highway transportation in national scale	101
Figure 67: Adana and river Seyhan	102
Figure 68: Highway transportation in regional scale	103
Figure 69: Light railway system	106
Figure 70: Adana D-400 city passage	110
Figure 71: Annual average daily traffic volume	110
Figure 72: Peak hour vehicle volume	111
Figure 73: Atilla Altukat Over Crosswalk.	111
Figure 74: Pedestrian volume in peak hours.	112
Figure 75: A view from Atilla Altukat Crosswalk to D-400	113
Figure 76: A view to Atilla Altukat Over Crosswalk and lighting tools	113
Figure 77: Hawkers on Crosswalk	114
Figure 78: Steps of crosswalk	114
Figure 79: 5 Ocak Crosswalk	115
Figure 80: Pedestrians on 5 Ocak Crosswalk	115
Figure 81: Pedestrian volume at the peak hour	115
Figure 82: Contradictions between vehicle and pedestrian	116
Figure 83: Reserve space	116
Figure 84: Türkusu Junction	117
Figure 85: Vehicle volume in peak hour	118
Figure 86: Pedestrian volume in peak hours	118
Figure 87: Ataturk Avenue and Municipality	118
Figure 88: Regulation violating pedestrian and vehicles	119
Figure 89: Accumulations while turning left	120
Figure 90: Using of wheelbarrow on D-400 national road	120
Figure 91: Proposed Solution	122

List of Tables

Table 1: Pedestrian killed and injured by age group in Turkey, 1996	15
Table 2: Pedestrian killed and injured by age group, U.S, 1999	16
Table 3: Rate on faults of driver, pedestrian, passenger, vehicle, road at crash	26
Table 4: The rate of pedestrian faults caused accident in urban and rural,1998	28
Table 5: Comparison between male and female risky behaviour	29
Table 6: Driver faults by year	30
Table 7: Pedestrian faults by year	31
Table 8: Road location of pedestrian collisions	32
Table 9: Interpersonal distances	77
Table 10: Levels of service for standing pedestrians	78
Table 11: Average free flow walking speed for pedestrians	79
Table 12: Level of service on walks	80
Table 13: Level of service on stairs	81
Table 14: Unimpeded pedestrian speed in crosswalks	84
Table 15: Rate of flow in crosswalk speeds by Oeding	85
Table 16: Rural and urban population growth for Turkey and Adana	100
Table 17: Number of death and wounded of traffic Accidents	107
Table 18: Kinds of accidents in Adana, 2001, for 5 months.	108
Table 19: Pedestrian faults causing accident, 2001, for 5 Months.	108
Table 20: Number of annual accidents	119

Chapter 1

INTRODUCTION

1.1. Definition of the Problem

The invention of motor vehicles in the 20th century is a revolution for humanity. Motor vehicles have become more important than the vehicles depending on animal power due to developing techniques for vehicles. The rapid rise in car-ownership and using faster vehicles made possible by developing technology caused the density of cities to rise, and land use demands to change, in addition causing new problems on pedestrians and vehicles intersections in the cities.

All over the world, countries have different rate and pattern urbanization, in this respect, effects of urbanization in cities are different. Economical structure which determines resources, and political system that arranges the use of the resources are basic factors that cause the differences. Consequently, approaches to problems of developed and developing countries require specific solutions related to their own peculiarities.

The effects of development which exist all over the world are different for developed or developing countries. In the developing countries, pedestrian circulation was given less importance than vehicles in the cities. Opposed to this; in the developed countries pedestrians are not neglected, and pedestrians are considered as well as vehicles. As a result, the rate of pedestrian related accidents are reduced in the developed countries, on the contrary they are increased in the developing countries.

Pedestrians and their needs are also neglected when in contact with the vehicle circulation. It is seen that safety, comfort, convenience, continuity and aesthetic principles have not enough importance because of inadequate use of public resources, and moreover especially the disabled are effected because of neglect. However, everyone is thought to be disabled when it is considered to be in different phases of life such as childhood, elderly, pregnant, ill etc. Therefore solutions should be produced to develop optimum design criteria for safe pedestrian crossing for everyone and set up between pedestrian areas.

1.2. Content of the Study:

The study includes seven chapters: They are, in order: introduction, transportation and city, conceptual definitions and explanations, protecting systems to accidents, design guidelines and standards, case study and conclusion. First chapter includes definitions of the problem, determination of methodology, and thus forms the framework of the study.

Chapter 2 defines urbanization in brief, and factors that cause variety are reviewed. Countries that have different -economic, demographic and politic problems- structures have different problems related to urbanization. Consequently, it is accepted that proposed solutions must be optimum with respect to opportunities in Turkey.

Chapter 3 includes definitions and explanations of the pedestrians and pedestrian related accidents. In this chapter pedestrian groups that have accident risks are determined while the concept of the pedestrian is explained. The pedestrian groups are classified so as to take such factors into consideration influences of age, physical ability, perceptual capability, and social and cultural character on pedestrian behavior. Children, elderly persons, the disabled, and pedestrians having social-economic levels emerge as groups having high level of risk. The cause of pedestrian related accidents, crash site and typical accident time are determined characteristics of pedestrian movements are explained.

Chapter 4 is about accident preventing systems, and also includes explanation for using the system for pedestrian crossings and to criticize these systems. The chapter, also examines the traffic calming techniques which aid in reducing the rate of accidents, its widespread usage especially in developed countries.

Chapter 5, aims to offer design standards and guidelines. Design principles are examined in two parts as quantitative and qualitative factors: Quantitative factors include human dimensions, qualitative factors include safety, comfort, continuity, convenience and aesthetic criteria.

Chapter 6 after examining design standards and guidelines, attempts to use optimum standards for solving the problems on certain problem areas in Adana. D-400 national road divides Adana city center into two parts. Solutions that unite the spaces on either side, and that provide safety crossing must be reached. Design must consider land uses, pedestrian movement, the pedestrians profile who use the land. The city

transportation system should be considered in integrity with these solutions, otherwise solutions will be temporary, unproductive.

1.3. Methodology

The methodology of the study consist of three steps:

- Theoretical
- Analytical
- Pragmatical

The theoretical framework is based on detailed literature survey about the definition and explanation of pedestrians, pedestrian related accidents, pedestrian crosswalk, and traffic calming techniques and human requirements. Statistical data which are prepared by the transportation departments of local municipalities on pedestrian and vehicle accidents are used. In this study books and articles, periodical and academic publications, also web sites were used.

Methods that developed and developing countries apply to protect the pedestrian from the accidents, are different from each others. In Turkey, appliance of traffic calming techniques dose not have enough importance but these concepts are getting important day by day. Because of that, the study focused on pedestrian crosswalk and traffic calming techniques.

Design standards obtained into theoretical step require verification through analytic and pragmatic procedures for solving the problems on three certain case areas. For this reason, case study is a step that includes both analytic and pragmatic approaches.

In analytic step land use, characteristics of pedestrian movements and users are determined. General characteristics of the area are determined by land use map, observations and public survey. In addition deficiencies and faults are determined by observation. It is necessity that the vehicle and pedestrian volume of the area, because of determination and selection problem parts. So it was necessary to count vehicles and pedestrians of different hours of a day, for a year period. But, the counting work of the working period was districted to one week, in January.

All of these steps attempt to determine the theoretical design standards in fixing up the problems in the areas, and potential land use with land use survey. Türkkuşu

junction is one of the three problem areas was selected because of having problems and potentials as different from others. Pragmatic step includes design study relating to the solution of the problems on the Turkkuşu junction, taking into consideration the special circumstances of Adana and Turkey in general.

Chapter 2

RAPID URBANISATION AND TRANSPORTATION

2.1. Rapid Urbanization

In the twentieth century, so many countries like Turkey have been transformed by rapid urbanization. Migration from rural to urban areas, the growth of urban economies, and rapid expansion of cities are integral features of the set of structural changes. Urbanization is not only modernization or industrialization, moreover it refers to a particular element of the development process the concentration of population in relatively large settlements. Concentration of population in relatively large settlements is associated with distinctive economic, social, and political changes.

However, urbanization is not the same everywhere. Substantial differences exist in its nature, extent, rate, and timing, and these variations have significant political consequences. A number of political systems are almost completely urbanized, others have sizeable urban and rural populations while some urbanizing countries remain largely rural. In some countries, a complex network of major urban centers, secondary cities, and market towns is common. In many nations especially developing countries like Turkey, by contrast, urban development is heavily concentrated in a single city. For this reason these cities grow most rapidly

After 1950, urban growth accelerated sharply in Turkey. Politically, this abrupt change in Turkey's rate of urbanization is extremely significant. The relatively slow pace of urban growth before 1950 did not severely challenge the political system. But suddenly, urbanization was sharply blessed. After this, city problems quickly became national issues. (Keleş, Danielson; 1985)

2.1.1. Demographic and Economic Factors:

All over the world, cities face increased population. But growth of population, especially in developed countries, is not as rapid and as extensive as Turkey. In Turkey,

urban population grew five fold, from 4 million to 20 million, between 1950 and 1980 years, despite overall population growth from 20 million to 45 million.

In the urbanization process, another important difference between countries is the relative importance of economic and demographic forces. Developed countries have experienced urbanization as a result of industrialization, with migrants attracted to the cities by an enlarging factory economy. But in developing countries, industrial growth has been less significant in the booming growth of cities. The change in agriculture resulting from technology, increased the rural overpopulation, accelerating the migration to cities. As a consequence of these demographic patterns, cities in Africa, Asia, Latin America, and the Middle East have grown at much faster rates than industry, and wide spread unemployment and poverty exist among urban new comers in much of the world. In this respect, most of the developing countries were shaped under the influences of rapid growth, weak economic bases, and large migrant populations. Moreover, “the common product is politics characterized by severely limited resources and intense demands for jobs, land, and urban services.” (Keleş, Danielson; 1985, pp:6)

Migration to cities has some general features in many societies. Traffic congestion, water supply, and housing pose common problems for public officials in cities everywhere. As a result, urban development generates similar pressures, issues, conflicts, and choices in different political systems.

2.1.2. Political Factors:

In Turkey, urban politics has been influenced by the distinctive features of the pattern of urbanization. Increase of demands on the political systems for services, facilities and jobs appeared because of fast growth. Public resources were inadequate due to costs of public services. “Complicating government’s task in allocating resources has been the variety of urban contexts-huge metropolitan complexes, rapidly growing regional centers, and a host of smaller urban communities- each with its own problems and priorities.” (Keleş, Danielson; 1985, pp:7)

2.2. Reflections of Urbanization

2.2.1. Advantages of Urbanization

In the history, growth of cities was proportional with the ability to control on excessive productions of the rural areas. Cities have a growing dynamism. The economical activity has an important role in the formation and growth of cities. The functions of the urban core had been transforming from agriculture to religious, to administrative, to market place, to production, and finance; parallel to the change of functions the urban core had been transforming from agora to church, to market place, to factory, to bank and to house.

Big cities have concentrated financial institutions, trade facilities and their executive offices, also social and cultural activities. They require investments in facilities located in their environs. In this respect people in cities have concentrated markets for all sorts of goods, and have the possibility of meeting their needs. Meanwhile, it is seen that growth feeds on growth. Because economic growth supplies public investments in transportation and communications, also the growth on transportation and communication creates new opportunities for economic growth.

2.2.2. Problems of Urbanization

Immigration to cities and increase of the population have caused higher density population in cities. Land value in city centers has risen because of this growth. For that reason, this functions which needs wide spaces have transformed their organizational structure and decentralized some of their units to larger and cheaper areas. Their contact offices, financial sectors and retail trade have been kept in city core.

The process caused some problems in the city center. The pattern and physical environment in urban area must adopt itself to the new functions as existing functions develops. But the problems of the adaptation process emerge because changes in the human and economic activities occur so rapidly.

Physical structure was originally built for completely different purposes, change of functions in city center created the problems. Motor vehicles provide easy and fast

transportation facilities which aid the development of activities and satisfactory urban life. Rising life standards cause the spread of the central activities. Nevertheless the greater pressure occurs on the town centers because of the increased exclusive demand. Commercial, office, industrial, and service requirements grow day by day. All of these changes create a conflict between the quality of physical environment and the activity of the dense use.

City centers which were exposed to these changes lost their inner balance. The capacity of the existing city center is not enough to provide new spatial requirements. High rises, inadequacy or lack of sidewalks, increased speed of the vehicular traffic, insufficient park lots are considered as the city center problems. Highways which have high speed and high volume divided cities into parts because of transportation demand.

2.3. Transportation

2.3.1. Transportation and City in History

Pre urban villages had buildings, but their paths were not always streets. "The street is an invention. At present it may be possible to locate the first conscious street in history at Khirrokitia (Cyprus), dating from the 6th millenium B.C. this spine of communication, running uphill from the riverbank and down on the opposite side of the hill, was built of limestone and raised considerably above ground level, with stone ramps leading down at regular intervals among the houses huddled on either side. The primacy of Khirrokitia may be challenged in future scholarship." (Kostof, 1992, pp:190)

The street remains the stage of a constant struggle between private and public interests. The street space should be kept accessible, open and well equipped for public good. The private urge is to appropriate this space for one's own purposes. Roads and streets developed mainly as needs of overland travel. Main factors defining roads and streets are form and role.

In most European countries serious road-building had taken place during Roman times. During the following centuries most Roman roads had been neglected and often merely tracks or bridle paths remained. In medieval times, few transport modes were available. Overland travel was either carried out on horseback or on foot. Goods were transported by pack horse. Although various forms of carriage had been developed

mainly from the late sixteenth century onwards, they only became common during the last quarter of the eighteenth century. With the increase in wheeled transport, tracks and bridle-paths had to be changed into roads which ideally would work best with smoother and harder surfaces. (Hass-Klau, 1993, pp:8)

In the post-Roman period, medieval towns were largely on foot, and pedestrian needs dominated. Medieval streets were in human scale, pedestrian friendly contrary to today's contemporary city streets. Streets were not designed to accommodate wheeled vehicles and neither water pipes nor sewage drains needed to be provided. (Hass-Klau, 1993) In Pompeii, the pedestrian had raised sidewalks and stepping stones across the traffic thoroughfare. However, in late medieval period wheeled traffic increased with the rise of mercantile economy.

Pavements protected pedestrians from wheeled traffic and were used as long ago as Roman times, but had been forgotten until the late seventeenth century (Figure: 1). In France and Germany pavements were not known until the middle of the eighteenth century, and then only in the "better" streets.

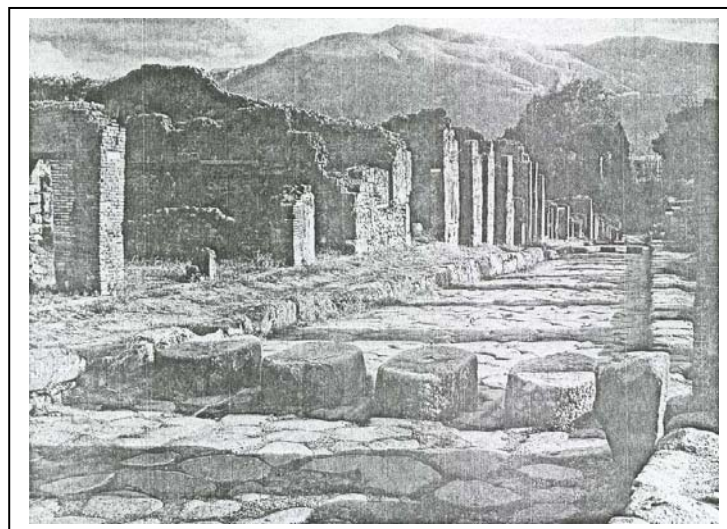


Figure 1: Pompeii (Italy), a Roman paved street, with sidewalks and stepping stones. KOSTOF, S: "The City Assembled" , 1992, pp:210

"Beginning in the late 18th century a series of improvements in street design were introduced and popularized in England. These include macadam paving, storm drains and sewers, piped water, house numbering and sidewalks. Rambuteau's regime in Paris adopted some of these improvements in the 1830's and 40's, including sidewalks, but here unlike England the form was associated with rows of trees. The sidewalk often

provided a site with improved drainage and protection from soil compaction and injury for street trees which until then had had to struggle for survival at the edge of the roadway.” (Kostof, 1992, pp:209)

Another changing in the eighteenth century, covered passageways which later became famous for their glass-covered roofs were firstly built in France, spreading later to all large European and some overseas cities. Arcades are the first planned attempt in congested urban areas to separate pedestrians from wheeled traffic. They were constructed mainly in and for the city centers to protect pedestrians from weather and traffic. The main economic function of arcades was to follow a different style of shopping which had developed from the middle of the eighteenth century. (Hass-Klau, 1993)

After the middle of the 19th century traffic congestion had become a serious problem because of increasing by two major inventions: Bicycle and automobile. Bicycle developed towards the end of the 19th century, therefore the period between 1890 and 1895 referred as the “ Bicycle Craze Era”. Then the car was first invented in Europe in 1885 than became universal after the mass production of Ford’s model “T” in 1907 (Hass-Klau, 1993). In Paris, number of coaches and carriages were increased because of new technological improvements. Henceforth some protest were begun against to the disturbance caused by wheeled traffic in the city streets. Because in medieval age, the streets which were curving, irregular in shape and confusing were not designed for the access of wheeled vehicles.

The increased in number of car-ownership required better roads which allow the comfortable movement of the cars. After 1885, asphalt, the all-purpose street cover, became standard in Europe and United States. Construction of better and wider roads effected to be faster and advanced automobile design, also higher road construction standards.

Chaos resulted from the protests which were begun with widespread use of automobile in 20th century. Laws and regulations were established for the solution of the chaos. Automobile impacts upon built-up environment were very destructive. Using of automobile changed the road design. Automobile became the powerful tool of urban extension, decentralization and social alienation. Futurists celebrated the advent of automobile. (Kostof, 1992)

The invention of motor vehicles has revolutionized our worlds. It has played a leading role especially in the congestion of cities. In the time before the invention of the motor vehicle, settlements had little access to open space, streets in those areas can be shared equally by cars and pedestrians. Densities of population were heavy because the urban radius was limited to distances that could be covered on foot, or at best by horse. Transportation and communication were developed to serve the urban cores, in the industrial age. Developed transportation systems facilitated long distance transportation. So transportation made great centers of production far from urban core possible.

Urban core is the image of city because of obtaining economical, administrative, cultural and recreational functions, at high degree. Urban core has a major characteristic which is to overlapping of different activities, such as administrative, retail trade, business activities, social and cultural activities and in some cases wholesales.

2.3.2. Transportation Policy and Effects

It can be said that, transportation is one of the most used means to shape settlement patterns. The network of transportation corridors, intersections, and terminals are the factors that attract development, and determine the way of growth. Because industrial and commercial establishments need to be near strategic intersections of modern expressways, and offices need to be around rail, concentrated bus and seaport. Road builders, transit officials, and urban planners use transportation investments to influence urban development, thereby determining the characters of settlement patterns in metropolitan areas.

In urban areas, investments that are necessary to develop, expand, and modernize urban roads, transit systems, traffic control networks require important size of capital. Developed countries can easily undertake these investments because of their economic strength. Unfortunately, developing countries like Turkey can not undertake a chance of these investments easily as well as developed countries. In Turkey resources are inadequate. The role of the central government is dominant. Authority function is fragmentary because a unified administrative body to deal with transportation comprehensively, does not exist

Demand increased for transportation. Caused by rapid urbanization spreading development has reached levels beyond the capacities the established services and

facilities. "...The public sector has been unable to expand highways, traffic control systems, and parking facilities fast enough to keep up with spiraling automobile usage. In the face of these monumental challenges, governmental transport efforts have mostly reacted to urbanization with too little too late." (Keleş, Danialson, 1985, pp:148)

Ironically, the number of private transportation operators, mostly taxi-dolmuş type, have increased because of the inadequate public transportation. The result was the rapid rise in the number of these services causing traffic congestion to increase. Resulting increase in the number of vehicles was beyond road capacity. As this trend continued, congestion got delays increased, and traffic accidents mounted.

The rapid rise in vehicular accidents caused great concern for many people, drivers, passengers, and pedestrian a like element was. "Traffic accidents increased over sevenfold between 1955 and 1977, with cities accounting for three-fourths of the 56,765 accidents in 1977, a year in which almost 3,300 people were killed by vehicles in the cities.... Almost all the increase in vehicles in the 1970's came from private automobiles, since the number of minibuses and taxis was limited by government. Private car owners were just as ready as taxi and minibus drivers to ignore traffic signals and parking regulations. Traffic anarchy reflected the breakdown of a complex and poorly coordinated transportation system." (Keleş, Danialson, 1985, pp:151)

However, before the 1970's, urban transportation attracted relatively little attention in systematic terms. Authority on transportation was fragmentary in Turkey. Transportation responsibilities such as road building, traffic control, municipal buses, commuter railroads were divided among a variety of establishment. For example traffic control by Traffic Directorate in the Ministry of Interior, highway building and maintaining by the General Directorate of Highways, municipal busses by Provincial Traffic Committees belonged to city governments, local road building and maintenance to the municipalities. But each of establishments suffer from limited resources.

Urban areas have different transportation systems, each of them under the responsibility of separate establishments. In Turkey, local governments have little authority over wide area of transportation systems. Most of the system is controlled by central agencies with national functional perspectives rather than urban concerns. For example major roads "called national roads" in urban areas and peripheral highway are built and maintained as part of the intercity road network by the General Directorate of Highways in the Ministry of Interior. In traffic control, Traffic Directorate of the

General Directorate of Security within the Ministry of Interior under the central government has general responsibility for highway traffic, vehicle and driver registration, and traffic safety

Another important body on transportation in urban areas is Provincial Traffic Committee. Provincial Traffic Committee “deals with traffic regulations, highway safety, and licensing and operating procedures for buses, minibuses, and taxis-including fares, routes, and limitations on the number of minibuses and group taxis. The Provincial Traffic Committee is an instrument of the central government in each province. All its actions must be approved by the Traffic Directorate in the Ministry of Interior.” (Keleş, Danialson, 1985, pp:152-153)

Provincial Committees had most of the functions to regulate traffic and public transport in cities under the Municipal law of 1930, until 1953. But after that, municipalities were left with some operating responsibilities such as traffic signals and signs, street repair, and public transportation service. In this respect traffic and transportation issues were ignored by city governments in spite of importance. So almost no authority made policies to deal with their traffic and public problems.

Transportation planning responsibilities are fragmented in the major urban centers. Although city governments prepare local master plans that include transport facilities, the city government has no control over most of the agencies that develop and control transportation. “At the same time, overlapping responsibilities, the existence of three layers of government, and pervasive central control and oversight, necessitate cumbersome procedures and endless red tape.” (Keleş, Danialson, 1985, pp:154)

Chapter 3

CONCEPTUAL DEFINITIONS AND EXPLANATIONS

3.1.The Concept of Pedestrian

The pedestrian is someone who is walking or using a human-powered device such as a wheelchair, skateboard or roller-skates. Bicyclists are not considered pedestrians ([http:// www.csa.com/about/education/pedestrian.asp](http://www.csa.com/about/education/pedestrian.asp))

“For every site there is an ideal use, and for every use an ideal site. Sites and activities have natural affinities for each other. Human behavior is the first step in designing an appropriate environment for the pedestrian.” (DOBER, 1969, pp: 267). Pedestrian behavior, like any activity, is a function of two major sets of factors, physical and cultural. People will walk for pleasure and necessity, but the distance covered will depend on topography, climate, and inclination, or the range may be set by custom more than anything else. In the same way, behavior of people who will cross the roads will depend on cultural structure, level of education, age and physical ability.

3.1.1. Pedestrian Groups at Risk

Every pedestrian has different characteristics from others. The differences are related with character of the age groups, physical and mental sufficiency, social and cultural structure. For that reason, the pedestrian groups should be determined as all of feature are considered. Pedestrian groups that have the risk should be designated taking into account the characteristics are put forward.

Some age groups appear to be at particular risk as pedestrians, including children and elderly persons. They have high death rates compared to the other population. Children deserve particular attention when considering pedestrian safety, because they rely more heavily than adults on walking to get where they need to go. Like children, some older adults may also overestimate their own abilities.

Table 1: Pedestrians killed and injured by age group in Turkey, 1996

AGE GROUPS	URBAN AREAS				RURAL AREAS				TOTAL			
	DIED	%	INJURED	%	DIED	%	INJURED	%	DIED	%	INJURED	%
1-6	198	20,5	2208	13,4	28	8,5	101	8,0	226	17,4	2309	13,0
7-15	185	19,1	4132	25,0	75	22,9	294	23,4	260	20,1	4426	24,9
16-20	51	5,3	1535	9,3	20	6,1	113	9,0	71	5,5	1648	9,3
21-30	56	5,8	1916	11,6	27	8,2	179	14,3	83	6,4	2095	11,8
31-40	56	5,8	1591	9,6	25	7,6	166	13,2	81	6,3	1757	9,9
41-50	79	8,2	1402	8,5	33	10,1	106	8,4	112	8,6	1508	8,5
51-60	92	9,5	1218	7,4	27	8,2	82	6,5	119	9,2	1300	7,3
OLDER THAN 60	197	20,4	1948	11,8	65	19,8	146	11,6	262	20,2	2094	11,8
UNIDENTIFIED	54	5,6	576	3,5	28	8,5	69	5,5	82	6,3	645	3,6
TOTAL	968	100,0	16526	100,0	328	100,0	1256	100,0	1296	100	17782	100

Source: General Directorate of Highway; “Trafik Kazaları Özeti”, <http://www.kgm.gov.tr> , 1998

Table 2: Pedestrian Killed and Injured by Age Group, U.S, 1999

Age Group (years)	Total Killed	Pedestrians Killed	Percentage of Total Killed
0-4	733	163	22
5-9	795	194	24
10-15	1,403	210	15
16-20	5,917	273	5
21-24	3,884	231	6
25-29	3,641	286	8
30-34	3,180	334	11
35-39	3,423	454	13
40-44	3,296	451	14
45-49	2,702	382	14
50-54	2,206	310	14
55-59	1,814	271	15
60-64	1,421	212	15
65-69	1,471	208	14
70+	5,617	876	16
Unknown	108	51	—
Total	41,611	4,906	12
Age Group (years)	Total Injured	Pedestrians Injured	Percentage of Total Injured
0-4	76,000	3,000	4
5-9	112,000	10,000	9
10-15	185,000	14,000	8
16-20	574,000	8,000	1
21-24	315,000	4,000	1
25-29	331,000	7,000	2
30-34	296,000	7,000	2
35-39	288,000	5,000	2
40-44	237,000	6,000	2
45-49	211,000	5,000	3
50-54	170,000	4,000	2
55-59	115,000	2,000	2
60-64	78,000	2,000	3
65-69	75,000	3,000	4
70+	171,000	5,000	3
Total	3,236,000	85,000	3

Source: Traffic Safety Facts,1999; US Department of Transportation National Highway Traffic Safety Administration

3.1.1.Children

Children are particularly vulnerable to pedestrian death because they are exposed to traffic threats that exceed their cognitive, developmental, behavioral, physical and sensory abilities. This is exacerbated by the fact that parents overestimate their children's pedestrian skills. Children are impulsive and have difficulty judging speed, spatial relations, distance and velocity. Auditory and visual acuity, depth perception and proper scanning ability develop gradually and do not fully mature until at least age 10. (<http://www.transact.org>)

The pedestrian skills of children are limited by at least five factors related to their physical attributes. First, young children may lack the physical ability to rapidly cross the street, and their short stature limits their visibility to drivers. Second, children are likely to choose the shortest rather than safest route across streets, often darting out at mid-block or entering the roadway between parked cars (Figure 2). Third, children normally disregard peripheral vision, have reduced attentiveness, localize sounds poorly, and lack sufficient impulse control. Fourth, young children do not evaluate potential traffic threats effectively; they cannot anticipate driver behavior, have less acute sensory perception, and process sensory information more slowly than adults. Fifth, children may engage in “magical thinking” that leads them to believe, for example, that they are protected from vehicular harm within the confines of a painted crosswalk.

(<http://aepo-xdv-www.epo.cdc.gov/wonder/prevguid/m0049687/m0049687.htm>)



Figure 2: Darting out to the road; <http://www.aafts-children traffic>

A study in Utah shown that children of ages 5 to 9 are at the greatest risk from traffic-related pedestrian death and injury (Table 2). More than one quarter of all children of ages 5 to 9 who are killed in traffic crashes are pedestrians. Sixty two percent of the traffic-related childhood pedestrian deaths in 1998 were among males.

Some of the reasons why children do not always make the wisest decisions when crossing the street, can be summarized as:

- Have a field of vision 1/3 narrower than an adult.



Figure 3: Vision of child, [http:// www.aahts-children traffic](http://www.aahts-children traffic)

- Are unable to determine the direction of sounds.
- Children especially under age 10 can not accurately judge the speed or distance of moving vehicles.
- Lack the ability to understand how much time and distance is needed for a vehicle to stop
- Overestimate their own abilities
- Are easily distracted, and tend to focus on one thing at a time like a ball or friend
- Are easily hidden by bushes, parked cars, etc.

(<http://www.hlinux.hl.sate.ut.us>, <http://www.mnsc.org/f-facts>)



Figure 4: Hidden by parked car, <http://www.aafst>.

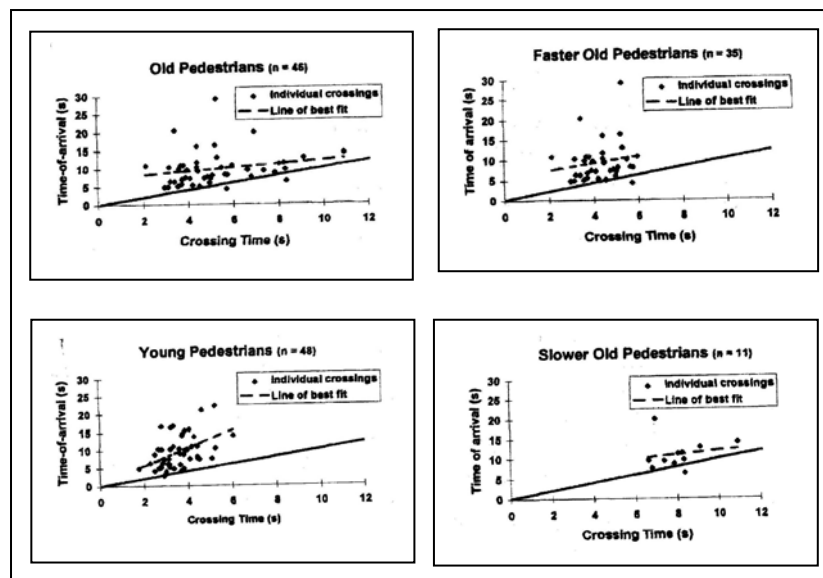
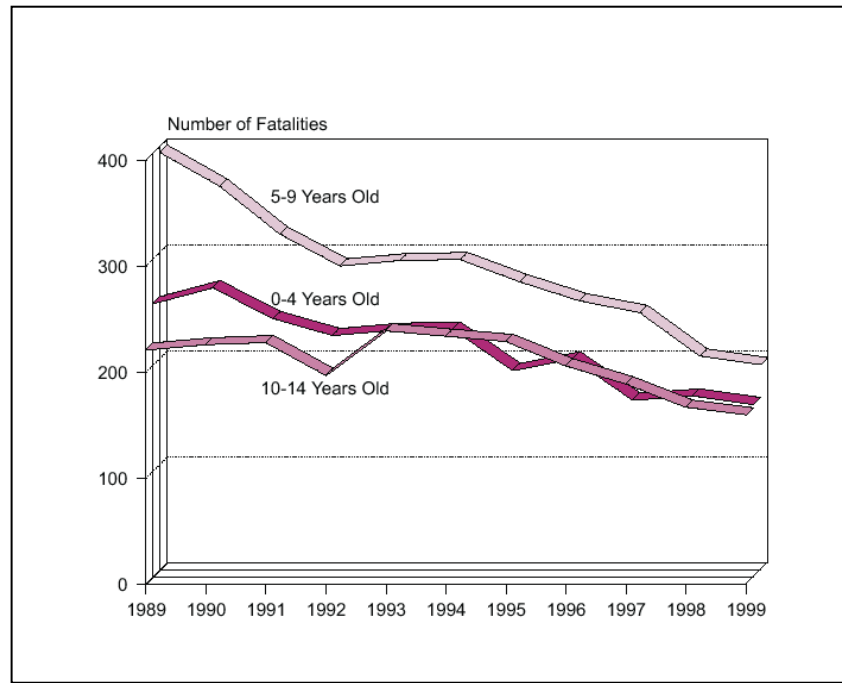


Figure 5: Distributions of crossing time by time-of-arrival measures for individual road crossings on two-way roads; “Differences in Traffic Judgements between Young and old Adult Pedestrians”, Monash University Accident research Centre

Children may have more difficulty in judging speed and distances than adults. Laboratory studies by Siegler and Richards (1979) indicate that the concepts of time, speed and distance undergo a lengthy developmental sequence. Five year old children in their study did not clearly discriminate the concepts of time, speed and distance, and marked confusion existed among the three concepts for 8 and 11 years old children, with many of the latter using distance to judge time, which appeared to be the last concept mastered. Distance judgements is less accurate and more variable than those of

adults. These findings point to perceptual, as well as cognitive, developmental processes affecting children's judgements. (Connelly, 1998)

Figure 6: Total pedestrian fatalities among children 0-14 years old by age group, 1989-1999



Source: U.S. Department of Transportation National Highway Traffic Safety Administration; Traffic Safety Facts 1999, Children

3.1.1.2. Elderly Persons

Elderly people as pedestrians face a higher risk of death than other groups. Many pedestrian facilities, particularly walk signals, are timed for use by young adults in good health, and don not give elderly people enough time to cross in safety.

A recent study undertaken at the Monash University Accident Research Centre revealed that in 1991, % 30 of pedestrian deaths belonged to people aged over 65 years. This study also revealed that for all casualty crashes and all injury severity levels there is a consistent increase in the rate of casualties Per head of population with ages >44 years. Most noticeably, pedestrian casualty rates increased sharply for pedestrians aged 75 years and over, particularly those involving a fatal or serious injury outcome (Figure 7).

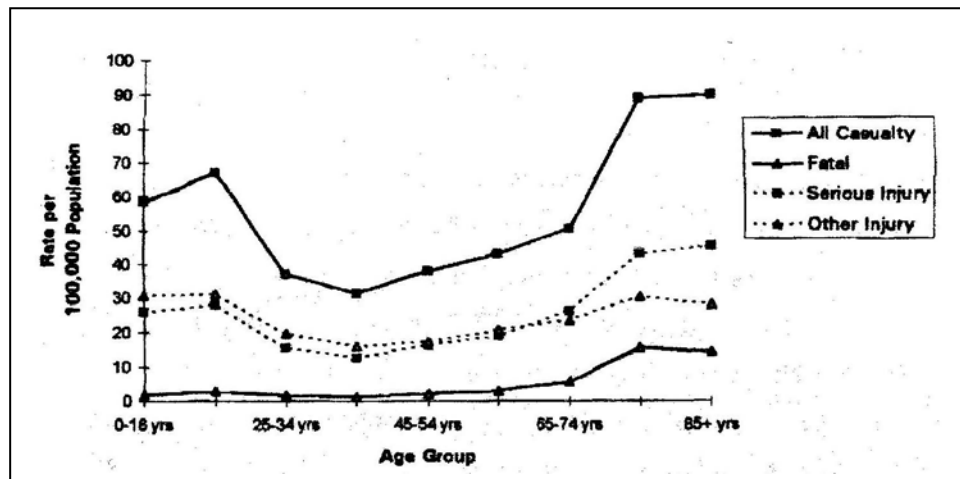


Figure 7: Annual average Victorian pedestrian casualty rates (Per 100,000 population); Fildes,B., Corben,B., Kent,S., Oxley,J., Le,T. And Ryan,P.; “Older Road User Crashes”. Baseline Research Project (Report No:61): Monash University Accident Research Centre, Melbourne, Australia.

One explanation for the high rate of older pedestrian casualties is that they are involved in more road crashes. Older people are often thought to precipitate their own accidents because of the way they cross the road. Their reduced physical capabilities result in less mobility and a reduced ability to move out of the way of approaching cars. Furthermore, their traffic judgements may also be quite different from those of younger people because of perceptual, sensory and cognitive deficits (Oxley, Fildes, Ihlen, Carlton; 1997)

Like children, some older adults may also overestimate their own abilities. Many experience physical changes that affect their ability to cross the street safely. Age and senility can lead to slowed reactions, and to awareness problems with physical mobility. Older people take longer to get around. In addition to the problems of moving from place to place, older people may have difficulties with their sight and hearing that make them much less aware than others of the presence and speed of traffic. (Appleyard, 1981)

Pedestrians aged 65 and older are more than 5 times as likely to die in traffic crashes than pedestrians age 14 or less. Elderly pedestrians are more susceptible than young pedestrians to injury and death. Young pedestrians have a better chance of withstanding impacts unharmed. (<http://www.dmv.state.va.us>)

As a summary, some of these changes are:

- A decrease in mobility and reaction time
- Some degree of hearing loss
- A decrease in visual acuity. (<http://www.hlunix.hl.state>)

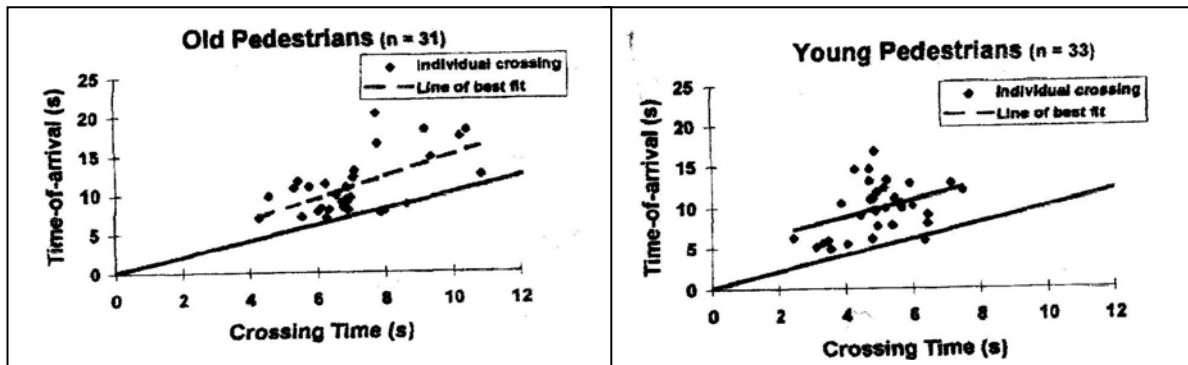


Figure8: Distributions of crossing time by time-of-arrival measures for individual road crossings on two-way roads, “Differences in Traffic Judgements between Young and old Adult Pedestrians,” Monash University Accident research Centre

3.1.1.3.Disabled Persons

“Disabled persons who are frail and handicapped, having an organ malfunctioning, of whose movement ability is usually constrained. It is expected that disabled suffer more from the disadvantageous positions. (Duvarci, 2000)

T.S.E (Institute of Turk Standards) defines disability as physical or mental impairment. It separates physical disabled into three parts:

- Physical impairment: These persons have movement impairments. They can not move without a helper like walking stick, wheel chair.
- Visual impairment: These persons have vision impairment that is complete or partial. “A totally or partially blind pedestrian who is carrying a predominantly white cane (with or without a red tip), or is using a guide dog, has the right-of-way. The driver of any vehicle approaching such a pedestrian who fails to yield the right-of-way or to take all reasonably necessary precautions to avoid injury to the blind pedestrian is guilty of a misdemeanor”

(<http://www.csaa.com/about/education/pedestrian.asp>)

- Auditory impairment: These persons have complete or partial loss of auditory ability.

In society, there are not only permanently disabled persons. Each person can be disabled for a part of his/her life. Therefore an important point is that disabilities are one of the most important factors that should be considered in design. People become temporarily restricted in their movements either through a disease or trauma that requires time to heal, or simply in performing the normal functions of everyday life. As an approach, both children under 12 years old and elderly over 60 years may be accepted as disabled. (Aydemir, 1988) In addition persons who have some illness, pregnant women, shoppers with his arms loaded with packages, mothers with child can be accepted as disabled during certain periods.

3.1.2. Social and Cultural Characteristics of the Pedestrian

There are significant social, economic, environmental and cultural differences between countries, and approaches to preventing road accidents. 85 Per cent of road deaths occur in the developing world which contains only 30 Per cent of the vehicles.(Dr. Got JACOBS, Road Safety Congress, 2000) In addition to this, in 1990 the World Bank estimated that 500000 people are killed in road traffic accidents each year and 350000 of these die in developing countries. (Downing,A.J.,1991) For example, pedestrians account for 40 percent of motor vehicle deaths in Russia, 38 percent in Poland, 36 percent in Israel and 28 percent in England. The problem is even bigger in developing countries. Pedestrians account for more than half of all motor vehicle deaths in Ethiopia and 45 percent in Kenya. (National Safe Kids Campaign, 1999)

A research made by Transact Organization shows that low income populations are more likely to be victims in pedestrian accidents. Other studies show that pedestrian injures and deaths, particularly among children, are correlated to income and several other socioeconomic factors including access to a car. Factors include unemployment, single-parent and especially female-headed households, young mothers, low levels of education, the number of times a family has moved, and the number of children in a household. (<http://www.transact.org/ca/design/tac.htm>)

3.2.Characteristics of Pedestrian Movements

Pedestrian movement is one of the most common and basic forms of transportation. Pedestrian movements are mostly at the local level, and the goal should be to improve the walkability of a community. Some measures to obtain this goal are:

- Encourage more walking
- Better accommodate those who use walking as their primary mode of transportation.
- Reduce the number of pedestrian-motor vehicle crashes.

Pedestrian movements may be examined under two points:

- Pedestrian areas (squares, sites, walkway...)
- Passing that provide connection between pedestrian sites.
(<http://www.bikefed.org/introduction.htm>)

An important point on design of pedestrian walkways is conflict between pedestrian and vehicle. Each year, many pedestrians die or are injured at vehicle-related traffic accidents. For that reason it is necessary to provide safe, suitable, and sufficient intersection points between pedestrian areas and crosswalks.. Therefore this study will be especially about crosswalks and their relation to pedestrian sites.

Another point the study considered is that there are different issues for pedestrians in different parts of the City. Areas like the Central City have a higher concentration of activity - both pedestrians and other road users - and so there is a greater need to concentrate on safety measures. This is also true for pedestrians crossing busy roads, where traffic speeds are higher. In contrast, many residential suburban areas have less traffic, moving slower and therefore are more attractive for pedestrians.

The typical walking trip is less than 1.6 km in length. So planning for pedestrians is focused on small scale improvements and local environments. Regional scale plans tend to overlook issues of most concern to pedestrians walking in a traffic. Specifically, detriments to walking and obstacles to pedestrians include:

- Missing section of sidewalk
- Uneven walking surface
- Misuse of pedestrian facilities

- Poor maintenance
- Narrow walkway width
- Missing curb cuts
- Difficult street crossing
- Lack of respect for walking as a travel mode
- Barriers on walking routes
- High traffic levels or speeds (especially near schools, parks, or retirement centers)

Conversely, environmental factors that are known to encourage walking include:

- Continuous sidewalks
- Safe street crossings
- Pedestrian signs, signals and markings
- Compact land use
- Sidewalk set-back
- Landscaping and lighting (www.bikefed.org/introduction.htm)

In Karachi, which is the largest city of Pakistan with an estimated population of 10 million, 250 pedestrian were observed. Of the 250 pedestrians observed crossing the street 194 were males (78%). A total of 86% were young adults; 8% were children and 6% appeared elderly. Only 60% of the pedestrians looked left and right before crossing. A total of 130 pedestrians (52%) crossing the street did so less before a vehicle passed the point they just crossed. A total of 87 pedestrians (35%) caused the traffic to swerve, that is the vehicles changed their trajectory to avoid striking the observed pedestrian. Pedestrians who crossed the street one lane at a time were 2.9 times more likely to cause the traffic to swerve than pedestrians who crossed the whole street at once. Children were 1.8 times more likely to cause traffic to swerve compared to adults. A total of 89 pedestrians (36%) ran on the street while crossing and these were 1.8 times more likely to cause traffic to swerve than those pedestrians who crossed without running.

A total of 84 pedestrians (34%) crossed the street as part of a group; 39 of these pedestrians (46%) were conversing with others in the group and in 33% of the groups only one person was assessing the safety of the group. Pedestrians crossing in a group were 1.8 times more likely to cause traffic to swerve compared to those crossing singly.

3.3. Characteristics of Pedestrian Accidents

Pedestrian deaths are principally an urban problem. Many pedestrians are killed at crosswalks, sidewalks, median strips, and traffic islands. Physical separations like overpasses, underpasses, and barriers can reduce the problem. Warning signs and pavement markings at intersections can also be effective. And because there's a higher ratio of pedestrian deaths to injuries where speed limits are higher, lowering the limits could reduce pedestrian deaths.(<http://www.highwaysafety>) People are killed and injured on the road in avoidable accidents in almost all countries. Many of the causes are the same: Poor driving, speed, drinking and driving, the vulnerability of pedestrians, pedal cyclists-motor cyclists, children and older people, inadequate highway design and so on. (<http://www.rospace.com>) Pedestrian fatalities are the second largest category of deaths from traffic crashes, motor vehicle occupants are the largest. (Table 3)

Table 3: Rate on faults of driver, pedestrian, passenger, vehicle, road at crash

YEARS	DRIVER	PEDESTRIAN	PASSENGER	VEHICLE	ROAD	OTHER
	%	%	%	%	%	%
1995	91.84	5.02	0.12	1.02	2	-
1996	88.08	9.48	1.35	0.69	0.40	-
1997	96.61	2.61	0.22	0.56	0.01	-
1998	96.48	2.77	0.21	0.53	0.01	-

Source: General Directorate of Highway; "Trafik Kazaları Özeti", <http://www.kgm.gov.tr> , 1998

Pedestrian road traffic accidents are a significant problem in many developing countries. In Karachi, Pakistan in 1994, of the 462 reported road accident fatalities almost two-thirds (63%) were pedestrian fatalities. This contrasts with only 14.5% of all motor vehicle crash fatalities in the US involving pedestrians. On average, in the United States, a pedestrian is killed in a traffic crash approximately every 101 minutes. Approximately every 8 minutes, a pedestrian is injured. (<http://www.nhtsa.dot.gov/people/outhreach/safesobur/Oplanner/ncpsw/pedest3.html>)

3.3.1. Factors Causing Accidents

Road traffic accidents have multiple causes including human error, the road environment and vehicle factors. A traffic accident research in developing countries noted that human error accounted for 64-95% of studied road traffic accidents. For example according to police records, 91% percent of road traffic accidents in Karachi, Pakistan are ascribed to road user error. (Downing,1991)

Speed is also a major factor in whether a pedestrian accident proves to be fatal. A ten-mile per hour increase in speed, from 20 mph to 30 mph, increases the risk of death for a pedestrian in a collision nine-fold. If a car going 20 mph hits a person, there is a 95 percent chance that the person will survive. If that same car is travelling 30 mph, the person has slightly better than a 50/50 chance of survival. At 40 mph, the picture is bleaker still – only fifteen percent of people struck at this speed can be expected to survive. ([http://www .region.halifax](http://www.region.halifax))

Even though pedestrians have the right of way at marked crosswalks, pedestrian/vehicle accidents do occur. Research suggests that pedestrians may have a false sense of security at marked crosswalks. They may step off the curb into the crosswalk and expect oncoming vehicles to stop. However, drivers sometimes fail to stop. (<http://www .state.nj.usy>)

Another frequent situation causing accidents at mid-block crosswalks happens when the driver of a vehicle nearest the curb stops for a pedestrian who is waiting to cross or who is already in the crosswalk. When the driver of a vehicle in the lane next to the stopping vehicle tries to pass the first vehicle and hits the pedestrian. Pedestrians should be very cautious when crossing in a crosswalk, especially when their visibility is limited by vehicles already stopped at the crosswalk as illustrated. At all crosswalks, both marked and unmarked, it is the responsibility of pedestrians to be cautious and alert before crossing the street. (<http://www.state.nj.us>)

Table 4: The rate of pedestrian faults caused accident in urban and rural,1998

CAUSES OF ACCIDENTS	CRASH					
	URBAN AREA		RURAL AREA		TOTAL	
	number	%	number	%	number	%
Crossing at red light	320	2.43	21	1.54	341	2.35
Not giving right-of-way	4.512	34.30	427	31.30	4.939	34.02
Darting to road	5.696	43.31	690	50.59	6.386	43.99
Darting from back or front of stationary car	854	6.49	61	4.47	915	6.30
Playing on road	1.299	9.88	78	5.72	1.377	9.49
Hitching a ride	65	0.49	0	0.00	65	0.45
Drinking	208	1.58	24	1.76	232	1.60
Blindness	28	0.21	0	0.00	28	0.19
Deafness	38	0.29	0	0.00	38	0.26
Pedestrian on highway	133	1.01	63	4.62	196	1.35
Total	10.153	100.00	1.364	100.00	14.517	100.00

Source: General Directorate of Highway; “Trafik Kazaları Özeti”, <http://www.kgm.gov.tr> , 1998

At the observations made in Karachi females were less likely to look in both directions of the road before crossing, more likely to cross one lane at a time, and more likely to cause the traffic to swerve than males. (Table 5) Most pedestrians used non-designated areas to cross the street. Since zebra crossings were absent at most intersections (six of ten sites in this study) pedestrians may be accustomed to this and as a result they do not look for them. More over, even when they cross at the zebra—crossing, the cars usually do not stop or slow down and therefore it is of no benefit. (Khan, Jawaid, Chotani, Luby; 1998)

Table 5: Comparison between male and female risky behaviour while crossing the street, Karachi, Pakistan, January, 1996

Risk behaviour	Relative risk	No. of females(%)	No. of males (%)
Did not look left and right before crossing	1,9	36(64)	65(34)
Caused traffic to swerve around them	1,6	28(50)	59(30)
Were not on zebra-crossing while crossing the street	1,1	20(80)	57(76)
Ran to cross the road	1,1	18(32)	71(37)
Crossed one lane at a time		36(64)	83(43)

Source: KHAN, Faraz; JAVAID, Munima; CHOTANI, Habib; LUBY, Stephen; "Pedestrian Environment and Behavior in Karachi, Pakistan" ; *Accident Analysis and Prevention*"; Community Health Sciences Department, The Aga Khan University; Pakistan, 1998

Another important observation of this study is about people crossing in groups. They were a significant cause for traffic to swerve as well. This was not only due to their slow movement across the street but also because nearly half of the observed pedestrians were talking to each other hence making their distance judgement less effective. One report has concluded that group crossing was one of the most hazardous situation in pedestrian-traffic conflicts.

In developed countries the usual target population for pedestrian road traffic accident prevention strategies are children and the elderly. A high proportion of child mortality has been reported from developed countries. In contrast, data from Karachi and other developing countries shows that the majority of road accidents occur in young adults with the male to female ratio ranging from 2:1 to 4:1.

Table 6: Driver faults by year

Date	Wrong lane	Faulty stop	Not stopping at walk signal	Unsuitable loading	Improvudent, absent-mindedness, sleeplessness	Faulty crossing	Faulty turning	Drunkenness	not considering right of way	Breaking speed limit	Near pursuit
1988	395 6.2	26 0.4	321 5.0	3 0.04	925 14.5	327 5.1	523 8.2	173 2.7	1299 20.3	594 9.3	1803 28.3
1989	397 7.2	3 0.05	201 3.6	1 0.01	905 14.5	385 7.0	348 6.3	135 2.5	1170 21.2	463 8.4	1487 27.1
1992	1235 11.4	2 0.02	422 3.8	-	1055 9.7	997 9.2	782 7.2	107 0.1	1683 15.4	852 7.8	3740 34.4
1993	1291 9.3	3 0.02	374 2.7	2 0.01	1521 10.9	1084 7.8	1317 9.5	118 0.8	2150 15.5	1130 8.1	4909 35.3

Source: IV. National Public health Congress (12-16 September 1994,Didim)

Table 7: Pedestrian faults by year

Date	Total	not crossing at pedestrian crosswalk	Darting across	Darting out to road from front of inactive vehicle	Walking on road	Sitting or playing on road	Hitching a ride on	Drunkenness	Crossing at red light	Others
1988	1095	-	652 59.5	68 6.2	24 2.2	7 0.6	4 0.4	33 3.0	46 4.2	261 23.8
1989	1165	12 1.8	741 63.6	111 9.5	19 1.6	4 0.3	1 0.1	35 3.0	46 3.9	196 16.8
1992	1205	1 0.1	551 45.7	165 13.7	28 2.3	- 0.0	- 0.0	30 2.5	43 3.6	387 32.1
1993	1054	5 0.5	494 46.9	157 14.9	15 1.4	6 0.6	2 0.2	19 1.8	45 4.3	311 29.5

Source: IV. National Public health Congress (12-16 September 1994,Didim)

There is a definite need for environmental interventions but they need to be designed in such a manner that they are adequately utilized by pedestrians. Pedestrian education can be an important component to improve the effectiveness of these environmental interventions.

The type of crash for younger and older pedestrians was classified into several discrete categories. (Table 8) . For both groups of pedestrians, almost half of the crashes occurred as pedestrians stepped off the kerb. These generally happened as they walked

out from behind parked cars into the path of an oncoming vehicle. While younger pedestrians had slightly more collisions on the far-side than the near-side of the road, older pedestrians were much more likely to have a collision on the far-side than the near-side of the road. This result may be a function of the sites chosen for investigation as many pedestrian crashes occur away from strip shopping centers where no cars are parked along the road.

Table 8: Road location of pedestrian collisions (%)

Road location	Older pedestrian	Younger pedestrian
On-road near side	9	22
On –road far-side	31	26
Stepping off kerb	48	47
Other	12	5

Source: Oxley, Fildes,Ihsen, Carlton; Differences in Traffic Judgements Between Young and Old Adult Pedestrians; 1997

*near side meant lane with traffic approaching from the nearside of the road

far-side meant lane with traffic approaching from the far-side of the road(

Note: cars in travel on the left side of the road.

A large proportion of collisions occurred in the far-side lane, and older pedestrians were more often involved in these types of crashes. This result is shows that a large number of older pedestrians made judgements on the near-side traffic and commenced to cross without consideration of the far-side traffic and often found themselves in a potentially dangerous situation in the center of the road. It is possible that the increased rate of far-side collisions in older pedestrians is a result of this lack of consideration for traffic in the far-side lane. However, higher crash rates in the fr-side lane may also be caused by slower walking speeds of older pedestrians. (Oxley, Fildes,Ihsen, Carlton; 1997)

3.3.2. General Characteristics of Crash Sites

In the early 1990's, a methodology for typing pedestrian crashes was developed by United States the National Highway Traffic safety Administration to better define the

sequence of events and precipitating actions leading to pedestrian-motor vehicle crashes.

A brief summary of the results showed the following:

- Nearly one-third (32.2 percent) of all crashes occurred in or near (within 50 ft) an intersection. Of these:
 - %30 involved a turning vehicle
 - %22 involved a pedestrian either running to cross the intersection or darting out in front of a vehicle whose view was blocked just prior to the impact.
 - %16 driver violation
 - Mid block events was the second major grouping of crash types and accounted for 26.5 percent of all crashes.
 - %25 Dash. (The pedestrian ran into the street and the motorist's view was not obstructed
 - %17 Dart-outs. The pedestrian ran or walked in to the street, but the motorist view was obstructed until just before the impact.
 - Just over %7 of the crashes involved a pedestrian walking along the roadway and not on a sidewalk.
- %72 It involved a pedestrian walking with traffic and being struck from behind. ([http:// walkinginfo.org/cps/index.htm](http://walkinginfo.org/cps/index.htm))www.

Sixty-eight percent of pedestrian deaths in 1999 occurred in urban areas. However, the ratio of deaths to injuries is higher in rural areas because of higher impact speeds on rural roads.

Thirty-six percent of pedestrian deaths among people age 65 and older in 1999 occurred at intersections. This compares with 7 percent of pedestrian deaths among children age 4 and younger. ([http:// www. highwaysafety](http://www.highwaysafety))

Most fatalities occur on neighborhood streets. More than half-55 percent-of all pedestrian deaths by automobiles occur on neighborhood streets. The problem is not that pedestrians are walking in the wrong places, but that our local streets are becoming speedways-designed to accommodate more cars passing through, not the people who live, walk, and play in their communities. (<http://www.transact.org/Reports/Mean/for.htm>)

Chapter 4

ACCIDENT PROTECTION SYSTEMS

4.1. Pedestrian Crosswalks

Two methods of reducing conflicts between pedestrians and vehicles are time separation and space separation. Separation in time means that while one stream of traffic moves through an intersection the other pretenders to its use must wait: The capacity of a traffic channel interrupted by an intersection is thus reduced in relation to the amount of time the intersection is occupied by the conflicting traffic stream Traffic signals are a mechanism for providing time separation. (Pushkarev, 1978)

Space separation is achieved by closing streets to vehicles and creating malls. Space separation can also be achieved by the use of undercrosswalk or overcrosswalk. If these are not with in the direct line of pedestrian traffic, however, they may not be fully used because of the inconvenience of a longer walking distance. (Rubenstian, 1992) Space separation is the ideal solution to pedestrian-vehicle conflicts, but can only be effective if its used. At a ground level intersection, simply the street is simply much more convenient than climbing two long ramps, up and down, in addition to elevation or is forced to use the ramps. ([http:// www. regional.halifax](http://www.regional.halifax)) In addition another important point is loss of energy in using crosswalks. The loss of energy in crossing the road is different from the loss of energy in using under crosswalks. Six-times more energy is used for under ground crosswalk's (Figure 9 and Figure 10). On the other hand, if loss of energy in level crosswalk is one value, the overcrosswalk's is nine value. (Figure 11)

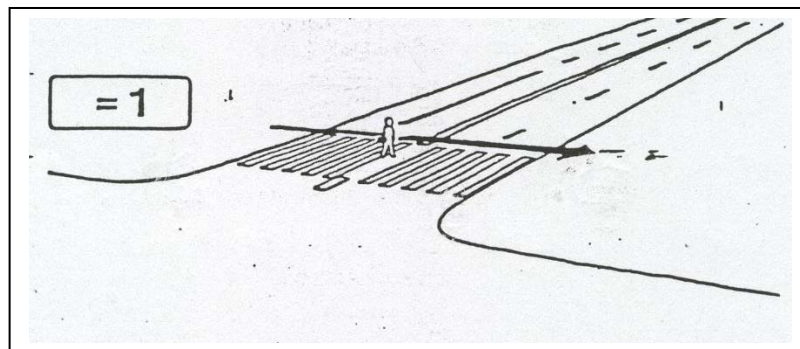


Figure 9: Loss of energy in level ground crosswalk (Institute of Turkish Standards)

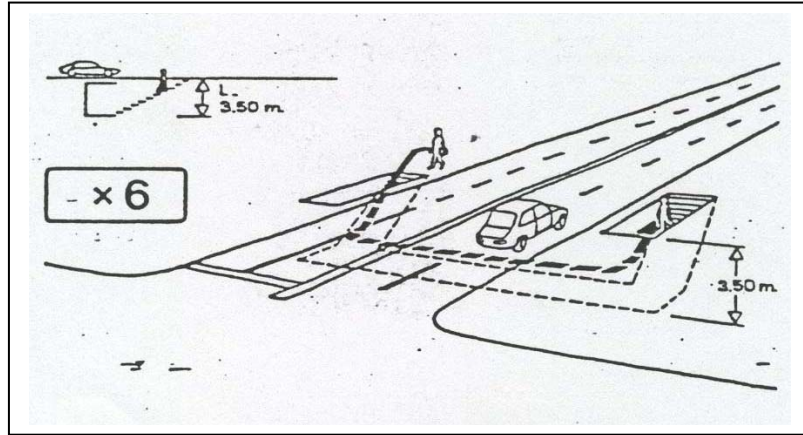


Figure 10: Loss of energy in undercrosswalk (Institute of Turkish Standards)

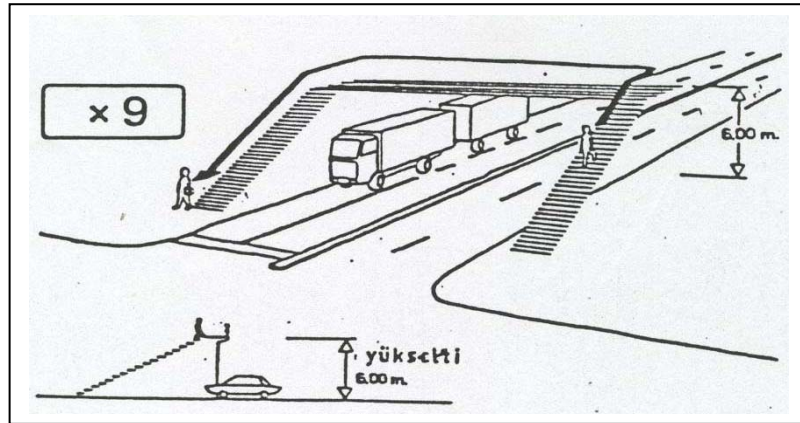


Figure 11: Loss of energy in overcrosswalk, (Institute of Turkish Standards)

The selection of the type and the technical warrants for crosswalks are based essentially on the potential for vehicle-pedestrian conflict and are calculated using vehicle volumes, pedestrian volumes, and other factors (<http://www.region.halifax>).

Crosswalks are usually marked at intersections where there is a substantial amount of vehicle and pedestrian travel. Examples of such locations are along school routes and at signalized and four-way stop intersections. Besides, occasionally crosswalks are marked at mid-block locations to accommodate greater pedestrian traffic or where there is a substantial distance between corner of the crossings. (<http://www.state.nj.usy>)

4.1.1. Ground Level Crosswalks

Important point for this type is time separation. The same roads are used at different times by pedestrians and vehicles. There are mechanisms for providing time separation, such as traffic signals. At intersections, crosswalks can be marked or unmarked. In either case drivers must yield right-of-way to a pedestrian crossing in the roadway.

4.1.1.1. Marked Crosswalks

“Marked crosswalks are widely classified as safety devices and most jurisdictions give the pedestrian the right-of-way when within them. Interestingly, however, there is strong evidence that these very facts prompt many pedestrians to feel overly secure when using a marked crosswalk to the degree that they may aggressively place themselves in a hazardous position with respect to vehicles in the mistaken belief that the vehicle can and will stop in all cases, even when it may be impossible to do so. It is not unusual, also, for this type of pedestrian behavior to cause rear-end collisions.”

(<http://www.dot.state.az.us/ROADS/traffic/xwalk.htm>)

One of the commonly accepted functions of the marked crosswalk is that it serves as a warning device to the traveling public. The marked crosswalk is a useful traffic engineering device for channelizing pedestrians and helping pedestrians find their way across complex and confusing intersections

The need for these systems are determined by:

- Level of vehicle and pedestrian density
- Number of existing accidents at the area
- Security, convenience, safety and advantages for pedestrians.

Some calculations are needed for application of marked crosswalk. The necessity for application of marked crosswalk is determined by calculating the PV^2 value. The equation is fixed by England Department of Transportation.

P : Pedestrian flow /hour

V : The number of vehicles in both directions / hour

PV^2 value must be the average of four most busy hours in a day. The value should be higher than 1×10^8 for application of marked crosswalk. If the value is higher than 2×10^8 , refuge should be constructed in addition to marked crosswalk on roads like these.

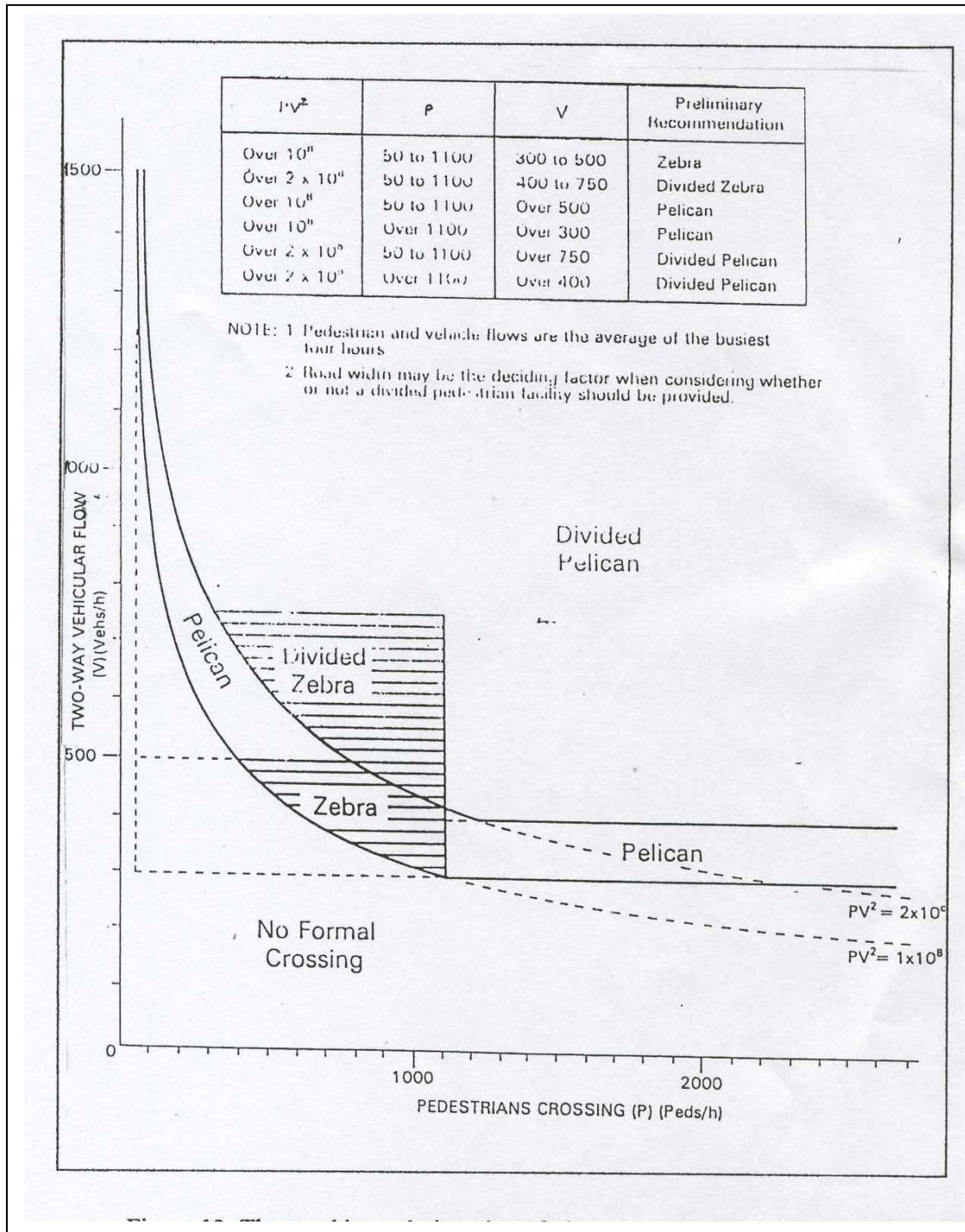


Figure 12: The graphic on designation of the crosswalk type

(In general, marked crosswalks have the following advantages and disadvantages:

❑ Advantages

- May help pedestrians to channel themselves and find their way across complex intersections
- May help show pedestrians the shortest route across traffic
- May help show pedestrians the route with the least exposure to vehicular traffic and traffic conflicts.
- May help position pedestrians where they can be seen best by oncoming traffic.
- May help utilize the presence of luminaries to improve pedestrian night time safety.
- May help to channel and limit pedestrian traffic to specific locations.
- May aid in enforcing pedestrian crossing regulations.
- May act, in a limited manner, as a warning device and reminder to drivers that this is a location where pedestrian conflicts can be expected.

❑ Disadvantages:

- May cause pedestrians to have a false sense of security and to place themselves in a hazardous position with respect to vehicular traffic.
- May cause the pedestrian to think that the driver can and will stop in all cases, even when it is impossible to do so.
- May cause an increase in fatal and serious injury accidents.
- May cause a disrespect for all pedestrian regulations and traffic controls.

Zebra Crosswalks

USA National standards identify zebra markings as alternating standard parallel white lines. (<http://www.regional.halifax>) At this system traffic lighting is absent but pedestrians have always crossing superiority. Crosswalks like these were first used in 1926 on London-Parliament Square in England.

Pedestrians have superiority at this type of crosswalk. But it is uncertain whether the vehicles will stop or not, on roads that have heavy traffic. They provide practical flowing for pedestrian and provide uninterrupted flowing when pedestrians are absent for vehicles although they have less safety than crosswalk with traffic lighting. At

points that have high pedestrian flows (such as station of public transportation, retail streets etc...) they cause traffic congestion.

The simple rule is that traffic volume level should be neither too high nor too low for application of zebra crosswalks. Because pedestrians can cross easily at a wide gap, and on high level traffic volume, often stopped traffic flow causes delay of vehicles, decrease of speed, fuel usage from which effects the vehicle traffic negatively way. (Gülgeç, 1986)

The negative side of zebra crosswalk is the increased maintenance cost for repainting and the reduced friction caused by the increased painted surface which is a hazard for pedestrians, bicycles and motorcycles. Although the zebra markings are more visible, the increased visibility is much more apparent to pedestrians than they are to motorists who view the markings from a lower and from an “end-on” perspective.

Pelikan Crosswalks

Pelikan crosswalks are applied on points where high level of flow is intersected by low level of flow. Pelikan crosswalks should be set up if equation of pv^2 is upper side of certain level. This type of crosswalk provides safety and special time to pedestrian for pedestrian crossing. thanks to lights they give a sense of security to pedestrian. Using time separation on pedestrian and motor traffic by using traffic lighting, pedestrians are delayed despite of rising safety.

Crosswalks with control lights are in two types:

- Normal lighting control: Pedestrian phase starts automatically
- Pushing lighting: It starts when pushed by pedestrians

Pelikan crosswalks are more suitable to use in places where there are a lot of elderly and ill persons, movement of vehicles are too fast and where city traffic controls are applied. On pelikan crosswalks signals that ring intermittently for helping the visually impaired impairments should be used. Use of rough surface also makes it easy to perceive for the visually impaired. Another system is the use of shiver boxes that start operating with the green light.

Puffin Crosswalks

Especially children, elderly persons, and disabled peoples may can not cross in certain time. In this case, time of green light is not enough for pedestrians. Puffin crosswalks are systems that have extension time for pedestrian crossing. Devices set on the crosswalks scan the crosswalks with infrared beams, so that light is green during the time devices perceive pedestrians. This type of crosswalks should be place near hospital, school etc

4.1.1.2. Unmarked Crosswalks

Contrary to the use of marked crosswalks pedestrians using unmarked crosswalks generally feel less secure, less certain that the vehicle will stop- and exercise more caution in waiting for safe gaps in traffic before crossing.

Divisional Pedestrian Island

This is a system where the pedestrian pays attention to one way vehicle thanks to a safety waiting point in the middle of the road. This system is used:

- Where level of pedestrian density is on the rise
- Where a marked crosswalk is unnecessary.

These systems are applied in places which don't have traffic lighting, zebra, and another crossing systems. Divisional pedestrian islands provide roads narrowed. For that reason the speed of vehicles is reduce.

The divisional islands that are on the crossroads without traffic lighting, provide crossing for pedestrians. In such situations, crossing must be provided at a distance from the intersection. The distance should be regulated so that pedestrians do not give up using the island. But, at the same time , it should be far enough to accommodate safe turning of vehicles. Distance can change in relation to use of vehicles and land use.

4.1.2. Separated Level Crosswalk

Under Crosswalks

A pedestrian under crosswalk or tunnel allows pedestrians free passage under busy roads, road junctions, buildings etc. In cities which have an underground railway

network, subways are often combined with station entrances and underground booking halls. (Cartwright, 1984)

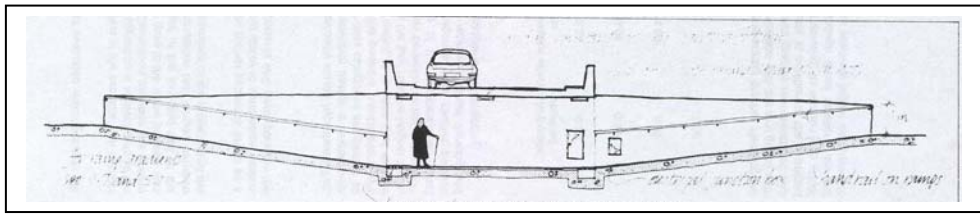


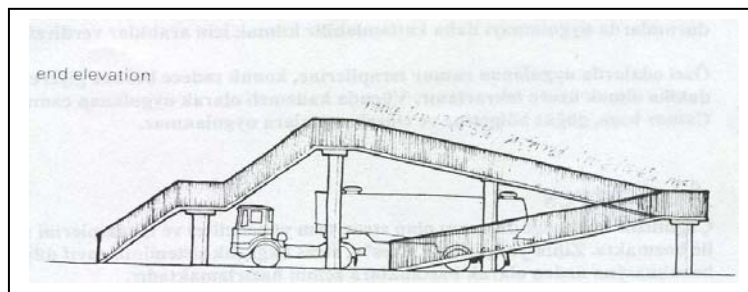
Figure 13: Under crosswalk, “Design of Urban Spaces”

Pedestrian under crosswalk can be entered by steps, ramps or both steps and ramps. Where space permits both ramps and steps should be provided at each entrance and exit. The slope of the ramps should not exceed 1/20 (%5). (Cartwright, 1984)

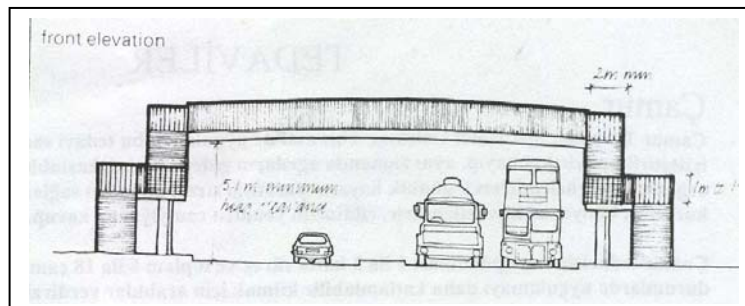
Pedestrian under crosswalk create security problems especially when there are dangerous places in the immediate vicinity.

Over Crosswalks

Over crosswalks allow pedestrians uninterrupted passage over obstructions, busy roads, railways, rivers, buildings and so on. (Cartwright, 1984)



(a)



(b)

Figure 14: Crosswalk elevations (a) end elevation with ramp, (b) front elevation with stairs; Design of Urban Spaces.

Over crosswalks have some advantages over pedestrian under crosswalks. Most importantly, they cost much less and can be erected very quickly, often in only one or two days on prepared foundations. However, they suffer disadvantages which may be impossible to overcome at particular sites.

- The minimum clearance of 5.1 m above the road surface, means that the pedestrian diversion from the horizontal route, is more than twice that for under crosswalks. Consequently, ramps and steps have to be more than twice as long, which does not help those in most need, namely the disabled or elderly and people with prams and small children.
- Where an over crosswalk is near buildings, there is often some degree of overlooking and a loss of privacy in the area surrounding the over crosswalk.
- The effects of wind and weather are usually more severely felt on over crosswalks than at the surrounding ground level.
- An over crosswalk is a large-scale item in any environment. In certain areas, particularly conservation areas and those of special historic or architectural value, the visual intrusion would more than outweigh any benefits gained by pedestrians, and an alternative form of crossing should be provided. (Cartwright, 1984)

4.2. Traffic Calming

Communities can take a variety of actions designed to make road safer, including: traffic calming-The installation of speed bumps, traffic circles or other devices in residential neighborhoods that slow cars down, and ensure that pedestrians are safe, providing separate walkways and other spaces for pedestrians, designing public spaces to be more pedestrian friendly-including the installation of sidewalks, handrails for the infirm, bricked crosswalks, and even actions as simple as changing the patterns of the lines on the road, enhanced public education on pedestrian safety, and adequate enforcement of laws designed to protect pedestrians. These tools are already making the roads safer for pedestrians in some communities.

(<http://www.transact.org/Reports/Mean/for.htm>)

Traffic calming redesigns streets to reduce vehicle speeds and give more space and priority to cyclists and pedestrians. Traffic calming includes a variety of changes that

slow or divert vehicle traffic, separate pedestrian pathways from vehicle traffic, and make the road corridor more pleasant. Common traffic calming measures include landscaped traffic circles, medians or extended sidewalks that narrow the roadway, and partial closures to divert through traffic. (<http://www.region.halifax.ns.ca>)

“Traffic calming involves changes in street alignment, installation of barriers, and other physical measures to reduce traffic speeds. Traffic calming in the vicinity of major crosswalks may reduce the potential for collisions” (<http://www.region.halifax>)

“Traffic calming” refers to the practice of designing streets to reduce vehicle speeds, ensure that drivers are more careful, or take safer routes. It includes narrowing the roadway, diverting non-local streets, changing pavement surfaces, installing speed humps, constructing roundabouts (a form of traffic circle) and putting up stop signs. These measures improve pedestrian safety, and make public spaces more conducive to pedestrian activity and street life. (<http://www.transact/Road/Measure/for.htm>)

Traffic calming typically involves the installation of such devices as speed humps (a gentler version of speed bumps) and traffic circles to discourage speeding and cut-through traffic. Other commonly employed techniques include changing the design of roadway by narrowing it in strategic places or using special pavement types. Traffic calming can also include modifications such as partial street closures and diverts, which actually serve to re-route traffic. (<http://www.nashville.org>)

The main objective of traffic calming has been defined as below:

- To reduce the severity and the number of accidents in built-up areas;
- To reduce air and noise pollution;
- At the same time to “improve” the urban street environment for non-motor users including pedestrians, cyclist and disabled people.(Hass-Klau,1990)

4.2.1. Traffic Calming Devices

Traffic control devices can affect the speed, composition, direction and volume of traffic as well as other aspects of driver behavior. A traffic device can, simultaneously, improve conditions for pedestrians, by widening the sidewalks or making a crossing easier to negotiate. (Appleyard, 1981)

Traffic calming devices can be separated into two groups based on the main impact intended:

- First are the measures to reduce vehicle speeds (speed control measures)
- Second is the supporting environmental and safety measures (volume control and pedestrian safety)

The distinction between the two types of measures is not as clear as it appears since speed control measures frequently divert traffic to alternate routes, and volume control, and safety measures usually slow traffic. (<http://www.trafficcalming.org>) So the planning objective is difficult to define in quantitative terms, as improvement of the urban environment will be judged differently by individuals. A reduction of motor speed is normally carried out either by physical changes of the carriageway, such as chicanes, parking at right-angles, narrowing streets, raised crossing, traffic signs which restrict the speed of motor traffic.

The environmental objective implies at best a reduction of the level of air pollution and noise level which are inflicted by motor vehicles. Both have an impact on the comfort and health of pedestrians, and the improvement of the urban environment. (Hass-Klau,1990)

4.2.1.1. Speed Control Devices:

Speed control measures are primarily used to address speeding problems by changing vertical alignment, changing horizontal alignment, or narrowing the roadway. (<http://www.transciportland.or.us>)

Vertical Shifts:

1.Speed Humps:

Speed humps are barriers constructed on roads. Hump is a greater version of speed bumps. (<http://www.nashville.org>) They provide safety on a large scale. Studies of humps have pointed out that humps have a prevention rate of 80 per cent for child related accidents. Humps ensure that drivers of motor-vehicle drive their vehicles, with limited speed and certain attention.

A raised proportion of carriageway laid at right angles to the direction of traffic. Can have flat top integrated with the footway to assist crossing movements. (Devon County Council, 1991; pp:31)

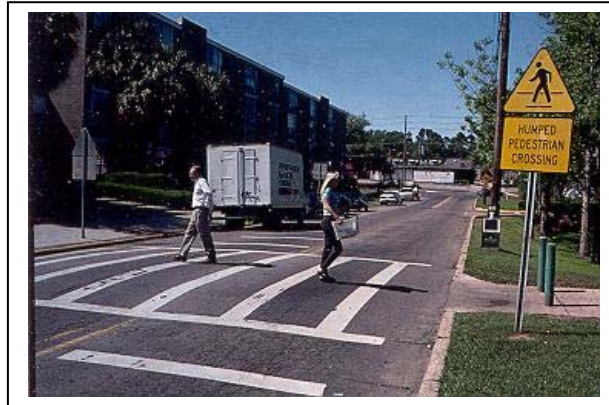


Figure 15: Speed Hump

The humps are about twelve feet long and rise gradually to a maximum height of four to six inches. The exact geometry is very important. The hump length is one-and-a-half times the wheel-base of the normal car, so that cars do not “fly” off it. Careful testing in Britain has shown significant effects on speed and no accident problems. Care must be taken in their location, and accompanying signs are necessary. (Appleyard, 1981, pp:299-300) Road humps are not recommended on bus routes due to the discomfort caused to passengers. (Hass-Klau,1990)

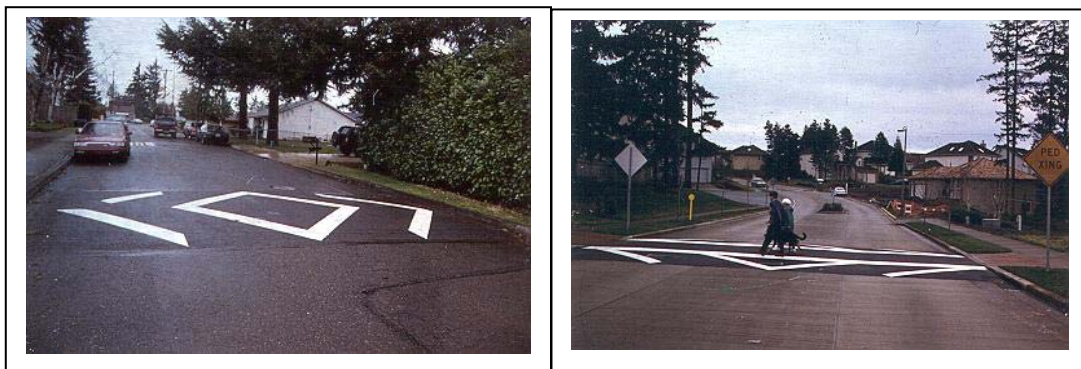


Figure 16: Colored speed humps ; [http:// www. transciportland.va.us](http://www.transciportland.va.us)



Figure 17: Speed humps; [http:// www. transciportland.or.us](http://www.transciportland.or.us)

2.Speed Bumps:

Speed bumps, which are shorter and more abrupt than speed humps, are typically used in parking lots and are not recommended for use on public streets. (<http://www.region.halifax.ns.ca>) Speed bumps are traffic management devices used for lowering the speed of motor vehicles along specific street sections. Speed bumps should be used only when justified by field studies (<http://www.trans.ci.portland.or.us>). Tests in California have shown that the problems with short bumps are that schoolbusses and fire trucks can have a bumpy ride, and teenaged drivers love to speed back and forth across them. They can cause a slight noise problem and are considered potentially dangerous. (Appleyard, 1981, pp:299)

Main advantages and disadvantages of speed bumps can be summarized as fallow:

Advantages	Disadvantages
• Effectively reduce vehicle speeds • Do not require parking removal • Pose no restrictions for bicycles • Do not effect intersection operations	• Can possibly increase traffic noise from braking and acceleration of vehicles, particularly buses and trucks • Slows fire vehicles

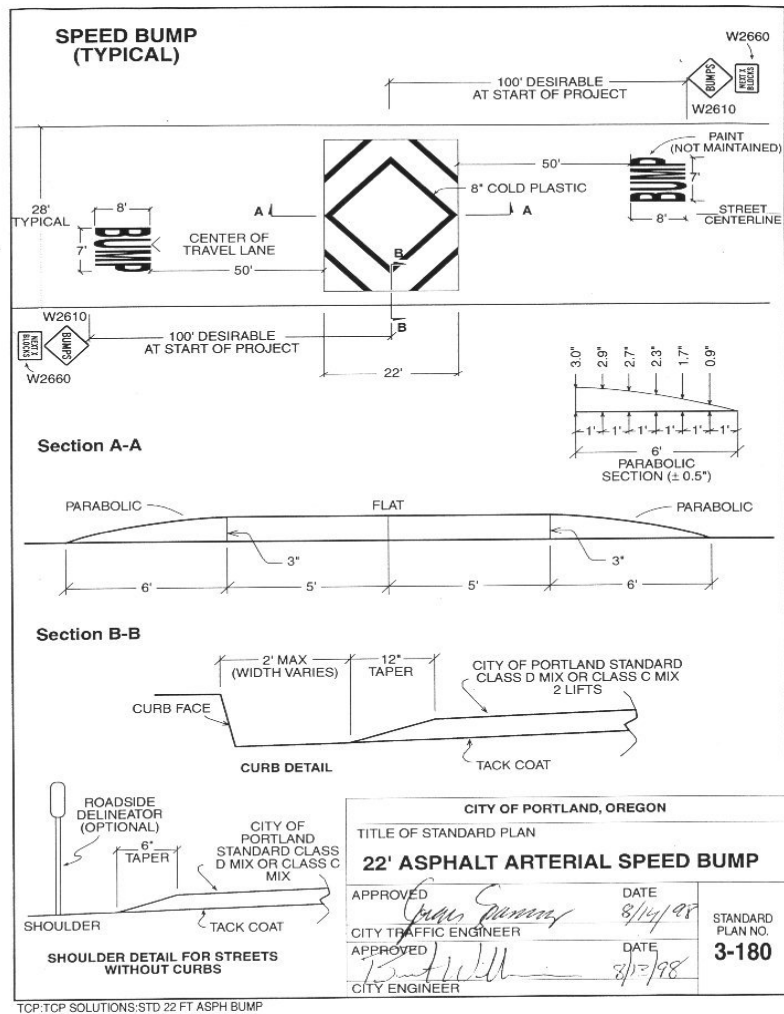


Figure 18: speed bumps, <http://www.transciportland.or.us>

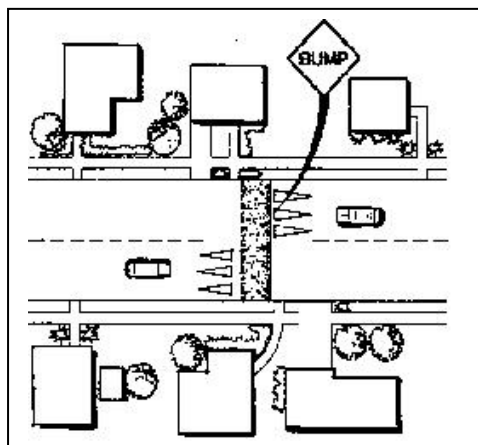


Figure 19: The graphic of speed bumps; <http://www.transci.portland>

Traffic volumes typically decrease slightly after speed bumps are constructed. Traffic on neighboring streets must be monitored for diversion. Speed bumps are not constructed on grades greater than 8%. (<http://www.transciportland.or.us>)

Rubber speed bumps are more preferable in the following situations:

- On residential streets to improve neighborhood livability.
- In construction work zones to create safer work sites and reduce flag personnel.
- At high or “at risk” pedestrian locations like street fairs and school crossings.
- In parking lots where traditional bumps only cause discomfort to the slow vehicles.

Rubber speed bump benefits:

Planning and design:

- Speed bumps slow traffic without reducing access.
- Test a bump layout before permanent asphalt construction
- Adjust a bump layout after first installed-try that with asphalt!
- Discourage infiltration of traffic diverting from a street under construction.

Construction:

- Consistently uniform shape that is difficult to achieve with asphalt.
- Extends construction season-rubber bumps don’t require warm weather.
- Consistent installation regardless of labor skill level
- Reduced manpower and equipment

Maintenance:

- Street resurfacing easily accommodated-unbolt the bump, resurface, and put the rubber bump back.
- Worn ramp sections can be swapped with sections not in the wheel path
- Inlaid markings are possible.

Temporary uses:

- Slow vehicles in construction zones
- Use during street fairs, or other high pedestrian activity events, to slow nearby vehicles. (Traffic Calming Devices)

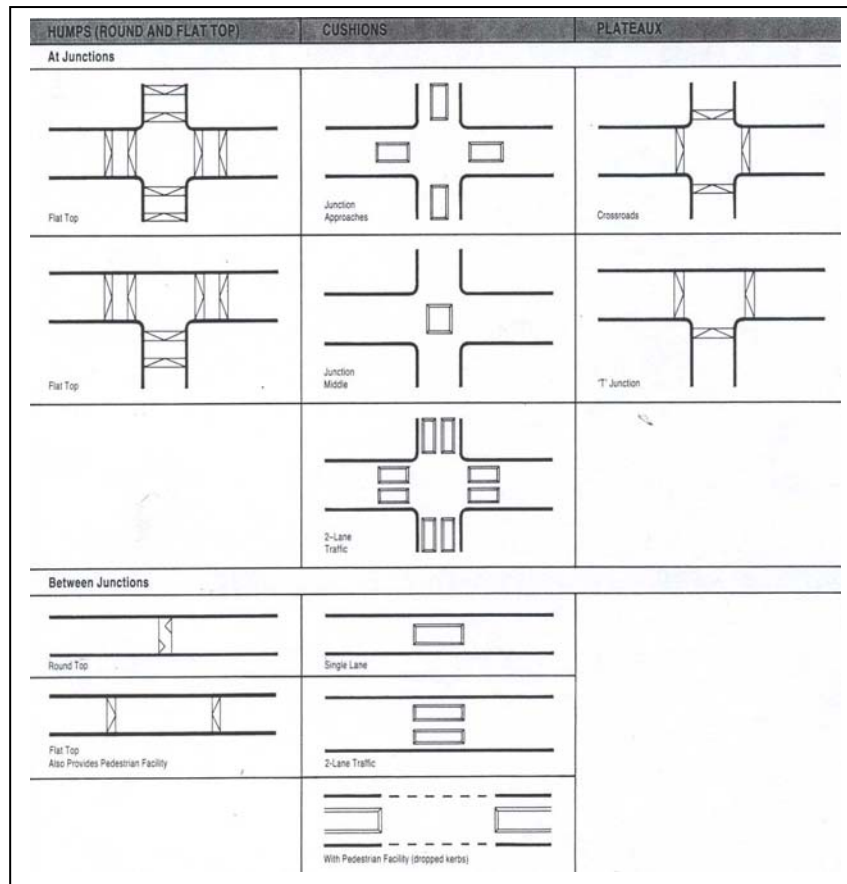


Figure 20: Vertical Shifts: Humps, cushions and plateau, Devon County Council,1991; pp:32)

3.Plateau:

Plateaus extend the full width of the carriage way between the kerbs and extend over a longer length of road than humps. The surface should be of a different material than the carriageway and sidewalks. Plateaus are more suitable than road humps when the measures are implemented on bus routes. The length of the plateau should be sufficient to accommodate the full wheelbase of the bus to reduce passenger discomfort to a minimum. (Velibeyoğlu, 1998)

4.Cushion:

Cushion is the portion of carriageway with flat top, extension over part of carriageway width allow exemption for certain emergency vehicles, other large vehicles and two wheelers. (Figure: 20) (Devon County Council,1991,pp:31)

5. Raised Crosswalk, Rumble Strips, and Platform Intersections:

Raised cross walks are intended to reduce vehicle speeds specifically where pedestrians will be crossing a street. Raised crosswalks may generate noise from vehicle decelerating and accelerating. Consideration for visually impaired persons dictates not placing the raised crosswalk at the same elevation as the sidewalk. Though the crosswalk is raised from the street surface, a pedestrian should also be able to tell when they are entering an area shared with automobiles. One benefit of the raised crosswalk is that painted markings (typically a triangular shape) on the ramped portion can be more visible to motorists than markings on a flat roadway surface. (<http://www.transci.portland.or.us>)

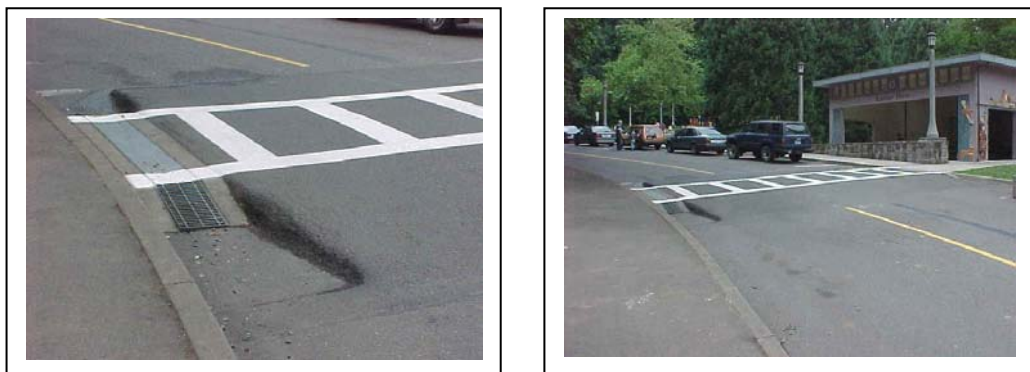


Figure 21: Raised crosswalk and it's detail, <http://www.transciportland.or.us>

Rumble strips are small raised ridges or cut channels in the roadway surface which create a noise when vehicles travel over them. Rumble strips may alert motorists to the presence of a crosswalk more effectively than signs. With rumble strips, the noise is made every time a motorist encounters a crosswalk, whether pedestrians are present or not. Rumble strips create difficulties for snow-clearing equipment and special gaps are needed for bicycle and motorcycle traffic. The sound made by a vehicle crossing the rumble strip can be heard by others than the driver. The continual sound of vehicles crossing a rumble strip would create a significant noise in an urban neighborhood. (<http://www.region.halifax.ns.ca>)

Main advantages and disadvantages of raised crosswalk, rumble strips, and platform intersections can be summarized as follow:

Advantages	Disadvantages
• Speed reduction effect	• Rough surfaces are potentially hazardous for cyclists and pedestrians • Create noise

Platform intersections and raised crosswalks, where the street pavement is raised to the level of the sidewalk, are more like elongated street humps, but they more clearly give the impression that this is pedestrian territory. They may be as effective as street humps, but more acceptable. One of the problems with them is that they are also noisy for residents. (Appleyard, 1981, pp:300)

Lateral Shift :

1.Chicanes:

chicane changes a street's path from straight to serpentine . A chicane may be constructed to give the illusion, from a distance, that a street no longer continues. A chicane is intended to reduce vehicle speeds with less impact on emergency vehicles. A chicane should not impede transit service or scheduling. A serpentine chicane is preferred to speed bumps on emergency response route. (<http://www.transciportland.or.us>)

Chicanes are less effective than vertical ones in achieving reductions in speed, but their impact can be significantly increased when used in combination with a vertical shifts.

Chicanes aim:

- To reduce traffic speeds and thus improve safety
- To rearrange street spaces such as parking and sidewalks
- To interrupt long views(Devon County Council,1991)

Main advantages and disadvantages of chicanes can be summarized as fallow:

Advantages	Disadvantages
• It can be cheap and easy to construct if no rebuilding of the carriageway is required • Alternative parking reduces pedestrian danger by ensuring unobstructed view of 50% of sidewalk • allows interesting street design features	• difficult to achieve good speed reduction effect whilst allowing access for larger vehicles • might be uncomfortable for bus passenger • can be hazardous for cyclists if speeds are higher than about 25 kph (Devon County Council,1991)

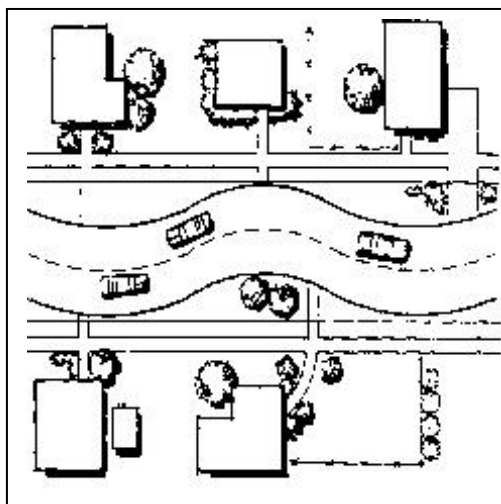


Figure 22: Chicane, <http://www.ite.org/traffic/index.html>)



Figure 23: Chicane, <http://www.ite.org/traffic/index.html>)

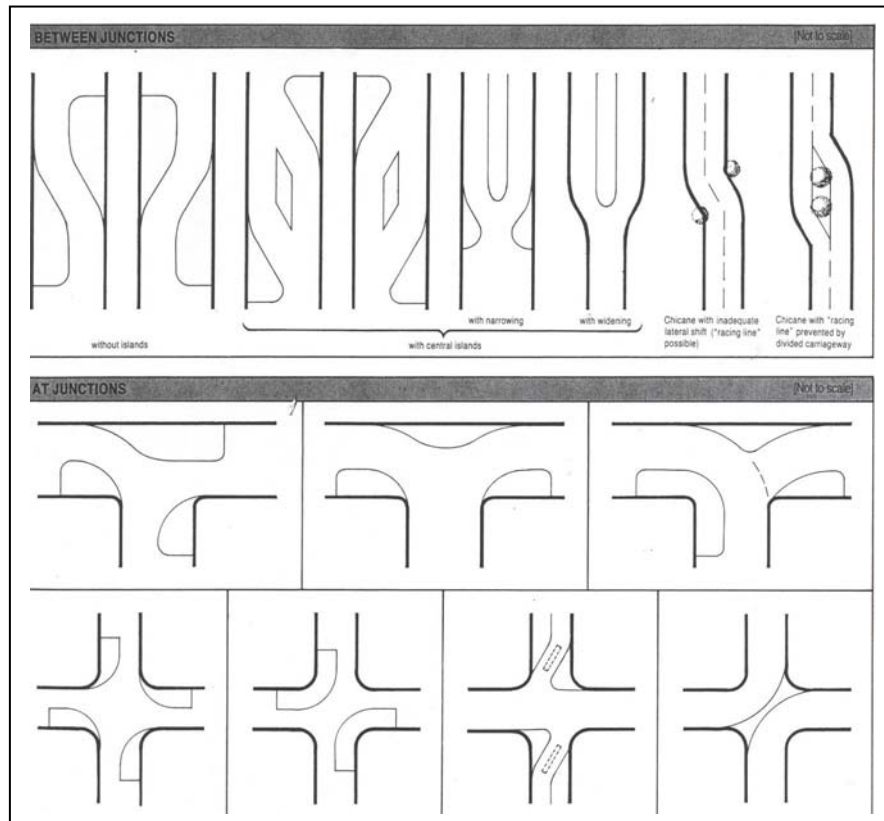


Figure 24: Chicanes (lateral shifts), (Devon County Council, pp:37, 1991)

2. Diagonal Diverters

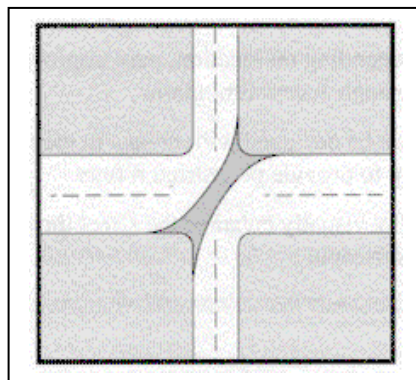


Figure 25: Diagonal diverters, <http://www.transci.portland.or.us>

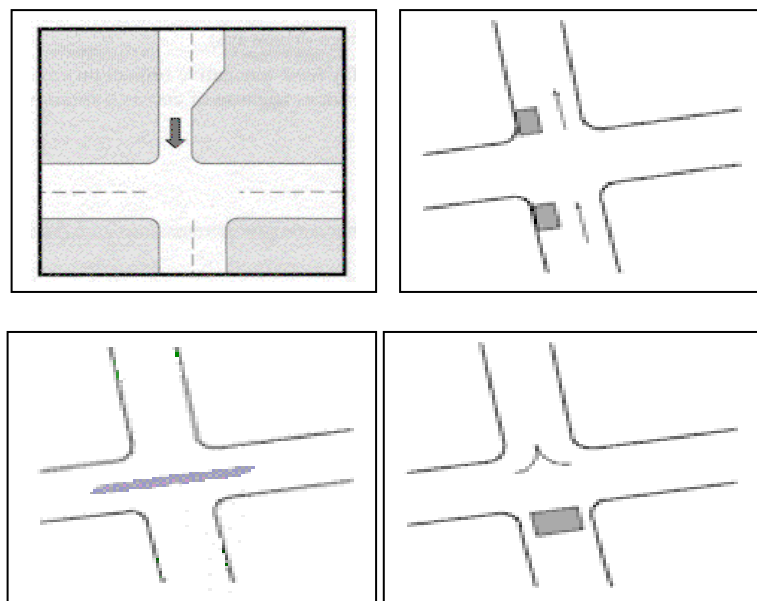
Diagonal diverters place a barrier diagonally across an intersection, disconnecting the legs of the intersection. Strategically located diagonal diverters reduce traffic volumes on a street. They prevent through moves at an intersection. Diagonal diverters should not be considered on transit streets. Generally, the turn restrictions imposed by a

diagonal diverter would apply to emergency vehicles as well and are typically not used on primary fire response routes. However, diagonal diverters can be designed and installed to provide for emergency vehicle access. They apply to all drivers, including local residents. Very special care must be taken to consider the availability, capacity, and appropriateness of the alternative routes drivers might use if a diverter is constructed. Provision should be made to make diverters passable for pedestrians and bicyclists.

Main advantages and disadvantages of diagonal diverters can be summarized as follow:

Advantages	Disadvantages
- Effectively reduce traffic volumes - Can restrict vehicle access while retaining bicycle and pedestrian access	- Prohibit or limit access and movement. While this is the purpose of diversion devices, some drivers consider it a disadvantage. - Restrict access for emergency and transit vehicles - They cause noise.

3.Semi diverties;



Figures 26: Semi diverters; [http:// www.transci.portland.or.us](http://www.transci.portland.or.us)

Semi-diverters are curb extensions or islands that block one lane of the street. Semi-diverters prevent drivers from entering or exiting certain legs of an intersection. Strategically located, semi-diverters can effectively reduce traffic volumes on a street. Semi-diverters are very effective in reducing volumes. Semi-diverters may effect curbside parking opportunities opposite the device to permit emergency vehicle access. Semi-diverters apply to all drivers, including local residents. Very special care must be taken to consider the availability, capacity, and appropriateness of the alternative routes drivers might use if a semi-diverter is constructed. (<http://www.transci.portland.or.us>)



Figure27: Semi Diverter - Left Turn Restriction, <http://www.transci.portland.or.us>



(a)

(b)

Figure 28: (a)Diagonal Diverter, (b) Semi Diverter - Auto Entry Restriction NE 17th at Mason Temporary Device

4.Curb Extension

Curb extensions narrow the street by widening the sidewalk or the landscaped parking strip. These devices are employed to make pedestrian crossings easier and to narrow the roadway. Curb extensions effectively improve pedestrian safety by reducing the street crossing distance and improving sight distance. They may also slightly influence driver behavior by changing the appearance of the street. They can be installed either at intersections or midblock. Curb extensions may occupy street area otherwise available for curbside parking. Where the crowns of the street are steep, curb extensions may actually go "uphill" because the new curb is higher than the original curb. If poorly designed, this can result in puddles on the sidewalk. Their noise impact is none.(<http://www.transci.portland.or.us>)

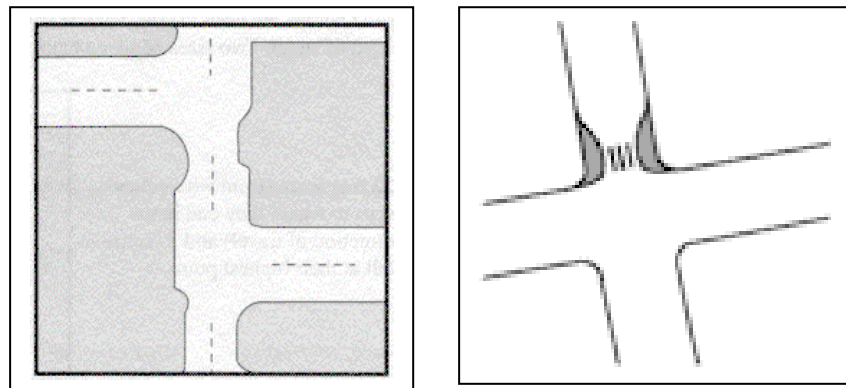


Figure 29: Graphics of curb extension, <http://www.ite.org>



Figure30: Curb extension detail, <http://www.transci.portland.or.us>

Main advantages and disadvantages of curb extension can be summarized as follow:

Advantages	Disadvantages
• Reduce pedestrian crossing distance and time • Make pedestrian crossing points more visible to drivers • Prevent vehicles from passing other vehicles that are turning • May visually enhance the street through landscaping • Do not slow fire vehicles	• Require some parking removal • May make it difficult to accommodate full bicycle lanes

(<http://www.transci.portland.or.us>)

5. Realigned Intersections(Small Corner radii):

The aims of small corner radii are, to slow turning movements at junctions, to assist pedestrian while crossing the street, and to provide greater safety for cyclists. Small radii should be supported by bollards which prevent overrunning of sidewalk at corners.

Main advantages and disadvantages of small corner radii can be summarized as follow:

Advantages	Disadvantages
• Assist pedestrians to establish right of way over turning vehicles at junctions • Reduce danger of cyclists being cut across by turning vehicles	• Create difficulty for large vehicles while turning

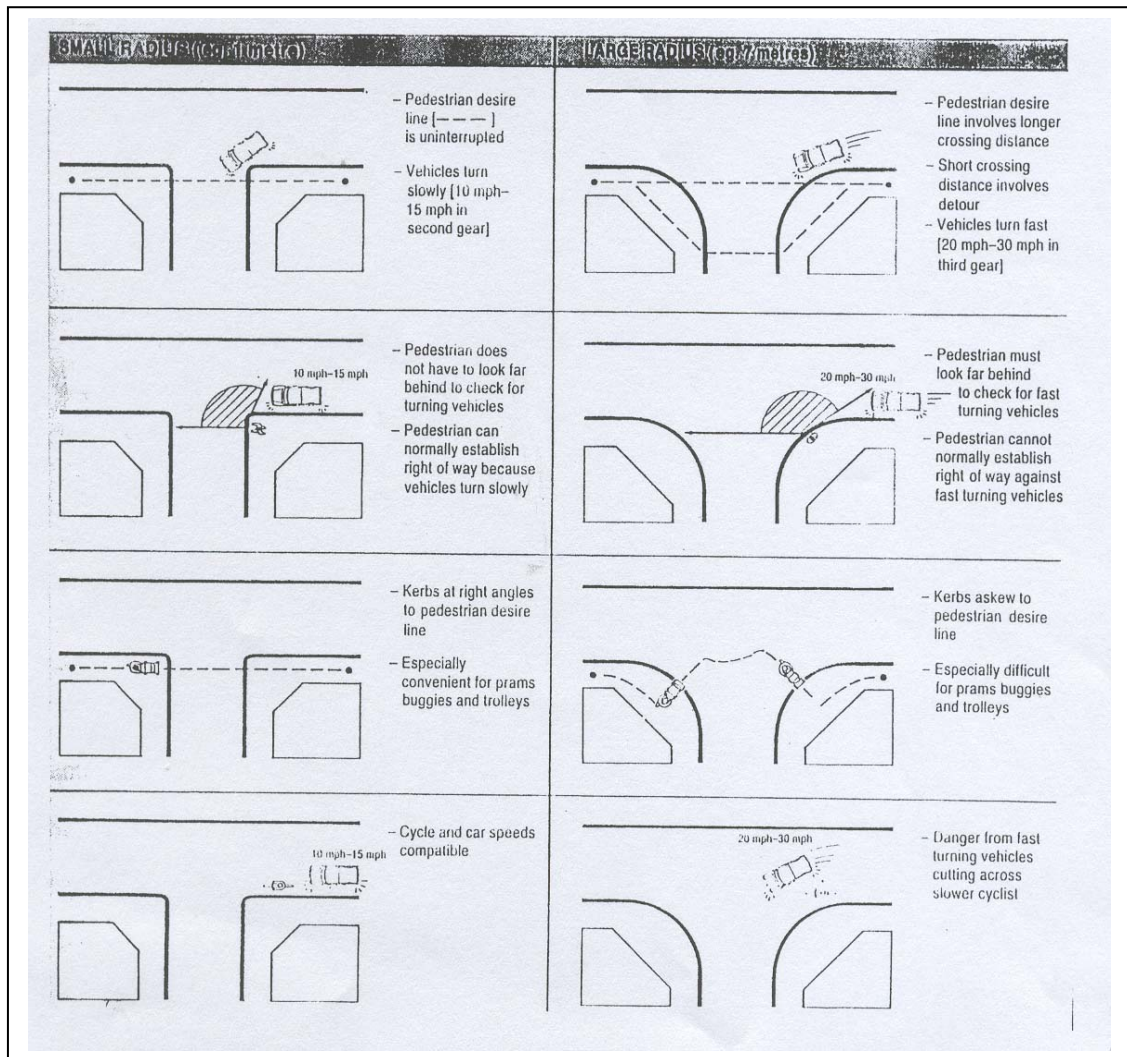


Figure31: Effects of corner radii on pedestrians and cyclists, Devon County Council,1991,pp:46

Narrowing Street

1.Neckdowns

Narrow streets slow traffic. Different ways of narrowing streets include the arrangements for parking, the provision of green strips and trees or play spaces, or simply widening the sidewalks. All these uses of former street spaces can improve conditions for residents.(Appleyard, 1981, pp:301)



Figure 32: Graphic of neckdown, <http://www.ite.org>

The objectives of carriageway narrowing are:

- To limit the ability of vehicles to pass one another, and thus to limit speeds or to interrupt traffic flow
- To limit overtaking
- To reduce pedestrian crossing distance
- To restrict the size of vehicle
- To provide priority for buses
- To prevent on-street parking
- To define or shelter on-street parking spaces (Devon County Council, 1991, pp:40)

Main advantages and disadvantages of neckdowns can be summarized as follow:

Advantages	Disadvantages
• Road narrowing greatly improves the safety of pedestrians resulting from the shorter distance to cross the street. • Assists pedestrian crossing the road • An important supporting measure for other speed reduction measures	• Not always reliable as a stand alone speed reduction device • Can cause problems for cyclists unless smooth materials are used, which in turn makes the narrowing less effective.

2.Chokers:

A choker is a device that physically narrows the street. The sidewalk area at intersection is increased when the width of intersection approaches is reduced. Pedestrian crossings are enhanced by creating an extended vantage point from which pedestrians can view traffic while selecting the appropriate time to use the reduced street width. Chokers also provide a location for traffic signs closer to the drivers' normal line of sight, where obstruction is also less likely to occur. The effect that chokers have on vehicle speed has not been documented, although it is believed that the narrowing will tend to reduce speed.(Appleyard, 1981, pp:300-301)

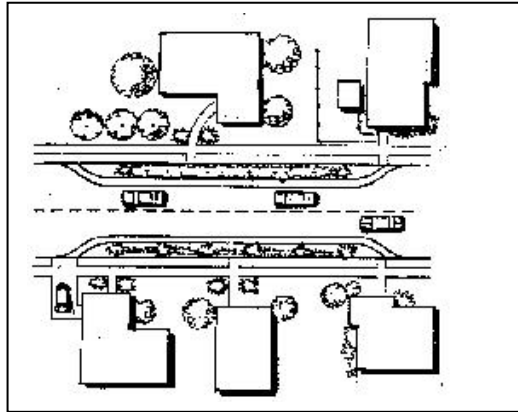


Figure33: Graphic of choker ; <http://www.ite.org>

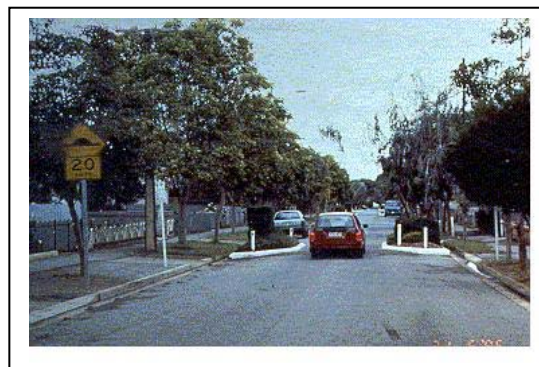


Figure 34: Choker; <http://www.ite.org>



Figure 35: Examples of choker; <http://www.trafficcalming.org>

4.2.1.2. Volume Control Devices:

Volume control devices are primarily used to address cut-through traffic problems by blocking certain movements, thereby diverting traffic to streets better able to handle it

1.Changes of Surface, Texture or Color:

The changing of the road surface from standard asphalt to interlocking brick, concrete pavers, or colored and stamped asphalt can influence driver behavior and reduce speeds (Velibeyoğlu, 1998)

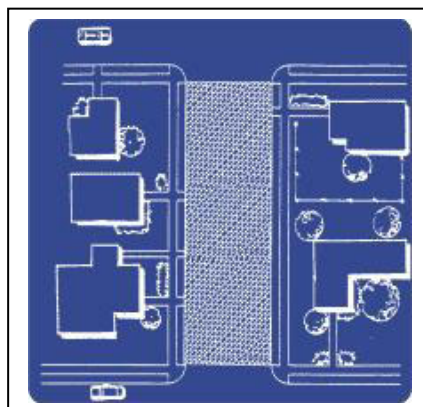


Figure 36: Graphic of text pavement, <http://www.ite.org>

Main advantages and disadvantages of changes of surface, texture or color can be summarized as follow:

Advantages	Disadvantages
• Can create visual interest and improved street appearance • If combined with vertical shifts can create speed reduction effect • Different uses and purposes can be separated easily with these devices	• Rumble strips are a traffic calming measure that result in noise levels between 3-5 dBA higher than smooth asphalt • Rough surfaces are potentially hazardous for cyclists and pedestrians.



Figure37: Textured crosswalk; <http://www.transci.portland.or.us>

2.Traffic Circles-Roundabouts and Islands

Traffic circles or roundabouts are raised islands placed in an intersection. They are landscaped with ground cover and street trees. Traffic circles require drivers to slow to a speed that allows them to comfortably maneuver around them. The primary benefit of circles is they reduce the number of angle and turning collisions. An additional benefit is they slow high-speed traffic. Traffic circles are very effective at lowering speeds in their immediate vicinity. Traffic circles are most effective when constructed in a series on a local service street. Their noise impacts are minimal. There may be some noise

related to vehicles decelerating and accelerating near the circles.
(<http://www.transci.portland.or.us>)

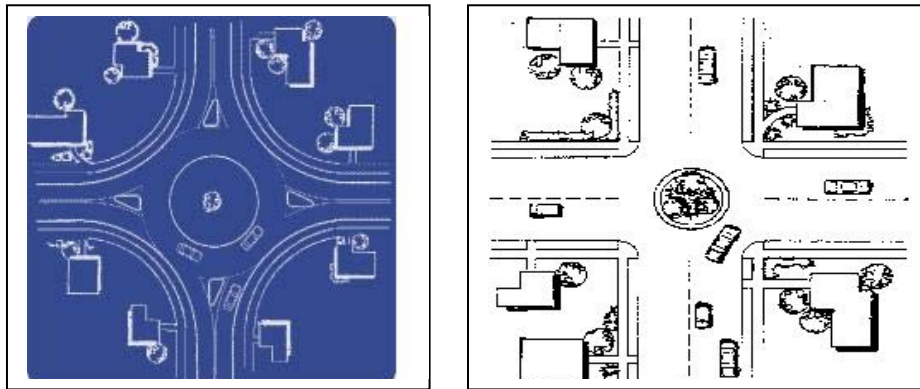


Figure 38: Roundabouts, <http://www.ite.org>, <http://www.trafficcalming.org>

If well-maintained, traffic circles can be very attractive. However, there are also a lot of traffic control signs and pavement markings associated with circles that are not so attractive. Traffic circles are less effective at T-intersections and difficult to design for offset intersections.



Figure 39: Attractive traffic circles. [http:// www. trafficcalming.org](http://www.trafficcalming.org)

Main advantages and disadvantages of traffic circles and roundabouts can be summarized as follow:

Advantages	Disadvantages
• Effectively reduce vehicle speeds • Improve safety conditions (for example, there are fewer left-hand turn crashes involving other vehicles) • Visually attractive	• Require some parking removal • Can cause bicycle/auto conflicts at intersections because of narrowed travel lane. • Can restrict emergency or transit vehicle movement if vehicles are parked illegally near the circle. • Uncomfortable for bus passengers

Traffic circles or roundabouts provide some reduction in speed, especially close to the intersection, although success is directly related to the usable approach width. Where parking is heavy and provides a physical barrier that narrows the approach, drivers tend to slow down at the intersection. Where parking is sparse, artificial narrowing or channelization must be used to create a narrowed approach. Drivers will then be more apt to slow down when entering the intersection, because they are physically restricted from flattening their angle of approach to avoid speed reduction. One problem with traffic circles is that they change the relationship between vehicles and bicycles, which is especially critical when vehicles are forced close to the curb in order to turn around the circle. Conflicts with pedestrians also occur, especially when there are no protected sidewalks or pathways for pedestrians to use. (Appleyard, 1981, pp:302)

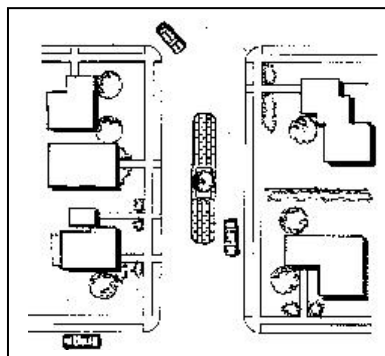


Figure 40: Graphic of the central island, <http://www.ite.org>

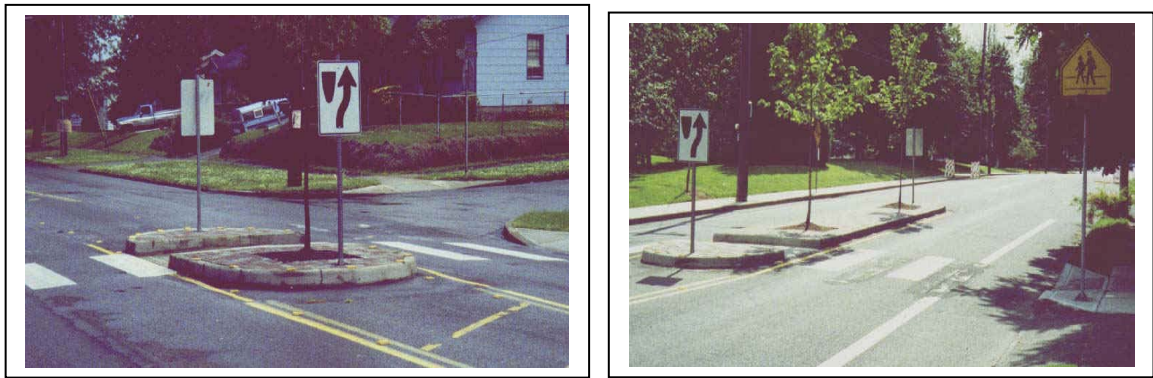


Figure 41: Pedestrian Refuge - Half Intersection N Willis at Emerald Peninsula Elementary

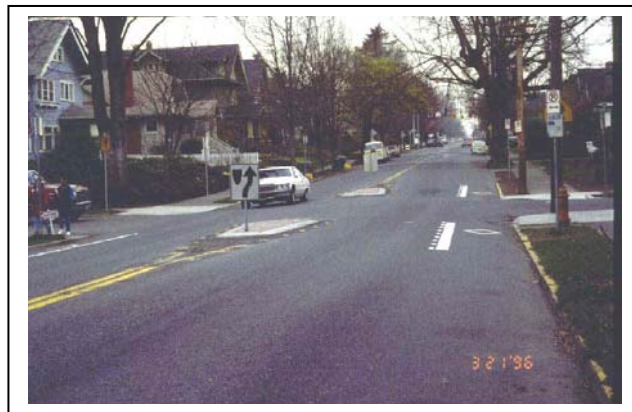


Figure 42: Pedestrian Refuge - Full Intersection NE 15th



Figure 43: Pedestrian Refuge Details - centerline approach / Pedestrian Refuge Details - Island end



Figure 44: Island; <http://www.transci.portland.or.us>

Islands or medians are generally center located and used to separate opposite lanes. They provide visual cue of change in roadway environment. They make crossing easier and safer for pedestrians. In addition, they prevent overtaking and interrupt forward views. Besides they assist in the creation of gateways.(Clark County Council,1997)

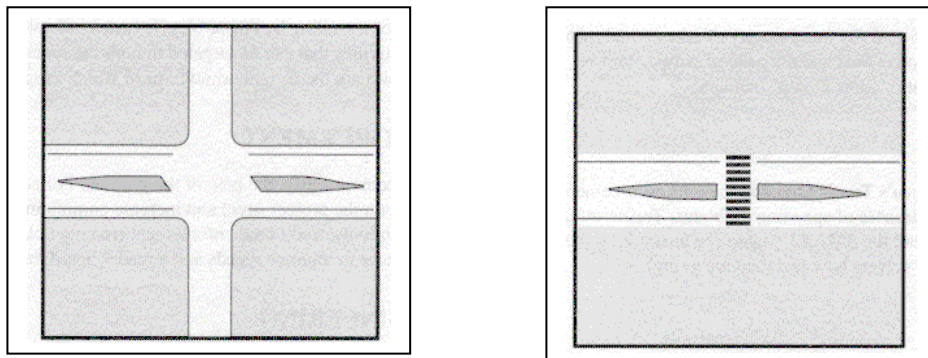


Figure 45: Midblock and intersect block; <http://www.transci.portland.or.us>

Pedestrian refuges or slow points are small islands in the middle of the street, typically designed with marked bike lanes on both sides. They serve to narrow the vehicle travel lanes. They can be installed either at intersections or midblock. Slow points are used to enhance pedestrian crossing points and provide a visual narrowing along the roadway. Depending on their location, they may also result in small to moderate traffic speed reductions. (<http://www.transci.portland.or.us>)

Main advantages and disadvantages of *Islands or medians* can be summarized as fallow:

Advantages	Disadvantages
• Allow pedestrians to cross half of the street at a time, stopping in the refuge before crossing the other half of the street • Make pedestrian crossing points more visible to drivers • Prevent vehicles from passing other vehicles that are turning • May reduce vehicle speeds	• Require some parking removal

Pedestrian refuges narrow the roadway available to a driver, provide a visual cue to drivers that they are in a popular pedestrian area, and provide a refuge for pedestrians so they can cross a street one half at a time, if they prefer. Pedestrian refuges are effective pedestrian amenities but have minimal influence on a driver's behavior. Pedestrian refuges have usually been used to supplement a pre-existing crosswalk, as compared to creating a new crosswalk location. (<http://www.transci.portland>)

3.Road Markings

Road markings assist drivers and improve predictability of vehicle path for the benefit of pedestrians, cyclists and state priority. They are useful in traffic areas for safety and can be also used for mixed priority areas. They are applied according to regulations of the municipality.

Main advantages and disadvantages of road markings can be summarized as fallow:

Advantages	Disadvantages
• Simple, cheap and usually effective • Useful at night	• Some markings, for example center lines, encourage speed

Stop signs: This control commands vehicles to stop, typically to reduce conflicts with other crossing vehicles or with pedestrians. Drivers must be able to see the sign well in advance. Even so, some drivers will not stop; they may be preoccupied with their thoughts, or may be following their habitual driving patterns, or may resist obeying a stop sign at a location where they see no need for it. Reactions to stop signs cover a range of behaviors, from coming to a complete stop to not stopping at all. (Appleyard,1981, pp:296)A stop sign is placed 10-15 meters in advance of the crosswalk for both approaching streams of traffic

Stop-signs can be an affective speed-control device, particularly in residential neighborhoods. If installed for this purpose, stop-signs will have to be closely spaced and invariably erected in many places that would not be advisable solely for reasons of safety. Vehicles start to decelerate about 200 feet in advance of stop sign and return to their normal speed about 200 feet beyond the stop sign. (Appleyard, 1981)

Speed limits:

Speed limits in residential areas are very common throughout the world. The chief problem with speed limits is that the street design often encourages driving faster than the limit, so that disobedience becomes frequent unless enforcement is strict. Although radar measures are available, the difficulty of monitoring multitudes of residential streets on anything like a continuous basis makes expectations of enforcement unrealistic. Speed limits must therefore be reinforced by a road design that discourages speeds over the limit. (Appleyard,1981, pp:296)

4.Traffic signals:

Pedestrian signals are installed at intersections for two main reasons: a high volume of foot traffic, or the signals that direct motorists do not meet the needs of pedestrians. For example, some intersections occur at odd angles and the traffic signals can't be seen by pedestrians. At other locations, turning and merging lanes make intersections so complex that special provisions must be made for pedestrians. (<http://www.state.nj.us/y>)

A traffic signal is used to manage traffic and pedestrians at heavily used, extremely hazardous, or complex intersections. Pedestrian signals are installed at intersections for two main reasons: a high volume of foot traffic, or, the signals that direct motorists do

not meet the needs of pedestrians. Installing a traffic signal is expensive, so every available factor must be thoroughly analyzed: the need for installation must be appraised, and that need ranked in relation to others.(Appleyard,1981, pp:297)

One often-expressed concern relates to the pedestrian signals. Walk and don't walk indications are confusing to many persons, who complain that not enough walk time is given to allow them to cross the street.

The right turn on red law, which has been used in California for some years, is now spreading across the country. There is reason to believe that this increases the hazard for pedestrians (especially children) at crossings, because traffic can still come from any direction when the lights change. This may be particularly hazardous in states where the procedure is new. (Appleyard, 1981)

5.Closures(Full-Half Closures)

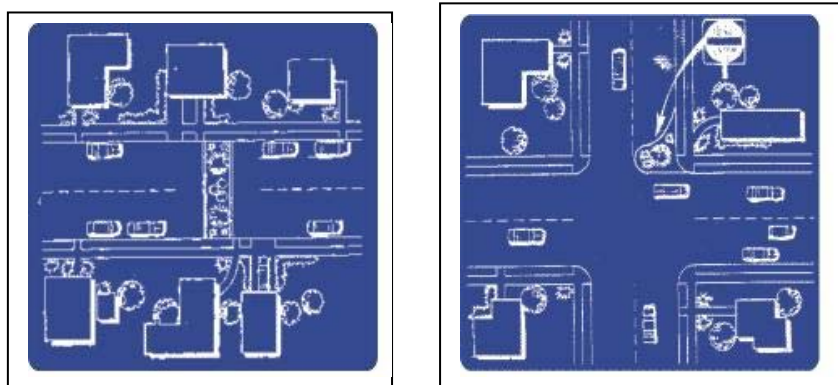


Figure 46: Fullclosure and half closure, <http://www.transci.portland.or.us>

6.Median Barriers

A median barrier is a concrete curb or island that is located on the centerline of a street and continues through the street's intersection with a given cross street. Strategically located median barriers reduce traffic volumes on a street. Median barriers prevent left turns from the through street and left turns and through moves from the cross street. They are very effective in reducing volumes. Median barriers apply to all drivers, including local residents. Very special care must be taken to consider the availability, capacity, and appropriateness of the alternative routes drivers might use if a semi-diverter is constructed. Provision should be made to make median barriers

passable for pedestrians and bicyclists.. They have not noise impact.
(<http://www.transci.portland.or.us>)

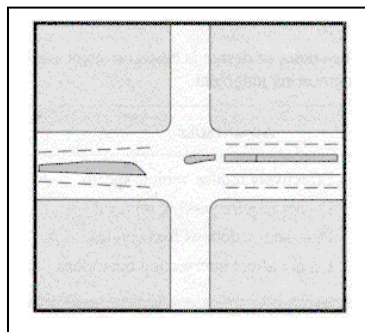


Figure 47: Graphic of median barrier <http://www.ite.org>

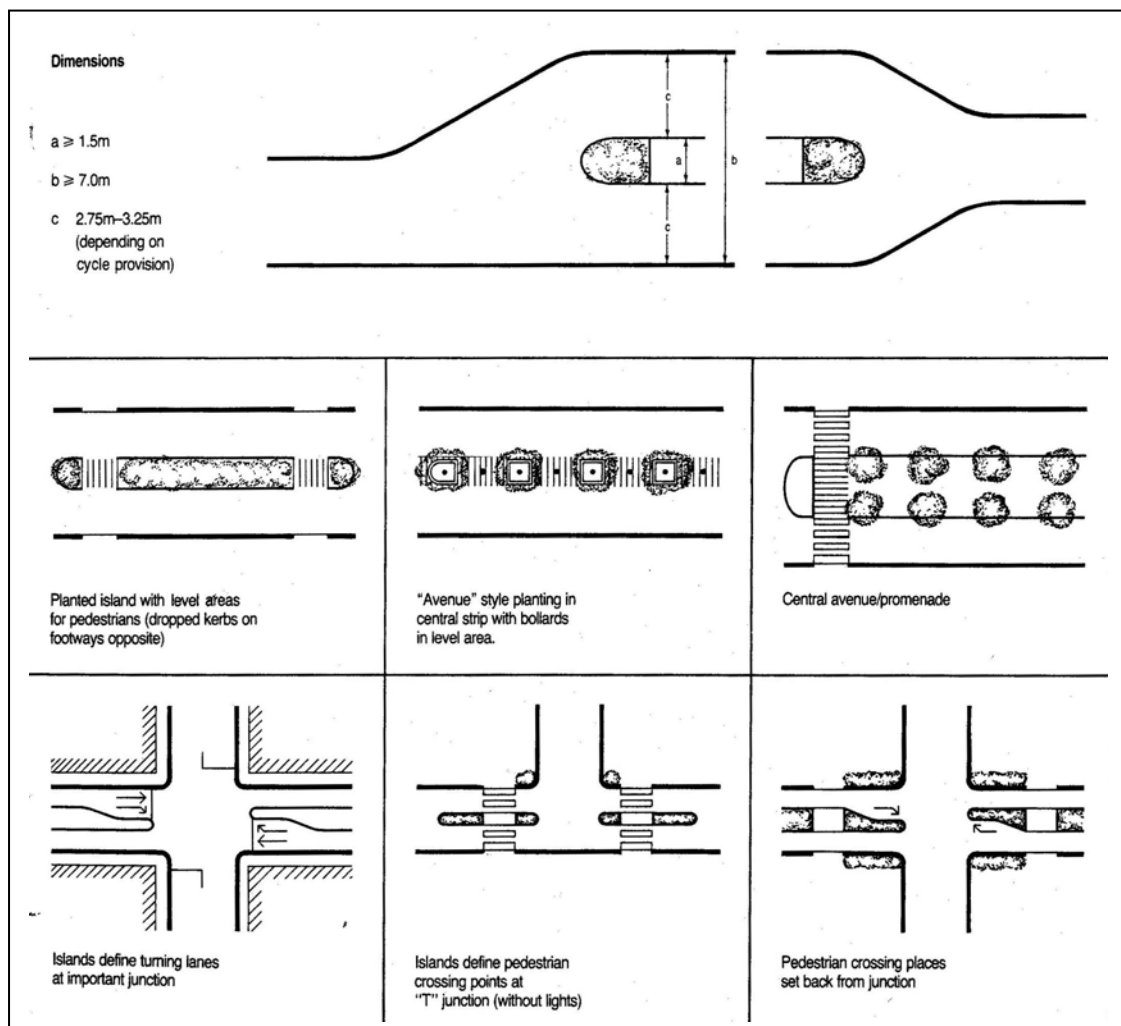


Figure 48: Central islands in mixed and traffic priority areas, (Devon County Council,1991,pp:66)

Main advantages and disadvantages of median barriers can be summarized as follow:

Advantages	Disadvantages
• Separate opposing vehicle travel lane • Prevent vehicle from passing other vehicles • Depending on location, may improve safety through access limitations • Can be designed with breaks in the landscaping to provide pedestrian refuge • May visually enhance the street through landscaping	• May require major parking removal • Prohibit or limit access and movement (from driveways) • May have a negative impact on emergency services because of access limitations

([http:// www. transci.portland](http://www.transci.portland))

Chapter 5

DESIGN GUIDELINES AND STANDARDS

5.1. Quantitative Factors of Design

5.1.1. Dimensions

5.1.1.1. Basic Human Dimensions

Body depth and shoulder breadth are the primary human measurements used by designers of pedestrian spaces and facilities. Human body dimensions are shoulder breadth of 51,75 cm for the 99 percentile (99 percent are less than this) of civilian men, with a recommended addition of 3,8 cm for heavy clothing. (Fruin,1971)

The plan view of the average adult male human body occupies an area about 1400 cm² and 46 by 51,75 cm body ellipse, equivalent to an area 2150 cm² is used to determine the practical standing capacity of a pedestrian (Fruin,1971).

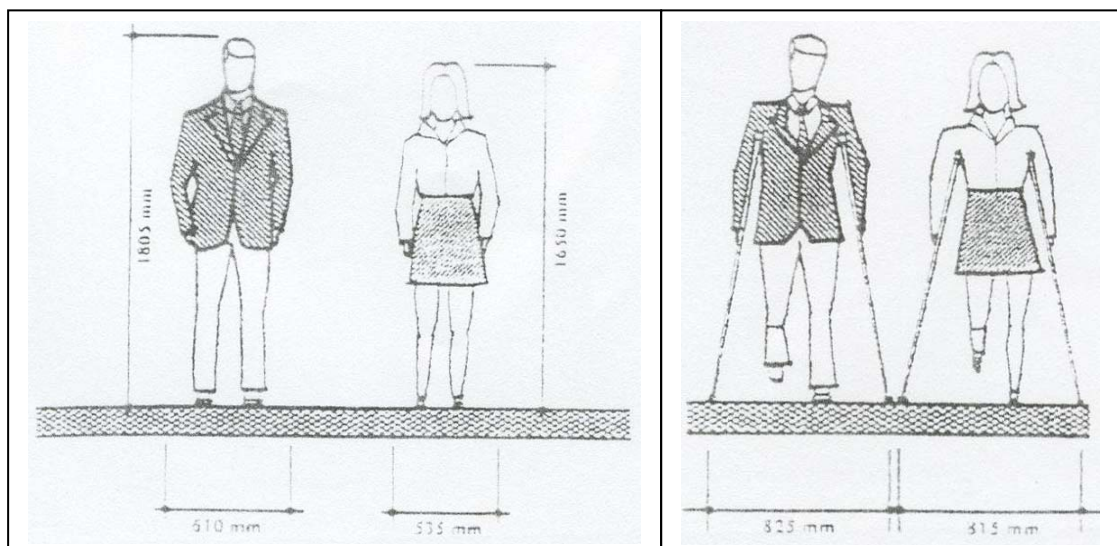


Figure 49: Body dimension of men and women & Body dimension of men and women with crutches

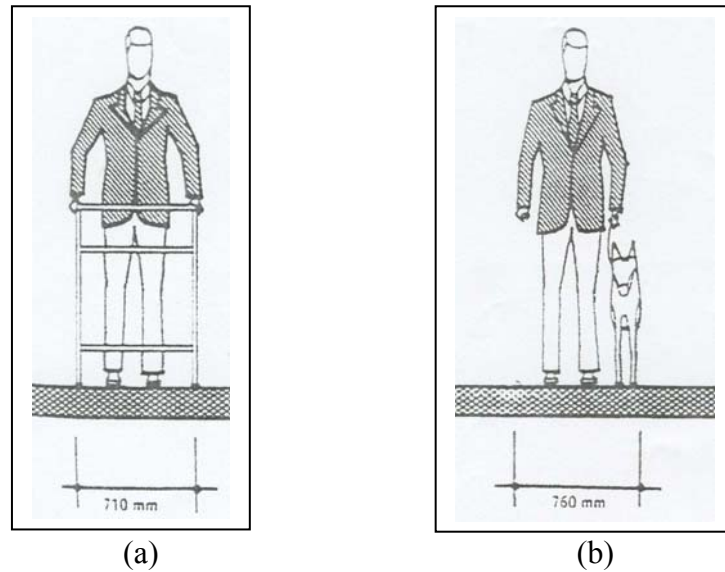


Figure 50: (a)Man with a Walker, and (b)Man with a Dog

5.1.1.3.Disabled People Dimensions

An important factor which effects particular amount of pedestrian is the consideration of physically handicapped people. According to most of the handicapped pedestrians, they are apprehensive of the dense, irregular and usually hurried pedestrian traffic in most travel situations

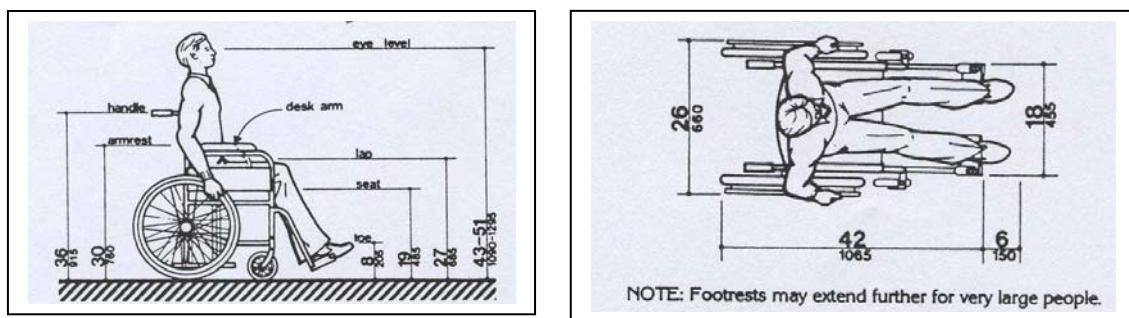


Figure 51: Wheelchair dimensions. Americans with disabilities act (ADA), “Accessibility Guidelines for Buildings and Facilities,” U.S. Architectural&Transportation Barriers Compliance Board, Washington, D.C.;1991

5.1.1.2. Clearances

On a site to provide to comfort stations access areas should be 60 in wide as figure 53a space that is required by a wheelchair to make 180° turn is 60 in diameter. A T shaped space can also be used (Figure 52 b)

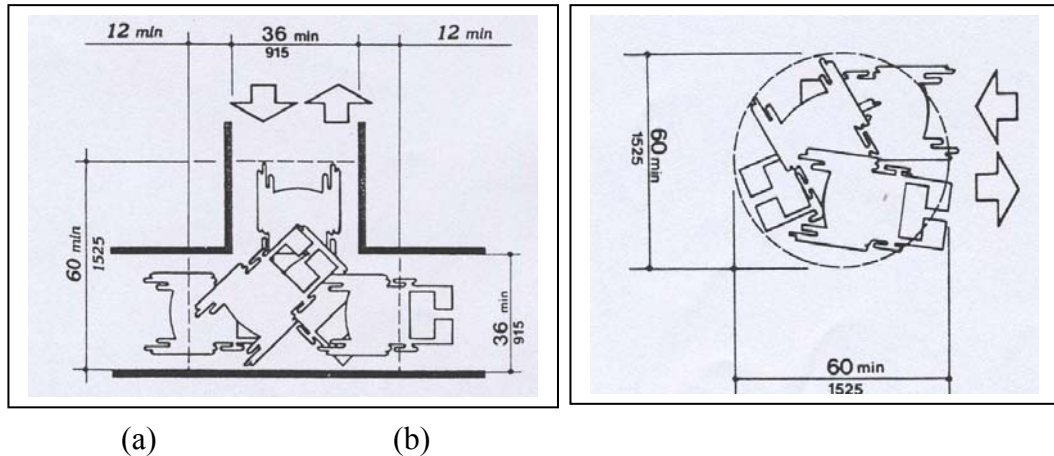


Figure 52: a) T shaped space for 180° turns. b) 60-in diameter space is needed for wheelchair turning; (ADA, 1991)

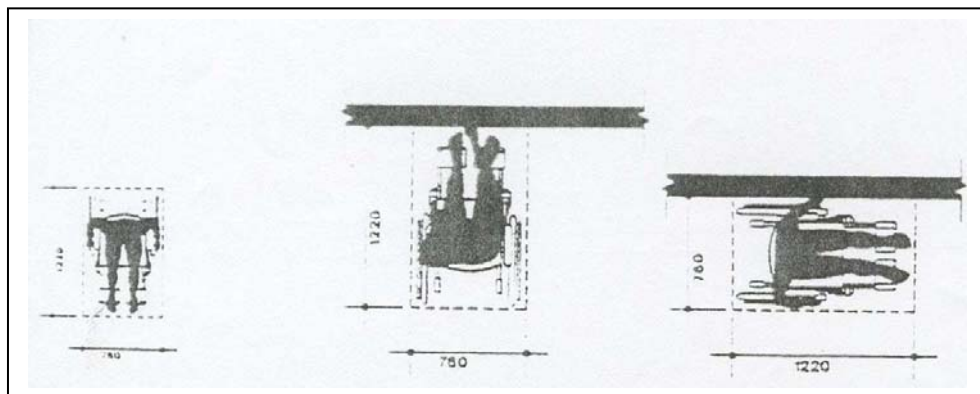


Figure 53: Clear ground space for forward and parallel approach

Minimum recommended design standards for the handicapped pedestrians:

Walks:

- Walks should be at least 152 cm. with maximum grade of 5 percent. Walks with greater than a 5 percent grade shall be considered a ramp.
- Walks should be of a continuing, common surface not interrupted by steps or abrupt changes in level

- Wherever walks or roadways cross, the pavement should be cut, and the walk ramped to road level
- Where walkway systems are frequented by the blind, or where walkways cross the streets, changes in pavement texture should be used, to provide the blind with tactile signals of route, and crossing, locations.
- Longer walks near the maximum grade should have level areas at intervals, for purposes of rest and safety.
- Walks should have stable, firm, and slip resistant.

Stairs:

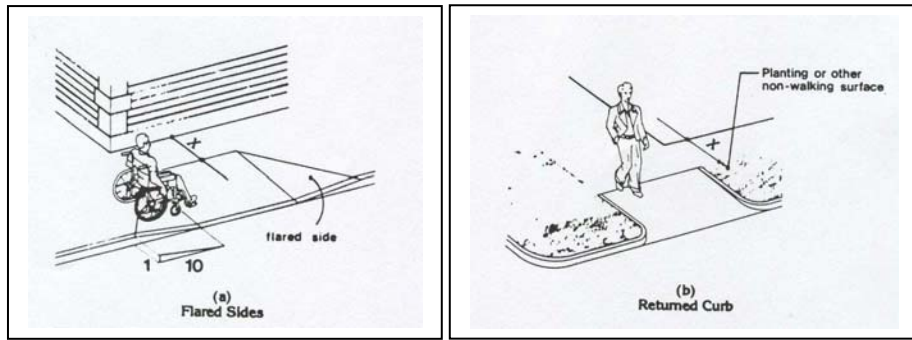
- Stairs should have plain faces. Open riser stairs, or stairs with edges projecting out over the face of closed risers are not recommended.
- Maximum riser heights should be 17 cm.; preferred riser heights would be between 12,7 and 15 cm. tread width should be at least 28 cm.
- Handrails on stairways shall be placed on both sides and should be set at 76.5 cm. measured from the tread at the face of the riser, and should extend 46 cm. beyond the stair ends.
- Stair lighting should be provided.

Ramps:

- Ramps slopes should not exceed a slope greater than 1/20 (5%grade) percent grade.
- Ramps should have hand rails on at least one side. Handrails should be set at a height of 81 cm. measured from the ramp surface.
- Ramps should have landing which are at the top and bottom of each ramp and each ramp run. Level landing provide to rest and safety. (FRUIN,1975, pp:180; RUBENSTIAN, 1996)

Curb Ramp:

Curb ramp is change in grade from street to sidewalk. The slopes of curb ramp should have a maximum grade in new construction of 8,33% grade (1/12 slope). If a curb ramp is located where pedestrians must walk across the ramp, it shall have flared sides. The maximum slope of the flare shall be 1/10. Built-up curb ramps shall be located so that they do not project into vehicular traffic lanes.



“Figure 54: sides of curb ramps. (source: Americans with Disabilities Act (ADA,1991))

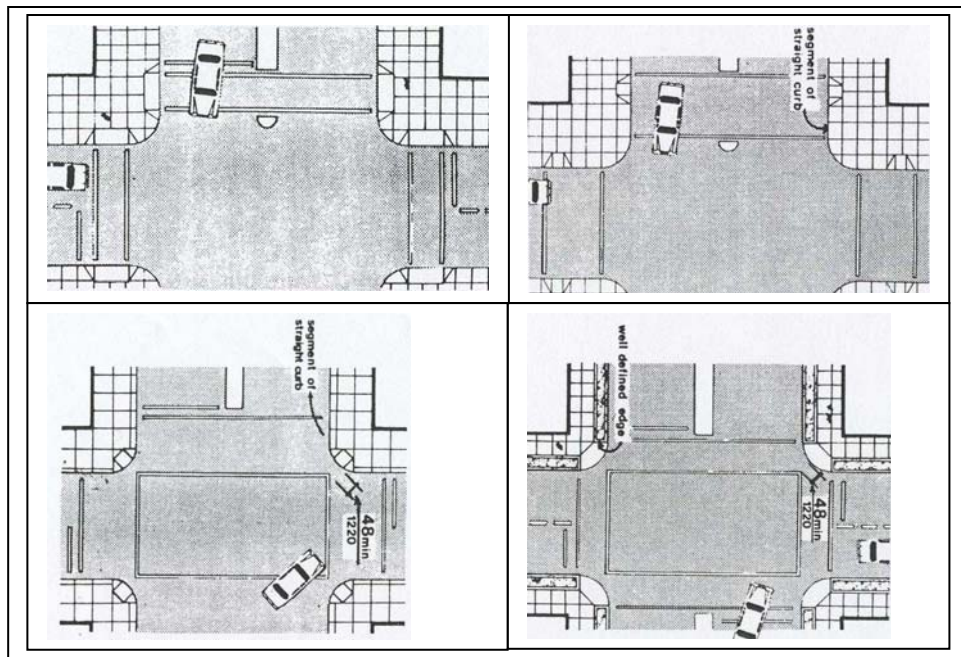


Figure 55: curb ramps at marked crossings. (source: Americans with Disabilities Act (ADA, 1991))

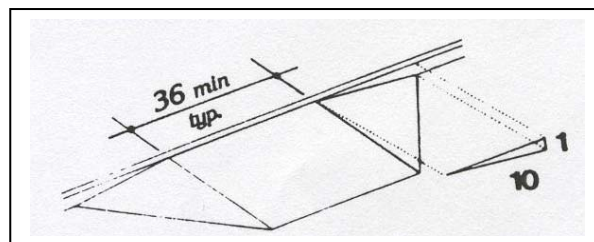


Figure 56: Built-up curb ramp. (source: Americans with Disabilities Act (ADA, 1991))

On existing sites where space limitations prohibit the use of a 1/12 slope or less, a slope between 1/10 (10% grade) and 1/12 is allowed for a maximum rise of 3 in. A slope steeper than 1/18 is not allowed

5.1.2. Capacity and Density

Capacity usually means the maximum possible ability to accommodate a flow. However, more often than not in traffic design, operation at maximum capacity is undesirable. Levels of service (LOS) have been defined to characterize the quality of traffic flow at various fractions of maximum capacity.

Standing room:

Average-size of human bodies in a vertical position, pressed together with virtually no ability to move, can occupy as little as 0.09 m² per woman and 0.14 m² per man. But, to avoid touching each other, standees require about 0.22 to 0.26 m² per person and prefer a body buffer zone of 0.27 to 0.84 m² to avoid emotional discomfort in the presence of strangers. (Puskharev, 1978, pp:77)

The interpersonal distance varies from culture to culture, depending on social conventions and taboos, and also from individual to individual, depending on psychological characteristics. A classification of interpersonal distances based on North America and suggested by anthropologist Edward T.Hall. are given in table 9 (Puskharev, 1978, pp:77)

Table 9: Interpersonal distances

	Distance face to face (m)	Area required Per person (m ²)
Intimate	less than 0,5	less than 0,3
Personal	0,5-1,2	0,3-1,2
Social	1,2-3,7	1,2-10
Public	more than 3,7	more than 10

Source: PUSKHAREV, Boris; Urban Space for Pedestrians, the MIT Press, London, p: 79, 1978

- “At an intimate distance, parts of bodies can touch each other; one is aware of odors and even of thermal radiation.
- At a personal distance, one has to reach out to touch another person, odor becomes less important and the visual perception of the other person’s face is most clear.

- At a social distance, one is beyond an “arm’s length” of the other person, that is, beyond the limit of possible physical contact
- At a public distance , recognition of and acquaintance is no longer mandatory, evasive action can be taken in case of danger, and speech patterns become more formal and impersonal.” (Puskharev, 1978, pp:78)

There are many situations in which the space available around standing pedestrians is of importance. These include queuing areas before ticket windows, elevator lobbies, subway platforms, and waiting areas at street crosswalks. Fruin described the characteristics of five levels of pedestrian density in these stationary situations which are shown in table 10

Table 10: Levels of service for standing pedestrians

QUALITY	SPACING (m)	AREA PER PERSON (m ²)	DESCRIPTION
UNIMPEDID	1,2	1,2	Circulation between pedestrian is possible without disturbing them
IMPEDID	1,0-1,2	0,9-1,2 0,7-0,9	Circulation between standing pedestrian is somewhat restricted Comfortable for standing without being affected by others, but walking between standees possible only by disturbing them (“excuse me”)
CONSTRAINED	0,6-0,9	0,3-0,7	Standing pedestrians do not touch each other but are uncomfortably close together, circulation through the group is severely restricted, and forward movement is possible only as a group.
CONGESTED	0,6	0,2-0,3	Contact with others is unavoidable, circulation through the group is impossible
JAMMED	-	0,2	Standees are pressed together, no movement is possible

Source: Fruin, Designing for Fedestrians

Walking room:

Human locomotion requires more room than standing. The spacing between pedestrians, just as the spacing between vehicles, is related to the speed at which they are moving: the faster the movement, the more space is required.

The traditional equation describing traffic flow is:

$$\text{Flow} = \text{speed} * \text{density}$$

Available space Per pedestrian:

$$\text{Space (m}^2\text{/ped)} = \text{speed(m}^2\text{/min)} / \text{flow(ped/min/m}^2\text{)}$$

Table 11: Average free flow walking speed for pedestrians on the basis of many different survey

Sex	Average walking Speed ft/min
Males	270
Females	254
Combination of all	265

Source: RUBENSTIAN, H.; A Guide Site Planning and Landscape Construction, 1996

Psychological factors, reaction to environment traffic composition and trip purpose can all contribute to each pedestrian's selection of his unimpeded free flow speed.

Besides the free speed, an important factor is the inability to choose one's path freely across the traffic stream. Fruin who studied pedestrian crossing conflicts in relation to available space per pedestrian, defined conflicts as any stopping or breaking of the normal walking, pace due to a too close confrontation with another pedestrian. He found that when flow is more than 1,4 m² Per person crossing movements become easier and the probability of conflicts drops to between 65 and 50 percent. However the

probability of conflict does not drop to zero until the space allocation Per pedestrian reaches about 4,2 m2. (Puskharev, 1978, pp:78)

The formula for calculating flow volume (P), in pedestrians Per foot width of walkway Per minute (PFM) is the following:

$$P=S/M$$

Where

P= pedestrian volume

S= average pedestrian speed Per minute

M= average number of square feet Per pedestrian (A Guide Site Planning and Landscape construction)

Table 12: Level of service on walks

Ft ² / person	Average flow	Speed and bypassing
35	7 or less	Free selection of speed Can bypass freely No severe peaks
25-30	7-10	Normal walking speed Can bypass others No serve peaks
15-25	10-15	Walking speed is restricted slightly Inability to bypass freely
10-15	15-20	Majority have normal walking speed restricted Difficulty in bypassing
5-10	20-25	All pedestrians have speed restricted Much difficulty in bypassing
5 or less	Up to 25	Extremely restricted Frequent unavoidable contact with people and bypassing

Source: RUBENSTIAN, H.; A Guide Site Planning and Landscape Construction, 1996

Stairs:

Pedestrian behavior on a stairway is fundamentally different from that on a level or inclined walkway. The dimensions of the steps restrict the spontaneous pacing distance and make it short and uniform. This results in a close spacing between pedestrians and reduces the range of freely selected speed.

Table 13: Level of service on stairs

Ft ² /person	Average flow	Speed and bypassing
20	5 or less	Free selection of speed Can bypass No severe peaks
15-20	5-7	Free selection of speed Some difficulty in passing slower pedestrians
10-15	7-10	Speed restricted slightly Inability to bypass slower pedestrians
7-10	10-13	Speed restricted for majority Inability to bypass majority of pedestrians
4-7	13-17	All pedestrians have speed reduced Inability bypass others Intermittent stopping may occur
4 or less	Up to 17	Breakdown in traffic flow with much stopping

Source: RUBENSTIAN, H.; A Guide Site Planning and Landscape Construction, 1996

Pedestrian behavior on a stairway is fundamentally different from that on a ramp or on a level walkway. Because the spontaneous pacing distance is restricted by the dimensions of the step. Besides dimensions of the steps make pacing short and uniform. So this results in a close spacing between pedestrians and reduce the range of freely selected speeds, because the paces are restricted by gravity. For that reason, speed is reduced so that it can overcome to control gravity. (Puskharev, 1978, pp:78)

Meanwhile it is obvious that, the speed on stairway is related with height of the steps. an increase in step riser height from 15,2 to 21 cm about doubled the energy

expenditure of a sample of woman in ascent and increased it by more than half indescend according to a medical study in the United States. Moreover Fruin shows 11 to 16 percent decline in speed as riser height increases from 15,2 to 17,8 cm. (Puskharev, 1978, pp:78)

Signalized intersection

Pedestrian circulation is greatly complicated by conflicts with vehicular surface traffic. Though separation in space, and time at intersections are gaining greater acceptance. When intersection flows are so heavy that random gaps in one stream do not allow safe passage for the other pretenders to its use must wait.

When the waiting group of pedestrians start moving for crossing the time needed to clear the roadway is important for determining the minimum length of the green phase of the pedestrian signal. The time has two components: first is the starting time, second is crossing time. The starting time needed for the group to get off the curb, and the crossing time needed to walk to the otherside of the roadway. Pedestrian need a short time as starting time because they don't start moving instantaneously. So there is a reaction time and an acceleration time for pedestrian because of waiting for the coming vehicles to stop. Oeding found pedestrians to have an average initial rate of acceleration of 1,8 km Per hour Per second, ranging up to a maximum of 3.5 km. (Puskharev, 1978, pp:78)

The five phases of crossing an intersection:

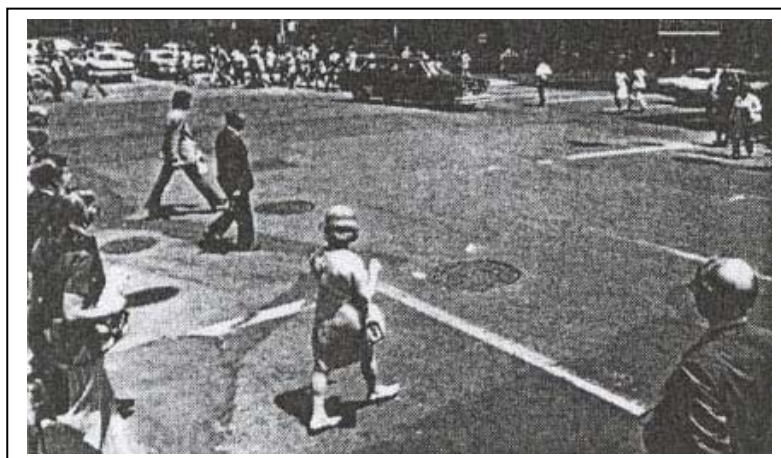


Figure 57: Led by a few venturesome souls, the waiting platoon of pedestrians is poised at the curb to accelerate. Puskharev, 1978



Figure 58: the platoons from both sides of the street start moving toward each other. Puskharev, 1978

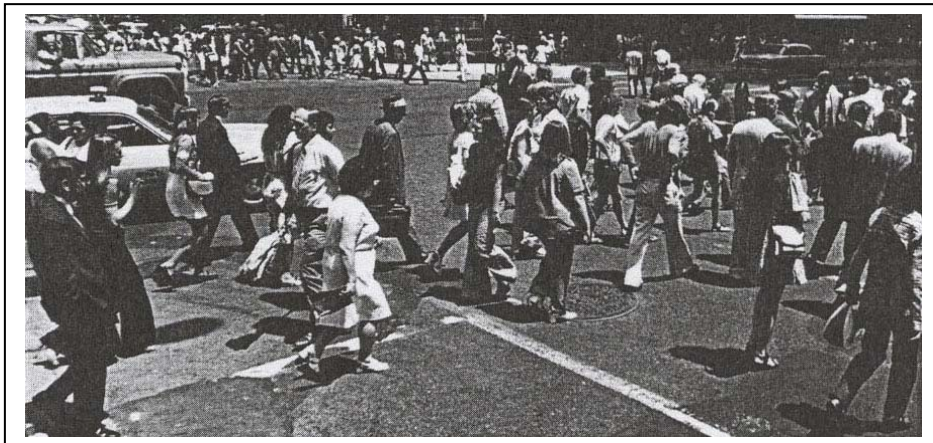


Figure 59: the platoons meet and interpenetrate. Puskharev, 1978



Figure 60: the platoons begin to arrive at opposite sides of the street. Puskharev, 1978



Figure 61: the major platoon flow is over, but stragglers continue to walk; cars begin to make turning movements. Puskharev, 1978

Under pressure from a waiting queue, pedestrians step off the curb at an average rate corresponding to 18 persons Per minute Per foot (60 Per meters) of crosswalk, and the length of the time during which the queue forms effects the total starting time. Oeding found starting time to vary with relative accumulation as follows:

$$\text{Starting time(sec)} = \text{relative accumulation(persons/foot or 10 m)} *$$

To determine the other component in crossing time, pedestrian speed in crosswalks has to be measured. The Traffic Engineering Hand book prepared by John Baerwald shows the full range of unimpeded pedestrian speeds from 45,7 to 122 meters Per minute. As given in The Traffic Engineering Hand Book unimpeded pedestrian speed is as follows:

Table 14: Unimpeded pedestrian speed in crosswalks by The Traffic Engineering Hand Book

Meter/Per minute	Average man	Average woman
45,7 to 122	82,3	76,2

Source: PUSKHAREV, Boris; Urban Space for Pedestrians, the MIT Press, London, p: 79, 1978

By contrast, Oeding found very substantial differences in crosswalk speeds, depending on whether the flow is one-directional or bi-directional, and depending on the rate of flow. According to Oeding is:

Table 15: Rate of flow in crosswalk speeds by Oeding

	In one way	Two way	
Speed	90 m/minute	79 m/minute	40 m
Space	9 to 1,4 m2 Per ped	3,7 m2 Per ped	0,5 m2 Per ped

Source: PUSKHAREV, Boris; Urban Space for Pedestrians, the MIT Press, London, p: 79, 1978

Time is needed to cross the roadway. The time needed has three components:

- The time needed for the two platoons to walk up to each other
- The time needed to penetrate each other
- The time needed to walk the rest of the distance to the curb on the opposite side of the street.

People waiting in queues and having unrestricted space available will select, according to Fruin, an area of roughly 0,74 to 0,84 m² for themselves, regardless of whether or not they have baggage. About 0,46 m² per person is the average space in groups waiting for a traffic light, while space allocations at mass rallies have been found to range from about 0,56 m² in dense crowds to 0,93 m² in loose crowds.

Reservoir Space:

People who are waiting for the light to change, need standing room. It is called reservoir space in traffic engineering vocabulary. Congestion is a problem in crosswalks and it causes loss of time. The dimension of the reservoir space needed to accommodate the waiting pedestrians can be calculated on the relative accumulation at the crosswalk, that is, the number of people Per linear unit of curb, who wait to cross the roadway during a signal cycle.

$$\text{Relative accumulation} = \frac{\text{approach flow} * \text{non-green phase}}{\text{Time of flow} * \text{width}}$$

The selection of an appropriate service level has to be related to the function of each particular facility. Reservoir spaces, or standing room for movie theater queues, to the extent that they do not conflict with sidewalk flow, can get by with less room, perhaps 0,74 m² per person, and still less room is required for short term queues at signalized intersections



Figure 62: pedestrian space in crosswalks. Unimpeded flow on approaches results in an acceptable space of about 1.80 m² Per person on the average in the crosswalk, and about 1.3 m² in the middle. (Puskharev, 1978)



Figure 63: pedestrian space in crosswalks. Constrained flow on approaches results in wall-to-wall people: an estimated 0,6 m² Per person on the average in the crosswalk. Puskharev, 1978

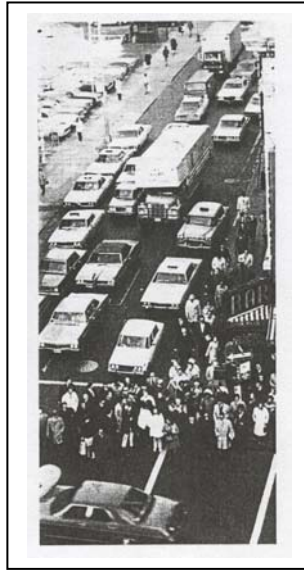


Figure 64: the absence of pedestrian reservoir space on narrow sidewalks forces those waiting for the light to change into the vehicular roadway. Without sidewalk widening at intersections, this kind of overspill becomes inevitable when flow on the average, and becomes critical when approach flow is in the constrained range. Puskharev, 1978

The relationship between speed and flow can be approximated by a parabolic curve, familiar from motor vehicle flow analysis. Top speed can be reached when there is no one else on the road or on the walkway, that is, when flow is near zero, as in the upper-left-hand corner of figure...

5.2. Qualitative Factors of Design

Qualitative factors on design can change as national or local conditions. At this point, especially character of problem point is important. So function is the most basic designated. Quality that is needed in city trade center, and possibility able do is bigger than industrial and commercial areas. Same event it may be changed in close either hospital or school areas.

An other important point that is determined factor in design is hard economy and limited resources. For that reason, in design some of quality can't be given up while take into consideration. But selection must be as well as optimize for economic and politic conditions that Turkey has.

5.2.1. Safety

Safety can be studied under two different aspects:

- Safety of pedestrians from the vehicular accidents
- Safety of pedestrians from crime, physical factor hazards

For safety one of the most factors is existence of peoples. Crowds of people discourages crime by creating an atmosphere of security. Most of the criminal events occurs at night. For that reason, it is necessary to make useable wide time of the days. it may be possible attract to difference activities. By providing different activities at night time the security can be created., such as cafes, markets, store. Several western cities have introduced special police controls, emergency phones and bright lighting in their traffic-free zones. Usually most of these cautions are unnecessary. Confidence in the downtown areas has been restored by existence of pedestrian streets. (SENİZ CIKIS, 1992)

5.2.1.1. Lighting

After dark, fears of personal violence and risks are heightened for both men and women. Badly designed and poorly lit areas offer opportunities for crime to occur and give the message that an area is uncared-for. If good lighting increases the risks that offenders may be recognized or increases the chances of someone coming to the aid of a victim who has been attacked then it deserves more attention as a preventive strategy than it has hitherto received.

Improved lighting encourages people to use public places at night and may increase informal, natural surveillance. As a community crime prevention strategy, good lighting improves the look of areas, encourages people to use the streets, contributes to a sense of personal security, and is often low cost. (WEKERLE, WHITZMAN, 1995)

5.2.1.2. Sight lines

The inability to see what is ahead along a route because of sharp corners, walls, earth barmes , fences, bushes, or pillars is a serious impediment to feeling and being safe. The ability to see what is ahead and around is known as “visual permeability.”

Of special concern are large columns, tall privacy fences, overgrown shrubbery, and other thick barriers adjacent to pedestrian paths which could shield an attacker; impermeable landscape screens and long fences that serve to cut off access to means of escaping, and elements such as insets adjacent to paths which could serve as entrapment spots. Low hedges or concrete planters, small trees, wrought-iron or chain-link fences, transparent reinforced glass or plastic, lawns or flower beds, benches and lampposts all denote boundaries while allowing users to see and be seen.

Routes may be planned with closed views in order to add “interest” to a building or public space. Grade separation and landscape screens are also used for their aesthetic value; to provide private outdoor space; to shield “unpleasant” buildings, parking lots, and car traffic. Conflict over right-of-way may lead to odd jogs in tunnels and pathways. While total visual permeability is not always possible, the above motives for blocking sightlines should be measured against potential personal safety effects. Grade separations, where building entrances are either above or below grade, block sightlines, especially when landscaping or walls are added. (WEKERLE, WHITZMAN, 1995, 32)

5.2.1.3. Entrapment Spots

Entrapment spots are small, confined areas, adjacent or near a well-traveled route, that are shielded on three sides by some barrier, such as walls or bushes. Examples are elevators, storerooms, fire stairs, dark recessed entrances that may be locked at night, gaps in tall shrubbery, curved or grade-separated driveways, or loading docks off a pedestrian route. Parking lots, gas stations, and used-car lots can become entrapment spots, especially when adjacent to pedestrian routes. Hidden areas adjacent to school buildings or isolated school yards may also be entrapment spots, especially at night. Below-grade or above-grade plazas may create places that are isolated or invisible from the street. (WEKERLE, WHITZMAN, 1995)

5.2.1.4. Mixed Use

Separating industrial, institutional, retail, and business uses from each other and from residences creates public streets that are unused at particular times of the day and evening. Mixed use is an important factor for pedestrian areas because of widening using time during a day. Especially in city centers and recreational areas, pedestrian areas and some kind of crosswalk such as overcrosswalk and undercrosswalk can consist of with other activities and functions, such as cafe, shop. Therefore widening of using time supply to sense of safety, too.

5.2.1.5. Movement Predictors

A movement predictor is a predictable or unchangeable route or path that offers no choice to pedestrians. An assailant can predict where persons will end up once they are on the path and can lie in wait for them. The obvious example is a undercrosswalk, but narrow passageways, overcrosswalks, and staircases also serve as movement predictors. Movement predictors are of particular concern when they are isolated or when they terminate in entrapment spots.

“Tunnels are not necessarily dangerous Per se , although they are almost always noted as places that are feared. However, a frequent stranger assault scenario involves an assailant meeting a victim in a tunnel, then taking her to a nearby dangerous place using force.” (WEKERLE, WHITZMAN, 1995, pp 37-38)

5.2.2. Comfort

Most critical factors effecting comfort are visual elements, climate, pollution, noise, physical elements, physical requirements. The tolerable range of comfort is partly biological, partly cultural and partly psychological. But for the most of the cases the limits of comfort are on a close ranges. People don't prefer too hot, too cold, too noisy, too crowded, too empty, too polluted, too silent environments

5.2.3. Continuity

One of factors that influence serve to design objectives about pedestrian walkways and intersect points is to aid the pedestrian in deciding where he is, and to orient him. Because of this, there is necessity for a system that in corporates the pedestrian walkway in the spatial experience.

The overall system must be directed and easy to comprehend. The basic elements of walkway system are the various paths and nodes involving activity concentrations, intersections or vertical access to over crosswalk or under crosswalk. It is also important to obtain standards of environmental control.

Physical determinant of continuity may be classically ordered color, texture of pavement.

5.2.4. Convenience

One of the most important features of a path from the point of view of convenience is the directness. It should provide people easy access without disturbing them by physical obstructions such as steep ramps, undercrosswalk and overcrosswalks. Unreasonable climbs disturbs mother with children and elderly people.

Another important feature of convenience is relation between origin and destination. People prefer direct lines. People mostly use a straight line between two destination points. Public transportation system and location of the stops or stations are important items which increase the level of convenience.

Besides these 3 factors, protection from climatic conditions, also enhances convenience. Climatic condition deeply effects people's preference of external space usage. Protection from rain, snow, wind, sun, ice are required in the design of exterior spaces by considering different climatic conditions.

5.2.5. Aesthetic

A properly designed pedestrian system should create positive impression on users. A place must not only fit the structure of our bodies. "It must fit the way in which our minds work; how we perceive and imagine and feel. This may be called

sense of place, and while sense varies with culture and with personal temperament and experience, there are regularities in these perceptions due to structure of our senses and our brains... Places should have a clear perceptual identity; be recognizable, memorable, vivid, engaging of our attention. (LINCH, 1988,p:72)

Pedestrians will generally follow the most direct path. If however a walk system is developed with points of visual interest people would take a longer route because of the added aesthetic enjoyment. The strategic point of a path system is the intersection, the point of connection and decision for the pedestrian in motion. If the motion is visualized clearly and if the intersection causes a vivid image, then the pedestrian builds a satisfactory structure.

Pedestrian crosswalks especially in recreational, and central areas required aesthetic condition. Because central areas are image of the cities in addition they have higher economic and social value. Because of that, any crosswalk in industrial area can be required aesthetic condition. On the contrary in city center, esthetic crosswalks create to visual effect and attractiveness.

5.3.Conclusion

Development and growth of cities have been determined by the transportation and communication technologies or possibilities available. The need for marketing the agricultural excessive production has added a new dimension to the functions of the cities as trade centres. The advent of wheeled transportation and the following developments in transportation technologies have altered the scale of cities beyond human dimensions, and accelerated their growth. Functions have become independent of locality as a result of developments in transportation and communication technologies and cities have spread outward while, at the same time this lateral growth has carried the use of faster and developed technologies to the city centers.

Technological developments and rapid urbanization observed after the 1950's have been reflected on the urban space in different ways depending on the particular conditions such as the level of economic and socio-cultural development prevalent in different countries. The inner dynamics of various countries have produced different measures and different levels of success in implementation when seeking solutions to the problems encountered during the urbanization process.

The most substantial effects of urbanization have been felt in the city centers. City centers project the urban image because of the administrative, commercial and cultural functions they contain. Rising demand for central land use and the consequent rise in land values have necessitated denser land use in city centers while, at the same time, changing urban center functions have brought into existence new land uses. The struggle between the existing urban land use pattern and new utilization demands have created a range of problems for the cities. A major parts of these problems have been concerned with transportation and traffic. High capacity arteries have been planned in city centers in response to growing commercial traffic demands. While answering the needs of central functions for traffic accessibility, these new arteries have severed the ties between the various functions and have created an unfavorable and hazardous environment especially for the pedestrians because of the congestion they have created.

Different countries have adopted different approaches in designing solutions to the urban traffic circulation systems, while developed countries base their urban circulation system on the pedestrian, developing countries have put the priority on the vehicle. The result has been a rising trend in damages, injuries and mortality in traffic accidents caused by the confrontation of pedestrian and vehicle traffic in the cities of developing countries.

Vehicle and pedestrian confrontation traffic accidents which constitute a major urban problem originate from human, vehicle, road, or nature factors. Studies have designated urban groups of pedestrians as carrying a higher risk than other groups in being involved in such confrontations. Children who have not yet completed their mental to physical development and elderly people whose mental and physical capabilities are on the decline, especially those over 65 years of age, are such groups. Another major group whose problems have been overlooked in many aspects of life and who have thus been largely excluded from city life, is composed of disabled persons. This is a very serious oversight as all individuals may be included in the disabled persons category at some point in their lives. Children, elderly people, pregnant women, people burdened various loads can all be classified as disabled with respect to traffic confrontations. When the difficulties faced by completely healthy and able adults in city pedestrian traffic are considered, it can be easily comprehended that this task is virtually impossible for the disabled. Designers of city circulation systems have to put equal emphasis on the requirements of all individuals involved in that circulation process.

Space or time separation in the use of the circulation system by pedestrians and vehicles are the basic means of decreasing confrontation possibilities between these users. Although different spatial levels require more investment costs, they provide uninterrupted flow for vehicles and, more importantly safe crossing for pedestrians. User profiles, space utilization, cost, physical human requirements and qualitative factors influence the type of level separation to be used in a particular instance.

Developed countries also develop and implement traffic calming measures which help to improve the quality of life and to establish a more secure environment. Traffic calming measures regulate the speed and density of the traffic flow. Vertical shifts, lateral shifts, narrowing carriageway, small turning angles, pedestrian islands, surface coloration and pavements are among such measures.

In Turkey, the existing political system and the resulting discord between local and central governing bodies and the lack of sufficient funds to finance the implementation of necessary measures makes the undespread application of such measures impossible. Consequently turkey has lagged behind other countries in the application of measures that would improve the quality of its settlements and provide safety and comfort for their inhabitants. Financial limitations have allowed only partial solutions consisting of efforts to adopt traffic calming measures to the existing circulation systems. these efforts have been unsuccessful in the absence of unified and comprehensive transportation planning. Serious efforts are needed in this direction.

Solutions that have been worked out in the developed countries include legal measures, planning activities, and financial provision efforts. Developing countries, on the other hand, have appraised these problems as the inevitable outcomes of the development process and have tried to implement measures that would save the day in the short term. Economic underdevelopment and insufficient financial resources have resulted in planning and implementation that are behind current needs and requirements. Concerns for economy lead to compromising solutions that are impractical, obsolete and short-term. Ironically this leads to failure of obtaining desired results and necessitates new measures which, in turn, creates new and extra demand on the limited economic resources.

As a developing country turkey is experiencing one of the fastest rates of urbanization. Economic resources can not meet the demands for public services created by both the fast rate of population increase and the fast growth of the urban macroform.

In addition, sluggish structures of the legal and bureaucratic systems prolong and delay decision making and implementation mechanisms.

As a result:

The following planning principles are required if our country is to create modern cities where pedestrians can enjoy safe and comfortable circulation in the pedestrian areas and on crossings that connect these areas:

- Phased solutions, which provide flexibility in view of financial resources, should be sought instead of solutions that are economic in the short-term.
- Cooperation between central and local government bodies should be strengthened providing for closer ties and free flow of information.
- Transportation planning should be comprehensively for the totality of the urban area and both the central and local government units should be included in and should contribute to the planning effort.
- Bureaucratic structures that impede and prevent effective decision making and implementation should be revised.
- Solutions should be compatible with the characteristics of locality and the functions that are prevalent there.
- Solutions should satisfy the needs of pedestrians, should provide for the smooth flow of vehicle traffic at a satisfactory speed and should make maximum use of road capacity.
- Solutions should provide for the safe circulation of disabled persons within the city
- Traffic education standing with primary school students should be implemented as a supporting factor.

Chapter 6

CASE STUDY; ADANA CITY CENTER

6.1. A Short History

Adana city was established on Tepebağ tumulus, which was one of the most ancient settlements. The remains, which were found in the nucleus of that rampant- surrounded tumulus, prove that the city had an importance in commercial and military relations. Besides, these remains also prove that Hittites lived here. Tepebağ was a halting place of trade caravans, which were coming from Syria and Karataş, and used as a shelter for the troops. (<http://www.angelfire.com/on/adana/200online>)

The city was also dominated by both Roman and Byzantine emperors. It became an important trade-center thanks to its convenient location. During this period, emperors built certain public buildings, such as Taşköprü. Adana was one of the important culture and trade- centers of Çukurova in 19 century. After Alparslan's Malazgirt Triumph (1071), it started to be dominated by Seljuks (1083-1097). 1097 Crusade ended Seljuk's sovereignty. Çukurova, which was invaded by Mamelukes in first half of the 14 century, started to be dominated by Yüregiroglu Ramazan Bey- one Turkish rulers, loyal to Memluks- in 1352. In this period, the center of that principality, which called itself Ramazanoğulları afterwards, was Adana. Under Ramazanoğulları's government, the city expanded, mosques, caravansaries and public buildings were built. Furthermore, during that period, small trade ships from Syria and Cyprus were coming until Taşköprü. Adana, which became an Ottoman land after Yavuz Selim's Egypt Campaign (1517), was governed by Ramazanoğulları until 1608. During Ramazanoğulları's sovereignty, that started in 1353, the city grew a lot and especially southern districts developed. (Adana City Plan Report, <http://www.angelfire.com/on/adana2000online>)

The fact that the American civil war, which started in 1861, increased cotton prices, made England, which was the biggest cotton importer of that era, seek new cotton sowing lands. As a result of England's researches, Çukurova, which was convenient for sowing cotton, started to be used for cotton agriculture, thanks to the co-operation of the mentioned period's Ottoman and English governments. Afterwards France and Germany also joined this initiative. Thus, cotton, which made Adana's economy gain its

first dynamism in the past, had a historical role in both Adana's industrialization and opening to the world. In 1881, the construction of Adana-Mersin branch of Istanbul-Baghdad railway provided Adana with connection to sea and made it open to the world. In 1886, thanks to the construction of Adana-Mersin railway and cotton agriculture, Adana region started to develop economically. (Adana Trade Chamber, 1994)

The changes in economic life also reflected to social life. The cotton sowing activity provoked seasonal worker migration to the plain in the second half of 19 century. And in coherence with this economic development, a big population density occurred in the city after the declaration of Turkish Republic. The population in 1990 was 1,93 million, which was 8,5 times more than the population of 1927's. This situation caused a labor-power accumulation in Adana, which could not meet the labor-power requirement before. On the other hand, this also caused certain problems, such as housing, health, education and transportation.

The first attempt about Adana city plan was in 1930. The first improvement plan for Adana was made by a German professor, Hermann Jansen in 1939. But, since the city continued to develop contrary to that plan, some additional improvement plans were made in 1943 and 1948. Although the plan, which was made by the Bank of Administrative Provinces in 1966, has been applied by regarding its basic principles, after 1985's planning etudes, which contain the metropolitan regions of Çukurova, were made by a foreign consortium.

Adana, which protected its average provincial features for a long time and whose population was not more than 20-30 thousand, started to develop in second half of 19 century. This development gained speed especially after 1950 and made Adana have its present big city characteristic. As a result of the connection of the city to Mersin port by railway in 1886 and contact of Hedjaz railway to Adana by passing over Taurus Mountains, during World War 2, the city started to develop. Especially after 1950, it spread out fast around the ancient nucleus and rather towards northern-east station and west. New planned districts were established, wide avenues and parks were constructed. During these progresses, the development overlapped to the west side of river Seyhan (Figure 65).

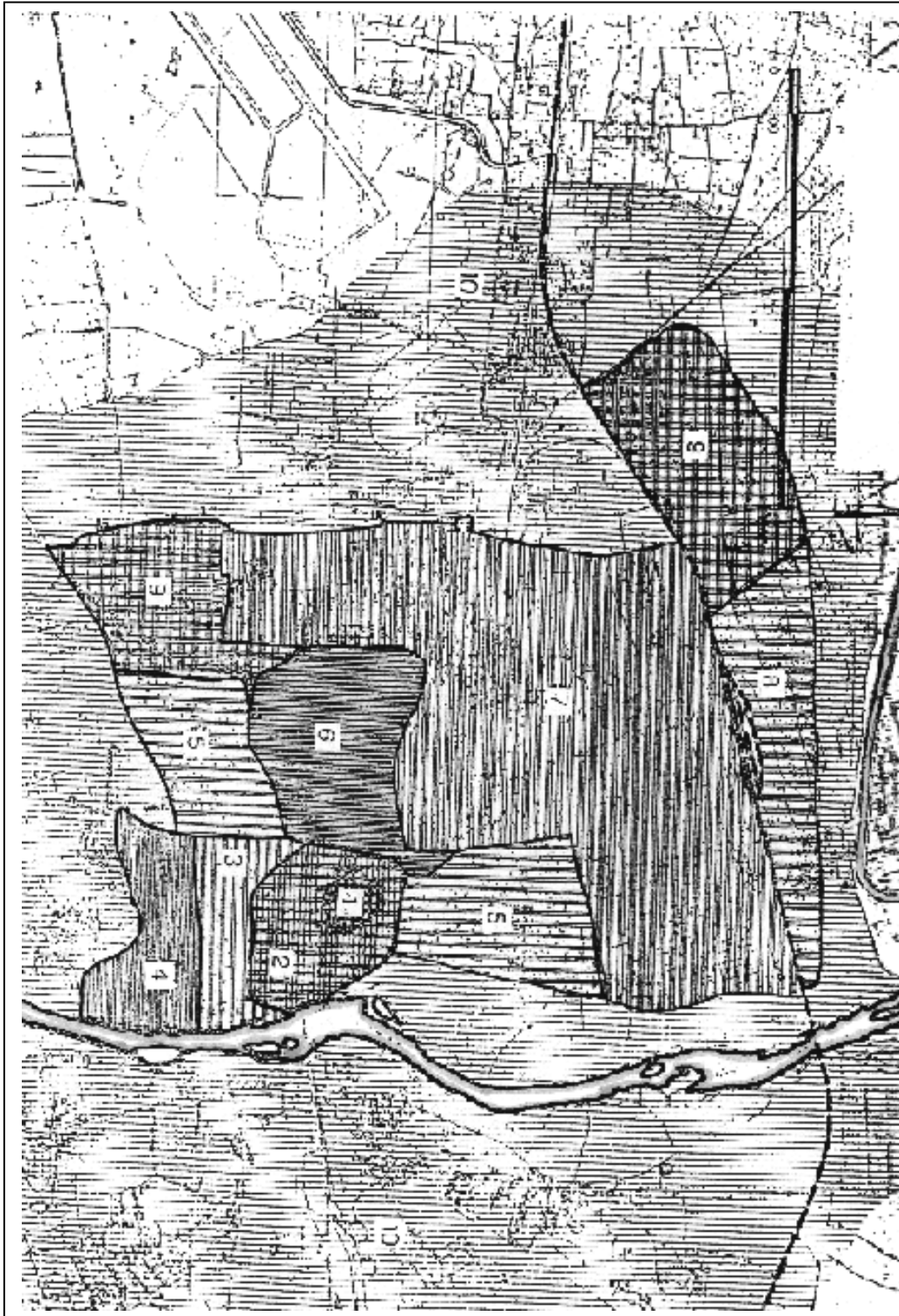


Figure 65: Development of Adana, Adana City Plan Report

The city, which developed around the nucleus until 1950's, continued its development, which became dense around the center, between 1950 - 1970. Main development was parallel to main roads. The most important developments were; in west, along Tarsus road, in north, along Karaisalı road and around the canal, which is at the west side of river Seyhan. Meanwhile, the development also spread out to east side. The area, where the industry is most dense, is around old station. The first industrial establishments in the city were settled here and in the course of the time spread along Tarsus road- towards east. At the east side of the river a big part of the industrial establishments were settled along Ceyhan, Kozan and Karataş roads. In Adana, industrial areas and slums are one with in the other. Most of the factory workers go to work on foot. Yet, the industrial areas, which are along road, are settled out of walking distance.

There was immense migration from rural areas to the city after 1950's. There are two basic factors of increase in activity and population density in Adana: Firstly; the agricultural developments that depend on irrigation and mechanizing in 1950's, second; industrialization, which gained importance after 1960's and first started by depending on agriculture and afterwards varied to some extend. Sowing cotton and, depending on this, industrialization had a big role in economic evolution and developments of population increase and dispersion of Adana. Adana, one of which the urbanization process is the fastest in Turkey, has become the most important center of Mediterranean region, regarding trade, industry and capital market.

While Adana was like a very wide village in 1966, the Bank of Administrative Provinces introduced a contract for improvement plan. The improvement plan, which were stated related to precise principles of this contract, arranged the housing areas, which grow towards the dam in north, the slums, which were settled in west and east, settlement districts of socio- economically various incomer groups according to radial line model. There occurred certain centers where trade, education, health, culture, tourism, administrative and transport services, which include development, became dense, in city center.

According to this plan the following projects were foreseen: Misis was to be an industrial area, construction of tramcar and bus ways, which would provide north-south connection for transportation, a main road, which would pass along south and collect agricultural products, reconstruction of D-400 main road, which divides the city into

two, in north Adana. So, the development of the city gained speed towards north Adana after the construction of 50 meters wide d-400 main road, which passes through the city. Both sides of river Seyhan were for resting complexes, small industry complexes were taken out of city, the whole sellers' complex, bus station and warehouse areas were constructed on D-400 main road.

6.2. The Existing Structure of Adana

Adana is one of the chief administrative provinces on account of population density, increase and number, urbanization and economic development speed. The population increase in Adana was more than general, in the period from 1935 to the beginning of 1990's (Table16). From the beginning of 1990's, after the decrease in migration- especially from east and south Anatolia- the increase speed has diminishingly accelerated. Such a situation was mostly the result of inauguration of GAP (South-east Anatolia Project) and similar projects. In 1945, both in Turkey and Adana the density per person was $1\text{km}^2/24$. But in 1980, the population density in Turkey generally increased to $1\text{km}^2/58$, where as in Adana it increased to $1\text{km}^2/86$. And the population increase speed was 2.3% for Turkey and 3.5% for Adana. (<http://www.angelfire.com/on/adana2000online>)

Table16: Rural and urban population growth for Turkey and Adana (%)

	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990
TURKIYE	23,5	24,4	24,9	25	28,8	31,9	34,4	38,5	41,8	43,9	53	59
ADANA	28,6	31,5	33,3	32,8	37,9	43,9	46,8	50,8	56,9	56,7	66,2	69,8

Source: Institute of National Statistic (DİE)

The population density in Adana approximately doubles Turkey general's average ($1\text{km}^2/95$). Approximately, 66% of the population (more than 1/3 in the city center) lives in urban areas and 34% in rural areas. Adana is the third fastest city with regard to population increase speed (approximately, 0.36%/year). The proportion of active population to whole population is 40%. Approximately, 65% works in agriculture and 15% in handwork industry. Certain agricultural produces, which play a key role in

Turkey's both domestic and international trade, are mostly cultivated in Adana. Approximately, 36% of the city land is used for agriculture. (Adana City Plan Report)

Approximately, 20% of the sown land is used for agriculture. This is more than Turkey's general average. The international demand, which increased because of the fact that the civil war in USA in the second half of 19 century hindered cotton production, influenced the development of agriculture and as a result of this, a part of the nomads were made settled on plain with winter quarters. Thus, plenty residential areas were established. After 1950, number of the settled increased as a result of; construction of the port and irrigation complexes, taking precautions against floods, dehydration of bogs, establishment of new industrial areas and cultivation and treatment of agricultural produces, which were gradually increasing and diversifying.

6.2.1. General Characteristic and Land Use

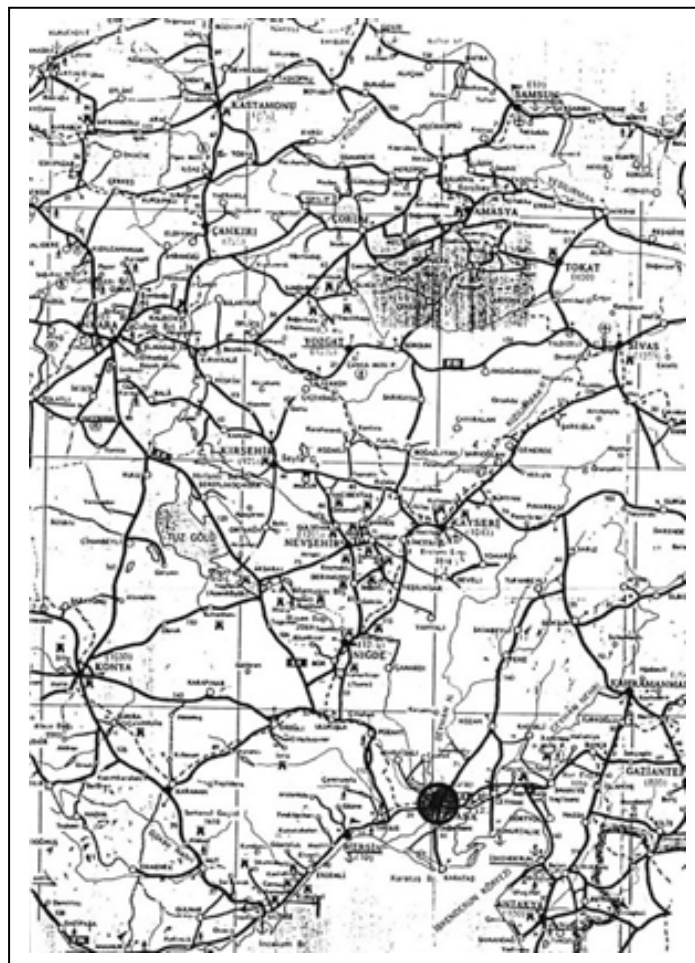


Figure 66: Highway transportation in national scale

Adana, which is in southern Turkey and has productive agricultural lands, can be taken as the center of Çukurova. It has a central role with regard to north-south-east-west direction connection of the region, where it is located. Adana, which is located on Mersin- Gazi Antep and Mersin- İskenderun main roads, is an important bridge for highway transportation. (Figure 66)

River Seyhan, which flows north-south direction, divides the city into two administrative districts- at the west side, Seyhan and at the east side, Yüreğir. (Figure 67). While Seyhan includes a big part of the functions of the city, in Yüreğir, the development speed is slower. And the growth is towards north at both sides of the river. Meantime, this growth causes density increase and so, while the housing areas has low density in south Adana, they become highly dense in north.

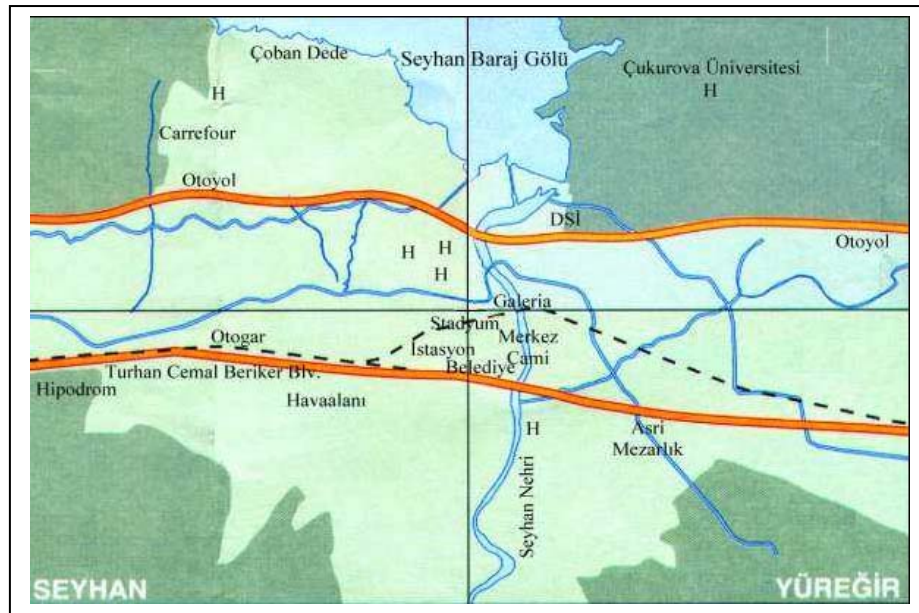


Figure 67: Adana and River Seyhan, <http://www.adana.gov.tr>

6.2.2. Transportation

Adana has always had a strategic location with regard to transport. Adana is road-bridge like with regard to its location. The traffic, which comes from Çukurova region's port, continues to middle Anatolia or to east and to southern-east. Besides, the traffic, which comes from Europe and Anatolia, continues to Middle East and gulf countries, Iran, Pakistan.

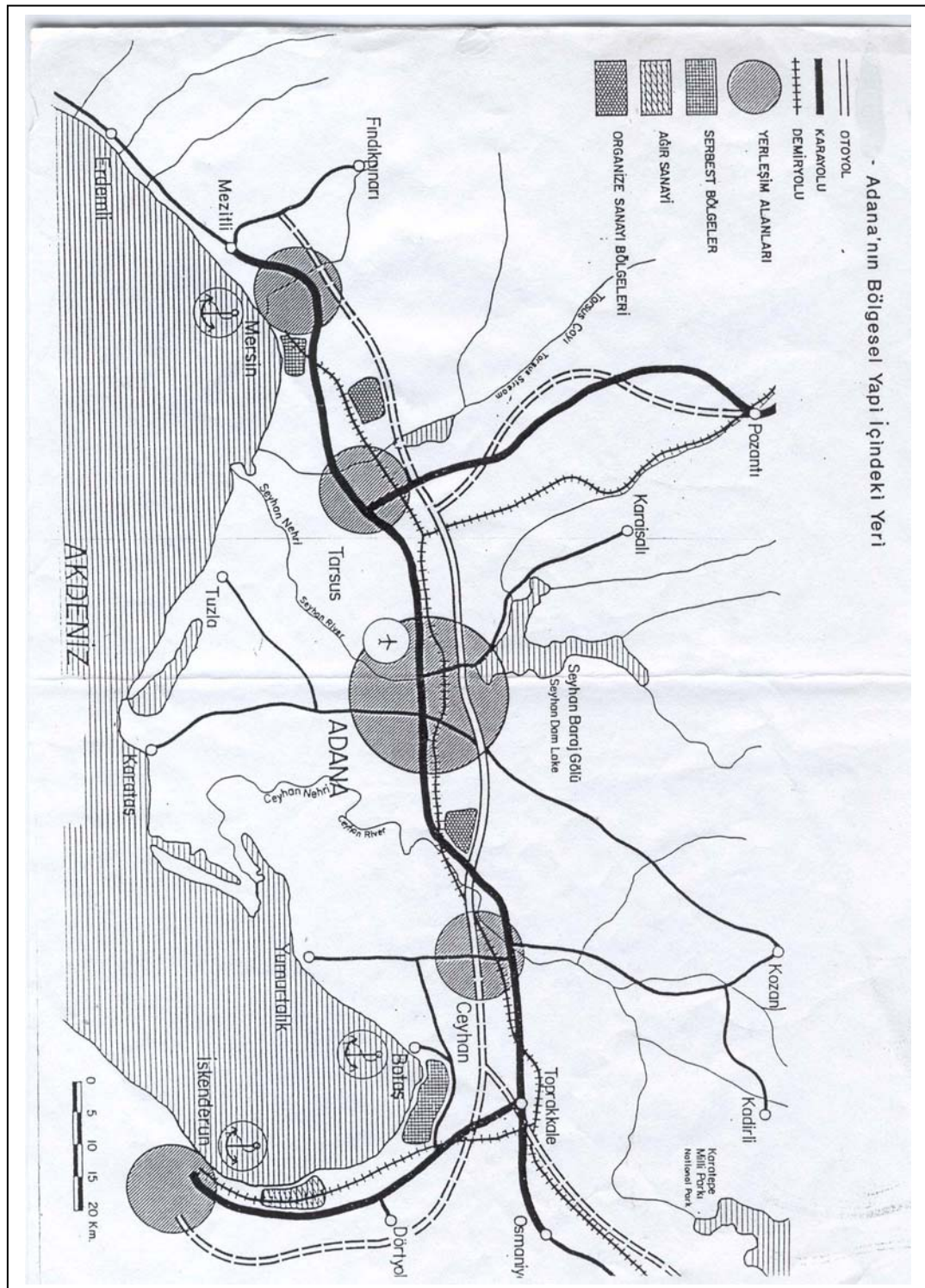


Figure 68: Highway transportation in regional scale, Adana City Plan Report

D-400 national road, which divides the city along east-west direction into two, is the most important road connection between Europe, East Anatolia and Middle East countries and South Anatolia (Figure 68). All agricultural and industrial products of Çukurova and South Anatolia are transported through this road connection. The dense regional relations among Mersin, Adana and İskenderun pass through this road.

Çukurova main road, which is a part of Trans-Europe Motorway (TEM), that will connect North Europe to gulf countries and provide Mersin-Adana-İskenderun connection has been introduced into service and this lessened a certain amount of traffic burden of D-400 passage, which was creating serious problems for the city. But, the traffic, especially among close cities, such as Mersin, Tarsus, İskenderun and Gazi Antep is still flowing on D-400 main road.

Local transport substructure of Adana consists of radial main road connections, which has been shaped in its historical evolution. This structure is affected and restricted by certain factors. The most important ones among these are: irrigation canals in the city, river Seyhan, which flows through north-south direction, and D-400 national road, which is through east-west direction.

Adana transport system has such a structure that, various transport demands intersect on same connection. D-400 national road, which passes through the city center, is not only used for transcontinental and trans-country traffic but regional and inner city travels. The roads, which provide the connection between north and south sides of the city intersect D-400 national road, which divides the city into two. Besides the main road is also used for regional transport, because of the urban uses on main artery.

The city transport system is set up on, firstly, in ancient city center, after, on radial ways, which connects the city center to north D-400 and focuses its new extension; and this system is adapted to urban uses which came into existence on both south and north sides of the city. Public transport and semi-public transport also seem to be radial-type like a line net. All public bus and minibus lines either come to an end at the city center or pass through the city center. The transport management, which is applied for inner-city transport system has no stepping up in road net. This became a part of the road net, after they linked to both D-400 and other areas, where regional connections are completed.

In Adana city transport, there are no public transport priorities, public and semi-public transport vehicles, which are run by private and public enterprises, share the

same road net with other components of traffic. In Adana inner-city transport the minibuses carry most the passenger. This proportion is 37.89%. This kind of transport uses often the main corridors. On d-400, vehicles pass very often, such as 376/hour/vehicle/direction. Public buses carry the second biggest portion of the passengers in inner-city transport. (City Plan, Report of Analytic)

Road :

Adana is after Istanbul, Ankara and İzmir with regard to relations with counter administrative provinces and road traffic density. Density is rather on Mersin-Adana-Gazi Antep, Mersin-Adana-İskenderun and Adana-Tarsus-Pozantı axis. Adana-Tarsus main road carries the burden most because of Mersin Port.

Regional traffic, which contains Adana has become dense and been forcing the city. In Çukurova region, Mersin-Adana-İskenderun axis will also develop with regard to service sector, as long as the transport and communication opportunities develop. And, thus, Adana will achieve the mission that is expected on account of expertise and division of labor. Adana will probably achieve this mission in the shape being a trade and finance center. While the city center will keep its importance on manufacture sector, the industry units will move to the out of the city center.

Railway:

After the construction of Mersin-Adana line in 1886, first railway was in service in Adana. This railway is a part of famous Baghdad railway. This railway, which was opened to service at the beginning of World War1 and connects to İskenderun with an additional line, does not function at the expected level concerning carrying.

While Adana suburb should be playing a key role for regional transport of Çukurova, it is used for urban needs. It is used for regional travels only at a limited rate.

Light Railway System:

Adana light railway system project was prepared to complete by 2010 in 1991-92. The system, which is still under construction, includes a 19.2 km line and 19 stations (Figure 69). The line starts from the Mental Health Hospital- north west of the city and ends south side of Çukurova University- north east of the city.

The system starts from Hospital Station, turns to MÜcahitler avenue from Anatolian High School junction, arrives to Mavi Boulevard station- to south east direction. It passes under railway via a viaduct, which is opposite to Ege Bağatur Bridge, arrives to Çifte Minare Mosque station by provincial Governmental Offices and intersect D-400 national road. It ends at Sofulu station by crossing over river Seyhan, towards northern east. Storing and factory complexes are in east of 100. Yıl Housing areas. The busiest station in the system is Vilayet Station After this Atatürk, Mavi Boulevard, Hastane, Kanal Köprü and Sofulu Stations come.



Figure 69: Light railway system, <http://www.adana.gov.tr>

6.3. Problems

D-400 national road passes through the city and central business district and it divides the city into two- from north to south direction. So D-400 national road is an obstacle to the activities among different areas of the city. Besides, the fact that the traffic, which is irrelevant to the city, passes on this road is an important factor that isolates this activity and relation among these areas. There are non-residential urban working and industrial areas along D-400 national road, and central business areas are

dense between Celal Bayar Bridge-type junction and Museum junction, and river Seyhan and Yüregir bus station. Adana passage of the national road is a negative factor, which isolates the relation among areas because of dense pedestrian and vehicle use, especially, in business center and of the intersection of these uses.

Number of accidents on D-400 main road is augmenting at a fixed rate. The rate of mortal and wounding accidents is 33% and of damaged accidents is 22% of total accidents. The chief reasons of these accidents are: too many junctions, which are brought into existence by roads and by-roads, that intersect D-400 national road; and again, dense crosswalks between north and south sides of D-400. The most negative effect of D-400, which divides the city into two, is on account of walker traffic. The secure passage need should be provided in order to prevent problems, which are caused by the intersection of main road, which has a dense vehicle volume that is created by the traffic, which is irrelevant to city center and walker traffic. (Regional Traffic Office Report)

Table17: Number of Death and Wounded of Traffic Accidents, Adana, 2001, for 5 Months.

Driver				Passenger				Pedestrian				Total			
Mortal		Wounding		Mortal		Wounding		Mortal		Wounding		Mortal		Wounding	
F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
0	11	19	326	0	4	152	223	4	9	59	100	4	24	230	649

Source: Regional Traffic Office, Accidents Report

Another handicap about transport system is trade affairs, which is made by manual or pedal-type vehicles. Vehicles occupy the sub-structure, which is already insufficient, on junctions, stopping places and connection points, and existing capacity of the road is decreasing.

Table 18: Kinds of Accidents in Adana, 2001, for 5 Months.

KINDS OF ACCIDENTS	NUMBER OF ACCIDENTS
Facing one another crash	37
Crash from back side	73
Crash from side or crash	196
Crash into stopping vehicle	24
Crash into a stationary thing	68
Crash into pedestrian	146
Crash into animal	1
Over-turn	30
Getting out of road	36
Dropping from vehicle	5

Source: Regional Traffic Office, Accidents Report

Table 19: Pedestrian Faults Causing Accident, 2001, for 5 Months.

PEDESTRIAN FAULTS	NUMBER OF ACCIDENTS
Crossing in spite of red light or police sign	9
Darting across	39
Darting out to road from front or back side of inactive vehicle	10
Violating vehicles right to pass	78
Running, playing, walking on the street	11
Hitching a ride on	1
Riding manual vehicles with a faulty manner	1
Others	7

Source: Regional Traffic Office, Accidents Report

Since the ways in historical center are designed for walker passage, the capacity is insufficient for today's increasing traffic and number of vehicles. Furthermore, the car-parking need, which is a result of such a situation, is met by using roadside.

Regional roads, which are especially out of local character, pass generally through the city center, because of transport demands. This passing provokes certain

effects on the city and citizens. The arising effects are not only originated from the developments, which are happening over a certain area, but it must be evaluated on whole city- even the region scale.

Adana is divided into two because of the fact that D-400 national road is at a regional and even national scale. The city center, where especially a dense use exists, is under the effect of a dense and fast flowing traffic. Disconnection among function areas affect the pedestrians, who use the city center, and this effect sometimes causes certain wounded, even mortal accidents. When all these features are taken into the consideration, it is evident that; a sectional-type applied traffic calming method will not perform successfully. For the solution, a comprehensive revision, starting from the transport plan of whole city to design scale should be done. Otherwise it should not be expected that the offered solution perform the expected success.

6.4. Redesign of the Problem Areas

D-400 Adana passage, which is in city center, is both used for regional connections and inner-city transport. The use becomes dense especially because of existing urban functions, which take place in central business areas. Since the fact that the transport system of the city use the main road, and the main arteries, which provide the connection between north and south sides of the city, intersect the main road, it is seen that, the vehicle traffic density is augmenting.

The city, which is divided along east- west as Seyhan-Yuregir central administrative districts by river Seyhan, is divided as north-south Adana by D-400 national road. These separated city parts differ in land-use, density and settlement qualities. While, in south Adana, lower dense constructed areas, where the ancient city tissue dominates, take place; in north Adana, higher dense constructed areas- in accordance with the improvement plan- take place. North Adana, which is a development area, is called “New Adana” because of its mentioned feature. In south Adana, where the ancient city tissue dominates, the roads are walker scale-type. So the vehicle traffic, which becomes dense in the city center, is in contradiction with traditional tissue. The vehicle traffic is common with its wide avenues in north Adana.

The city center accomplishes trade and administration functions. The trade spreads along main arteries, which are extended in a radial-type from the center, and

there are non-residential urban working areas especially along D-400 national road. So for residential areas, it is low dense in south and high dense in north. Thus, the activity from north to south is vice versa in the evening.



Figure 70: Adana D-400 City Passage, <http://www.adana.gov.tr>

The vehicle and pedestrian volume of the area is an important datum for determination of problematic parts for the work, which is planned to accomplish. So it was necessary to count vehicles and pedestrians of different hours of a day, for a year period. But, the counting work of the working period was districted to one week, in January. However, it was clear that the data were reliable, if seasonal and monthly variables are taken into the consideration, and if they are compared with annual average daily traffic volume of General Office of National Highway (Figure 71) So, it was accepted that the data, which are acquired from counting, were reliable. (Figure 72) due to the fact that the climate in Adana is dry in the summer and temperate in the winter and by regarding the population variety of each season and also people's going out hours, the walker volume was counted in busiest hours with pre-acceptance of differential error.

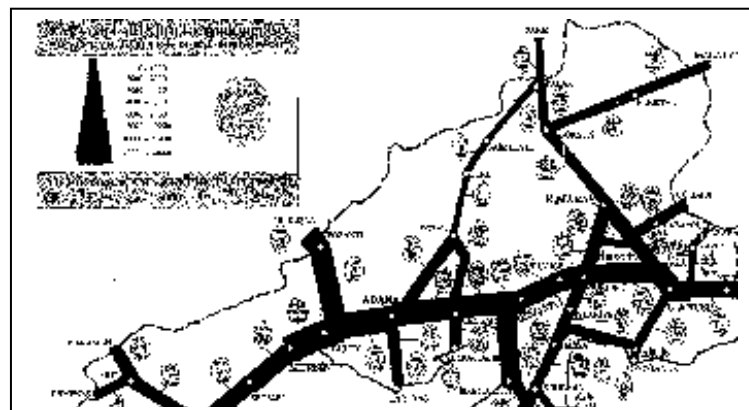


Figure 71: Annual average daily traffic volume, General Office of National Highway, 2000

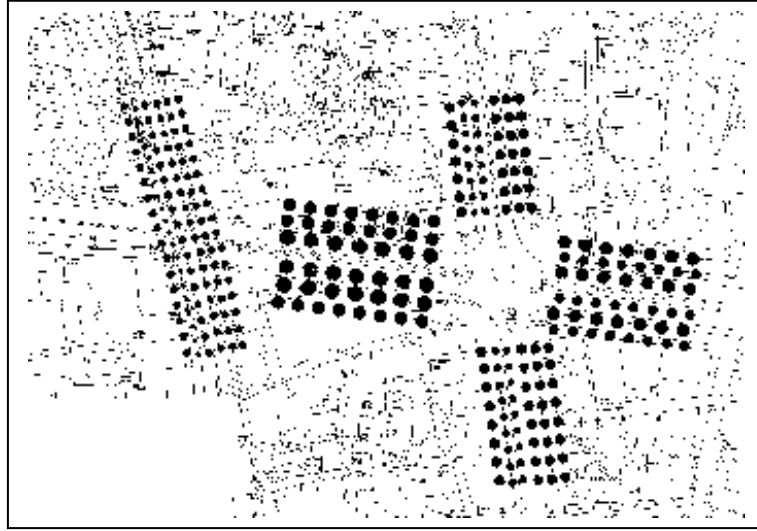


Figure 72: Peak hour vehicle volume

In the existing system, there are problems about vehicle and pedestrian traffic, especially in the part, which is between Celal Bayar multilevel interchange and museum junction of D-400 national road, which is in central business area. Especially, increasing pedestrian traffic, which is caused by central functions, intersects fast and high dense traffic on the main road, and therefore provokes accidents, which are related to walkers. By taking this point as the core, the work includes Atilla Altıkat over crosswalk, Türküsü junction and 5 Ocak crosswalk, where the walker and vehicle traffic is dense in the city center and it is focused on designing Türküsü junction, where the density is highest.

6.4.1. Atilla Altıkat Over Crosswalk



Figure 73: Atilla Altıkat Over Crosswalk.

Atilla Altıkaynak Over Crosswalk is along the bridge, which connects Ziyapaşa Boulevard to İnönü Avenue. The bridge was constructed as having 4.30 meters of height and for bars from north and south points and east and west sides. Steel construction and concrete were used with to building technique and material.

Ziyapaşa Boulevard includes both residential areas on north side of D-400 and mostly service and trade sector. Trade activities rather take place on south. This boulevard passes over D-400 through the bridge; thus, the dense traffic on the main road is not cut off.

The crosswalk, which is on a different platform than vehicle way, provides the walkers with a safe crossing service. Pedestrian volume counting works show that the over crosswalk is used more in the afternoon. (Figure 74) Yet, these values are of January.



Figure 74: Pedestrian volume in peak hours.

The part of the city, which is between Atilla Altıkaynak and Türküsü, is the unique inner-city terminal station of inter-city buses. Inter-city travel agencies are not allowed to have an office in any other parts of the city. So it is frequent that you can see pedestrians who carry loads, such as luggage, bag etc. and also service minibuses for taking passengers to the bus station, vice versa.

The over crosswalk is mostly steel construction and there is concrete material in some parts of the steps. This boulevard passes over D-400 through the bridge, thus, the dense traffic on the main road is not cut off.

6.4.1.1 Problem Definition

This area, which is the unique inner-city terminal station is –because of its mentioned feature- used a lot by service minibuses. Especially, since the fact that there are not any service areas for passenger getting on-off and waiting, and that minibuses use the main road, increases traffic dense more and more. (Figure 75)



Figure 75: A view from Atilla Altıkat Crosswalk to D-400

The crosswalk is constructed at a 4.3 meters height along Ziyapaşa Boulevard. The crosswalk, which has four entrances in total from east and west sides of the bridge, unites under the bridge. Lighting tools are settled on these uniting points for security in the night. But this system is not working because of lack of sufficient maintenance. Especially, the over crosswalk, which provides pedestrian passage to north-south direction, is silent in the night and makes the pedestrian feel unsafe because of different functions absence. (Figure 76)



Figure 76: A view to Atilla Altıkat Over Crosswalk and lighting tools

This over crosswalk, which is at an important point of city center, was constructed without any aesthetics. While, on the one hand the over crosswalk attracts

pedestrians and provides them with a safe and protected from vehicles-type crossing, on the other hand the lack of design elements, which will get them to notice the importance of the place they are using has made it a place for beggars and hawkers. (Figure 77)



Figure 77: Hawkers on Crosswalk

It lacks not only aesthetic values but also other designing principles. It is uncomfortable even for a healthy person with its step heights, differing between 13-24 cm. (Figure 78) Yet, the fact that the luggage carrying people, including the disabled use here because of its terminal station-type feature, is obstacle to an efficient use of the over crosswalk.



Figure 78: Steps of crosswalk

6.4.2. 5 Ocak Crosswalk

5 Ocak Crosswalk is shaped by walker lines and sign boards without a lighting system, and it provides the pedestrian connection between 5 Ocak Avenue and İnönü Avenue. It connects the north residential and central business areas to south business areas. It was established after removing the barriers and the refuge on D-400 in order to provide the connection between 5 Ocak Avenue, which was opened to walkers use and is and at the north side of the primary school and the foot-path, which is connected to İnönü Avenue and İnönü Park.



Figure 79: 5 Ocak Crosswalk

5 Ocak Crosswalk is the unique point where a crosswalk exists between Türkusu and Museum junctions. The iron barriers, which were constructed to prevent crossing from every point along D-400, are removed at this point and the crossing is allowed. The density of the crosswalk affected by not only the fact that it is in central business area but also by the presence of a primary school. This density is especially in the morning, afternoon and evening, which are the beginning and finishing times of the lectures. There is dense walker traffic because of students. (Figure 80) More than 2000 walkers use the crosswalk at the peak hour. (Figure 81)



Figure 80: Pedestrians on 5 Ocak Crosswalk

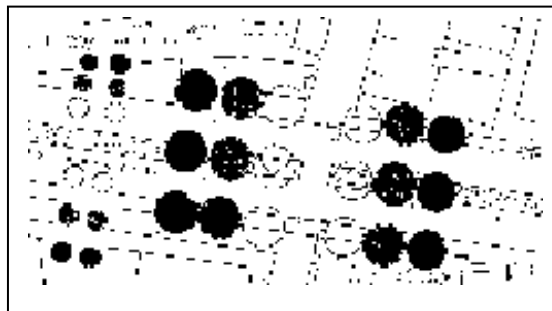


Figure 81: Pedestrian Volume at the peak hour

6.4.2.1. Problem Definition

5 Ocak Crosswalk, which is on D-400 national road and where the traffic volume is most dense, is such a crosswalk that both pedestrian and vehicle are on the same platform, and there are not any traffic regulating systems part from traffic signs and pedestrian lines. The pedestrian is not safe against vehicles, while crossing. (Figure 82) The fact that the crosswalk is especially used by school children increases the accident risk.



Figure 82: Contradictions Between Vehicle and pedestrian

Another problem is insufficiency of waiting area on the reserve space. (Figure 83) The crossing walker is facing vehicles as a result of accumulation, because of the insufficiency of waiting area, when he comes to reserve space. Thus, the insecurity of the walkers against vehicles increases.



Figure 83: Reserve space

6.4.3. Türkusu Junction

Türkusu Junction is one of the most important junctions Adana city passage. It intersects D-400 national road, which is along east-west direction, Atatürk Avenue at the north side and Çakmak Avenue at the south side. There is a dense traffic volume at this point along north-south and east-west direction.



Figure 84: Türkusu Junction

6.4.3.1. Existing Structure of Türkkusu Junction

Atatürk Avenue is in central business area and its functions are mostly about service sector and trade. Besides, the area, which is on the north side of the junction, includes high standard residential areas. The presence of Municipality House, Municipality Symphony Orchestra and Theatre unites various uses in this area. So the activity is continues in various periods of a day.

Public transport vehicles and minibuses, which connect north to south and west, use Atatürk Avenue, consequently D-400. This part of D-400, which is used both for inner city and inter-city transport and also a public transport route, is, with its this feature, one of those, which has the most dense traffic volume. Furthermore, since it is an inner-city terminal station, the waiting vehicles, increase the density more. (Figure 85)



Figure 85: Vehicle volume in peak hour

The dominant service sector, administration, trade and, in addition to these, housing, in north Adana is rigidly related to retail trade area of south. Pedestrian movement is denser from north to south during a day. (Figure 86) In south, the existence of stopping place, which is used as the main transfer point of public transport vehicles, which are at the west side of İnönü Park, and of minibus-stops on Cemal Gürsel Avenue are also another important factors in density increase. Walker traffic, which is along north-south direction, is denser at the west side of the junction. This occurs because of both public transport stopping places and the width of the pavement, which is along Municipality House. (Figure 87)

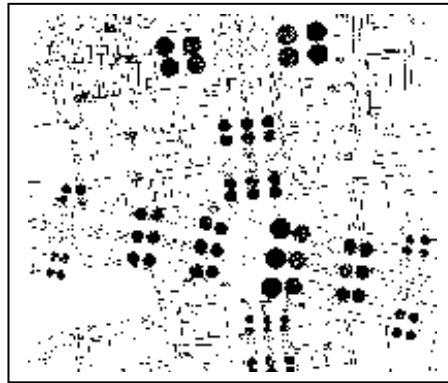


Figure 86: Pedestrian volume in peak hours

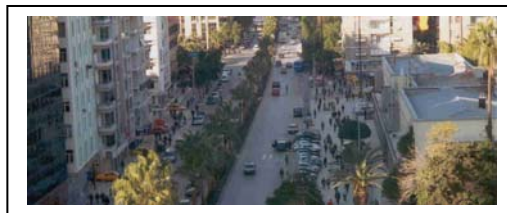


Figure 87: Ataturk Avenue and Municipality

The fact that such dense vehicle traffic intersects the dense pedestrian traffic provoked certain problems. The fact that the passing system between vehicle and pedestrian depends on time separation on the one hand causes a delay for vehicles and on the other hand provides the pedestrians with an insecure crossing. Especially, because both pedestrian and vehicles violate the regulations, the danger increases. (Figure 88) So, the junction is one of the dangerous points with regard to pedestrian-related accidents. (Table: 20)

Table 20: Number of Annual Accidents

YEARS	The types of accident				Number of crash
	Crash	Capsized	Crash into pedestrian	Other	
1995	10	0	2	1	13
1996	29	0	2	2	33
1997	38	0	1	7	46
1998	35	0	2	11	48
1999	33	0	2	9	-

Source: National Highway Administration



Figure 88: Regulation violating pedestrian and vehicles

6.4.3.2. Problem Definition

The junction is exceeding its capacity, because of the dense traffic volume on it. Especially, because of dense traffic and turning left, signaling system is insufficient and accumulation occurs. This situation causes the cut off of the flow of the traffic, which is on the green phase and stopping up of the traffic. (Figure 89)



Figure 89: Accumulations while turning left

The traffic has different density during a day, since it is in the city center and its relations, which is between the residential areas of north side and working areas of south side. Accumulations occur on junction branches, because of the augmentation of traffic density in the morning and evening.

In Adana, manual and pedal vehicles, motorcycles and bicycles use is very common because of either climatic or socio-economic reasons. And these kinds of vehicles are often seen because of the historical city center, where the ancient city tissue is still protected. But, these kinds of vehicle cause traffic accidents not only in inner-city traffic but also on D-400. (Figure 90)



Figure 90: Using of Wheelbarrow on D-400 national road

6.4.3.3. Proposed Solution

Achieving the optimum cost solutions, which will not intersect the dense pedestrian flow, that is originated from being in the central business area with the dense vehicle traffic on the road, provide the pedestrians with a secure and peaceful crossing and,

while providing these, establish the complementary systems, which are in coherence with the city's central feature, is the main target.

High volume pedestrian flow between north and south of D-400 national road, which caused to separate the city centre, conflicts high volume vehicle movement on the road. Because of that, the system aims to solve the problems. The system will be established on east of junction as first because of having more pedestrian movement there. Another reason is that pedestrians, who cross the road by 5 Ocak Crosswalk, will use proposed system that will be attracting thanks to design. (Figure 91)

Function, cost, culture, structural technology are factors for appearing the shape in design. Importance of the factors changes as related with location, land use of site, and social structure. The site in city centre has importance forming city image. Because of that, aesthetic is an important factor in the design.

Structure is as an important factor related with road geometry and building interval that is forming design. The system must be pass wide openness, meanwhile should have minimum high of floor. It should have minimum construction cost and maintenance, and also has aesthetic value. Consequently, II beams will be established.

After the acceptance of the existing transport net, through getting acceptances for the close surroundings of the area on public transport stopping points and lines, it was accepted that the fact that the corridor which is for public transport vehicles at the east side of Turkkusu junction of D-400, is used for this target. In accordance with this, the fact that the stopping-places of the buses and minibuses lines, which are İnönü Park and Cemal Gürsel Avenue, are to be on this corridor was accepted. Thus, the stopping-places became an important component of walker system.

City centre, and also the problem site have retail, education, culture and services sectors. Because of this, the crosswalk will include rest areas, retail activities, and fast-foods for either worker or people come to city centre for an aim, It is accepted. Safety sense rises by liveliness that is created to provide by various functions. In this way, pedestrians are protected from crime

City centre has not enough green and open areas because of having high land value. Adana City Centre has not also green and open areas. For that reason, proposed solution must be character gives comfort in city centre has high density.

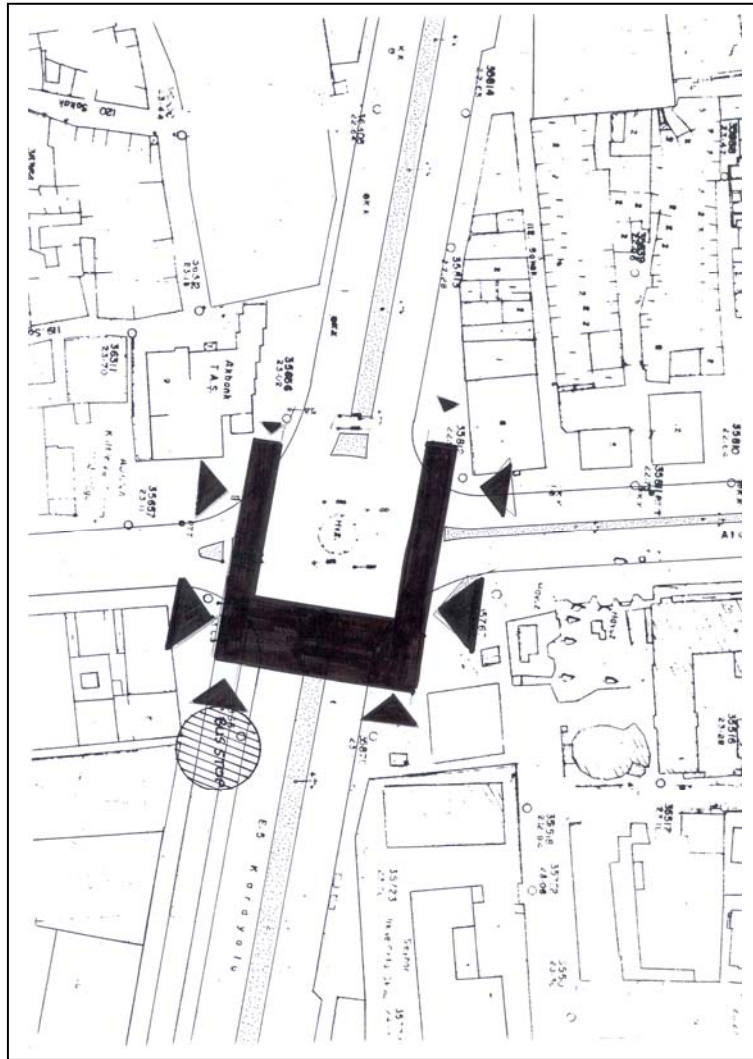


Figure 91: Proposed solution

Climate is an important factor for Adana City. Weather is warmish and rainy in winter, harm and dry in summer. For that reason, plantation is important for making climatical effect minimum, in addition that creating green and open space in city centre. necessity on sun and shadow, toleration on polluted, high and spread of plants was taken into consideration for throughout plantation.

The proposed system, first of all meets the physical needs of the people. Steps' height, which is also suitable for the handicapped, was constructed with the ramps on the upper altitude. Besides, escalator and also lift for the handicapped are included in the system. The system is, at the same time, also an open land in the city center, which is constricted regarding increasing rents, since the city centers have image features. Yet,

at this point, since the cost is an important input, the equipment and the material, which will be used, must be an optimum solution, which will not need a frequent maintenance, is long-life and meet the physical and aesthetic demands. Both there will be an activity and the construction and maintenance costs will be met through the trade functions, which will take place on the over crosswalk.

CHAPTER 7

CONCLUSION

Adana, which could be taken as the center of Cukurova, is an important connection point on countrywide road net. It is on the road, which connects Mersin and İskenderun Ports to Middle Anatolia and other regions. The road, which bears such dense traffic, passes through Adana. Apart from its benefits for Adana, thanks to its importance, D-400 national road divides the city into two along north-south direction by passing through the center. This makes the relations between functions and sites weak, even sometimes isolated.

The city centers include dense work, services, culture and education functions. The structural density of the centers augment because of certain reasons, such as density in functions, land value increase in return for demand. Adana city center was under the pressure of the demand, which were created center functions, in such period. High-capacity roads were constructed in city center especially in return for demand for transport, and thus, the city center, which has already a dense pedestrian flow, was divided in parts by vehicle ways and the relations among areas weakened.

We have to find a solution to prevent the conflicts between vehicle and pedestrian. In the existing system, the solution is hindered by lack of money and bureaucracy. The solutions, which are obtained by having a consensus limited by the authority limits among different institutions, afterwards, is hindered by economic obstacles, and it can not be applied because of lack of economic source or the expected result is not obtained.

Other important issue is that the solution efforts are evaluated at a point-scale, nowadays. The decisions, which will be taken for a certain part of the city, is related to whole city and influenced by the whole and influences the whole; so a transport planning for the Adana as a whole and the public transport routes should be stated by stating vehicle and pedestrian systems. Otherwise the proposed decisions for our problem area will not create proper solutions. But, we accept the existing structure with regard to transport, since, in the content of the work, we did not spend our time and effort for transport planning of the whole city, and besides we could not foresee our chance for success about the intervention to the whole city. So the existing structural

features are into account with regard to statement of the system, which will be established.

The point, which should not be forgotten on account of the effort of solving the problems, which are the result of the fact that a countrywide and regional scale road inserts the traffic, which is irrelevant, to the city center, is that, the problem area is in the city center. City centers create the images of the cities. At the same time, it is also an indicator of the city and the government's power. So, in solution efforts, both functionalism and aesthetic is gaining importance.

So, the solution is to create transition systems, which, by taking the center's image feature, do not compensate about functionalism, where the construction quality and cost at the optimum level, which do not have maintenance and repair cost, or in which the cheap material is used and which is long life.

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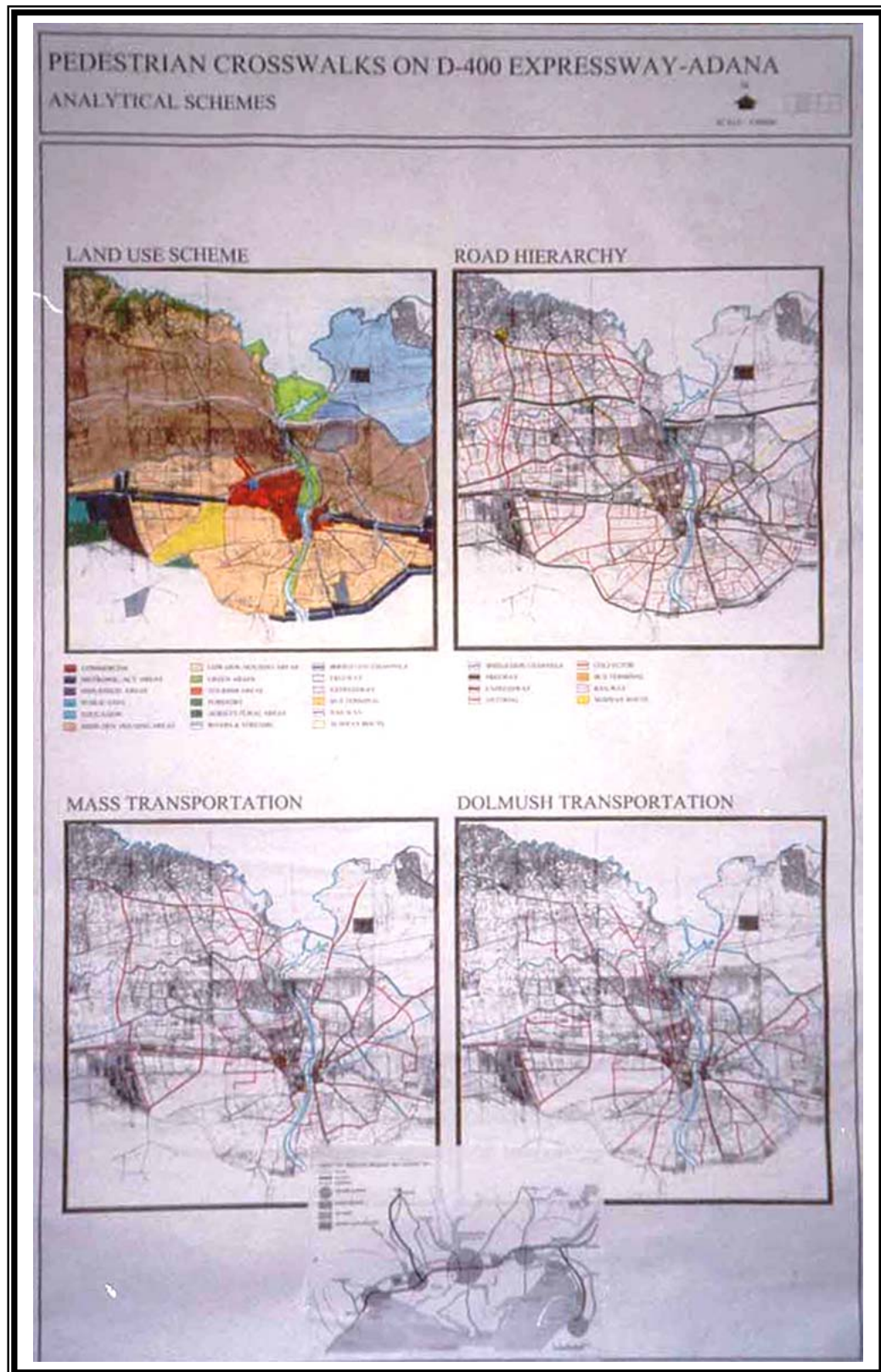
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APPENDIX



PEDESTRIAN CROSSWALKS ON D-400 EXPRESSWAY-ADANA

LANDUSE

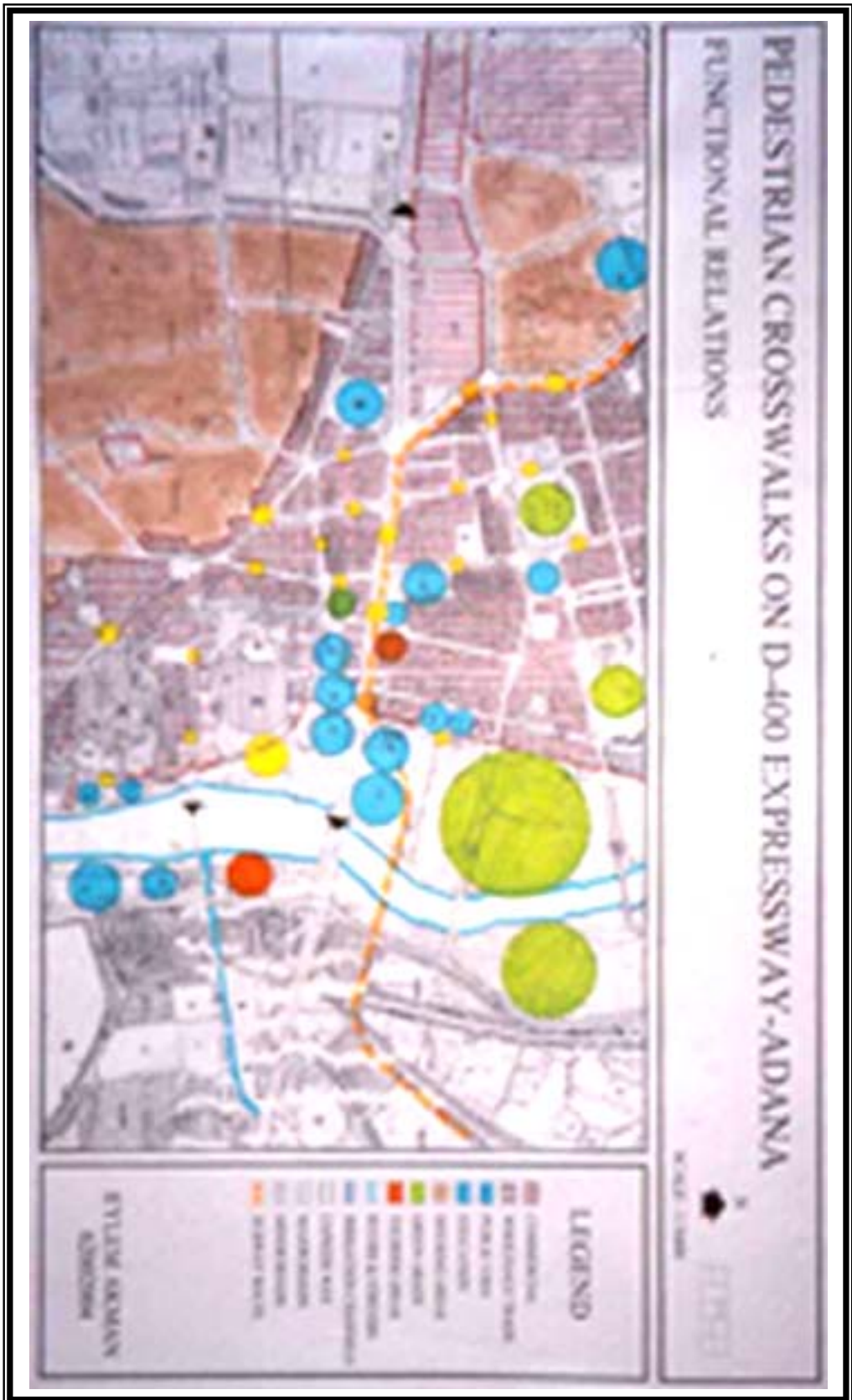
SCALE : 1/5000



LEGEND

- COMMERCIAL
- RESIDENTIAL TRADE AREAS
- PUBLIC USES
- EDUCATION
- RECREATION AREAS
- GREEN AREAS
- OPEN AREAS
- RIVERS & STREAMS
- IRRIGATION CHANNELS
- EXPRESSWAY
- MAJOR ROADS
- MINOR ROADS
- HIGHWAY ROUTE

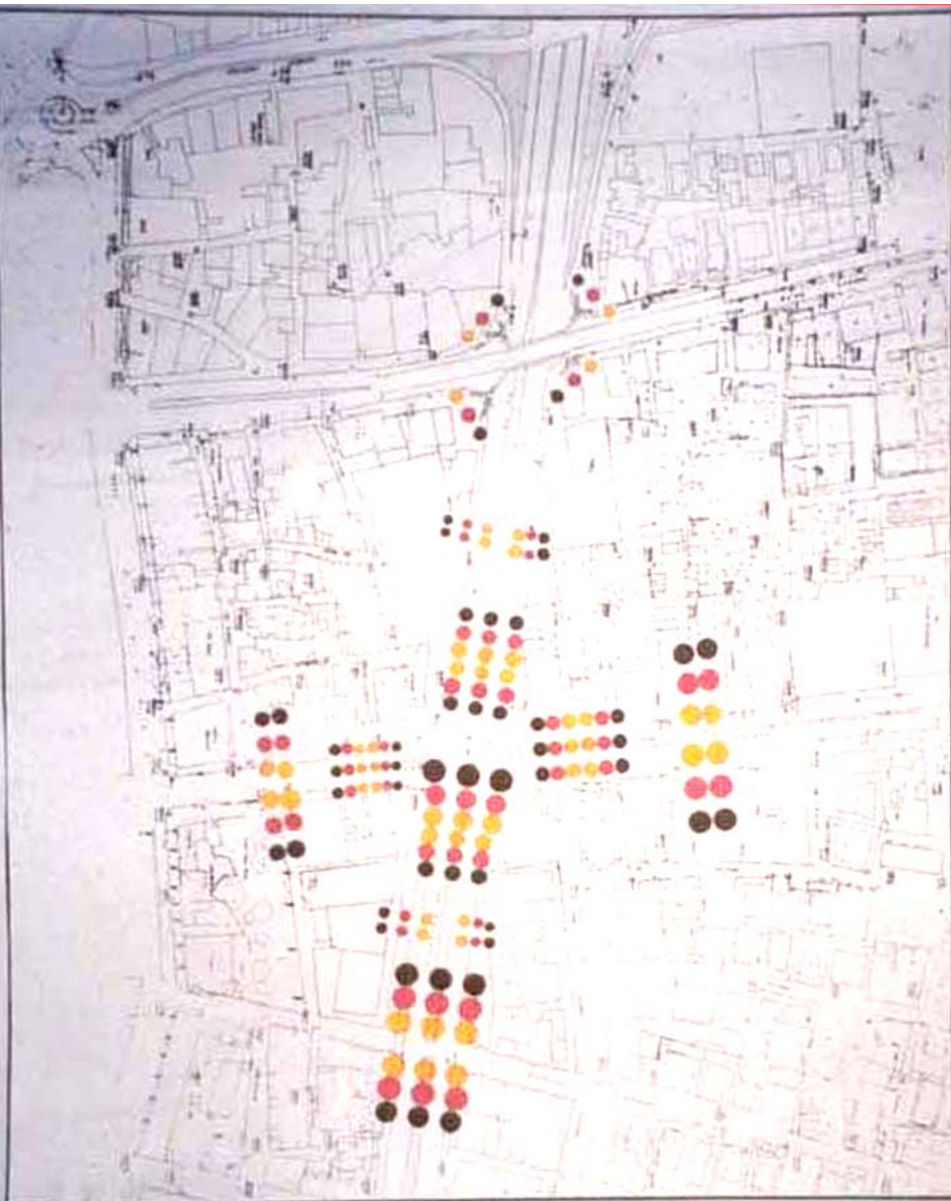
EYLEM AKMAN
62002004



PEDESTRIAN CROSSWALKS ON D-400 EXPRESSWAY-ADANA PICKHOUR PEDESTRIAN VOLUME



SCALE : 1/1000



LEGEND

MORNING (08.00-09.00)



NIGHT (12.00-13.00)



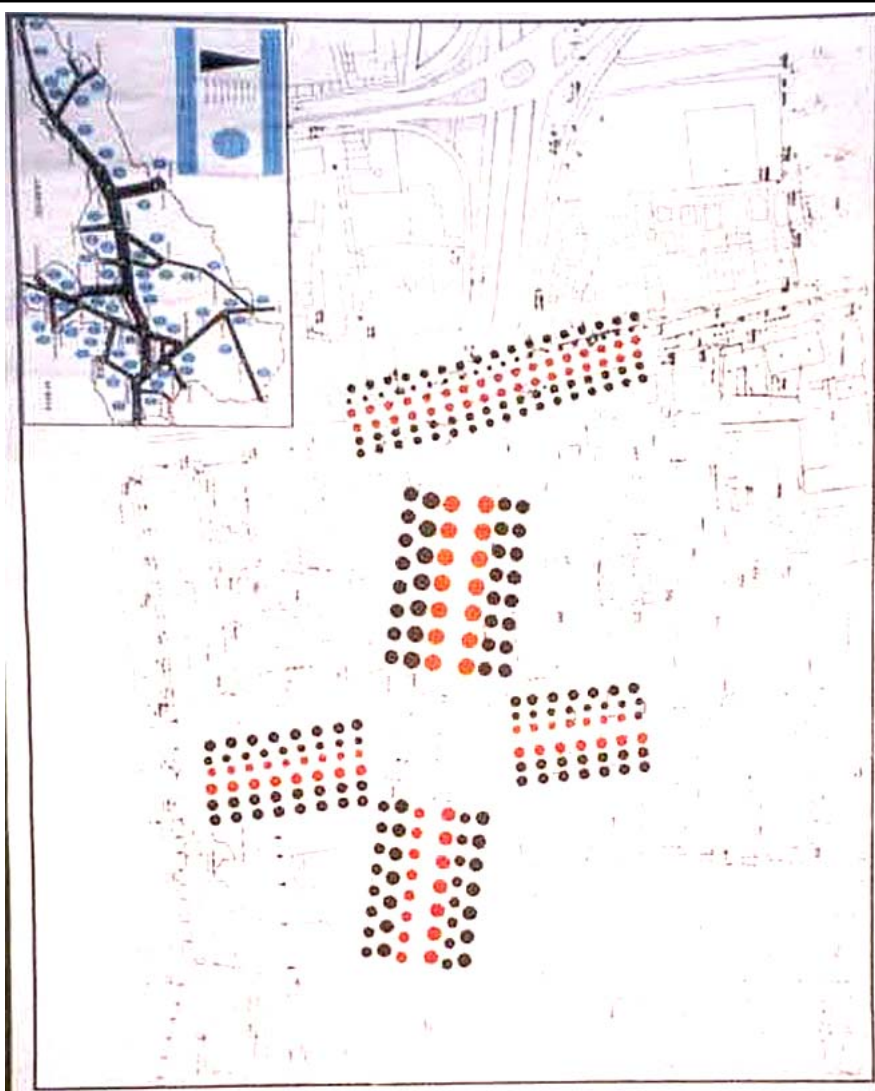
EVENING (17.00-18.00)



EYLEM AKMAN
 62002004

PEDESTRIAN CROSSWALKS ON D-400 EXPRESSWAY-ADANA PICKHOUR VEHICLE VOLUME

SCALE : 1/1000



LEGEND

MORNING (08.00-09.00)

- 0-500
- 501-1000
- 1001-1500
- 1501-2000
- 2001

NIGHT (12.00-13.00)

- 0-500
- 501-1000
- 1001-1500
- 1501-2000
- 2001

EVENING (17.00-18.00)

- 0-500
- 501-1000
- 1001-1500
- 1501-2000
- 2001

EYLEM AKMAN
62002004



PEDESTRIAN CROSSWALKS ON D-400 EXPRESSWAY-ADANA VIEWS FROM THE AREA



PEDESTRIAN CROSSWALKS ON D-400 EXPRESSWAY-ADANA VIEWS FROM THE AREA

5 OCCAK PEDESTRIAN CROSSWALK



2



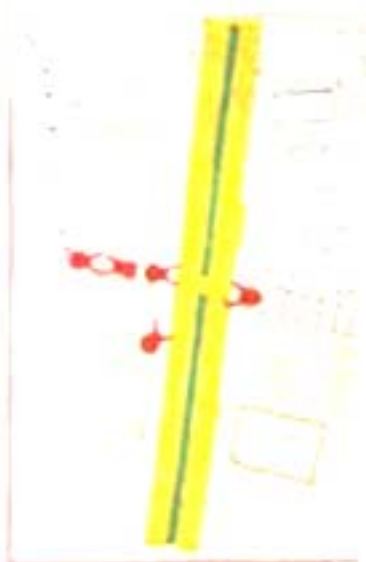
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PEDESTRIAN
CROSSWALK

PEDESTRIAN CROSSWALKS ON D-400 EXPRESSWAY-ADANA
VIEWS FROM THE AREA

TURKUSU JUNCTION

