*Pavement Structure Designed for Traffic Volume*

The following procedure was adopted to decide the design parameters of the road pavement structure:

- Axle load and the number of axles that will operate on the road per day for each type of vehicle;
- Forecast annual traffic growth rates for each type of vehicle; and
- Decide on the design life of the pavement structure.

In this context, all heavy vehicle types in use are considered during the load evaluation process. Consideration will be given to sub-grade strength, material availability, road terrain drainage condition, and environmental conditions when selecting proper materials for the pavement structure. The estimated cumulative standard axle values have been used to design flexible pavements in Sri Lanka using the Structural Catalogue Charts given in Overseas Road Note 31.

Although RDA follows these standards; however, there are no proper mechanisms established to measure the loading capacities of the vehicles. Although such mechanisms are under discussion for national roads to minimize damage, since overloaded vehicles damage pavement structures, which increases annual maintenance costs and decreases time interval between periodic maintenance.

## 5.3 Traffic Characteristics

### (1) Traffic Volume and Composition

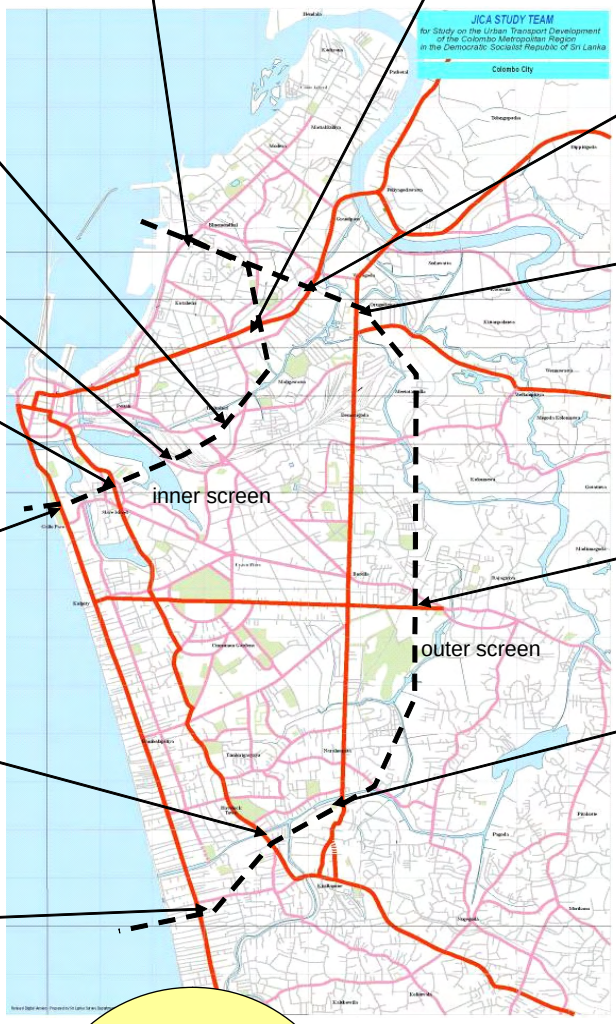
*Traffic Survey and Volumes*

The JICA Study Team conducted a screen traffic survey for the CMR and the summary of the traffic counts are shown in Figure 5.7 below. The results show approximately 350,000 vehicles (based on passenger car units – pcu) enter the municipality and 140,000 vehicles enter Fort and Pettah.

RDA undertakes several kinds of traffic surveys including: (i) average daily traffic (ADT) counts (manual, classified, and automatic); (ii) turning movements; (iii) parking; (iv) pedestrian movements; (v) axle loads; (vi) pavement roughness and (vii) road inventory. Traffic data and updated origin/destination (OD) tables are kept by the University of Moratuwa (UoM) where they also maintain a Geographical Information System (GIS) database and a transport database and analysis system known as TRANSPLAN.[7]

Figure 5.8 shows traffic volumes on major arterials in CMR as prepared by RDA, including Negombo, Kandy, Low Level, Kotte, Narahenpita, High Level, Horana, and Galle Roads. These corridors carry over 60,000 vehicles per day.

[7] TRANSPLAN (version 3.0) was updated at the end of 2005 to maintain 33 zones in Colombo core area and 30 zones in Western Province.




| Hettiyawatha | |
|---|---|
| Vp12hr | 23,919 |
| PCU | 24,719 |
| Peak Hr PCU | 2,459 |
| HVR | 10.5% |
| Peak coming | 1,466 |
| Peak outgoing | 1,744 |

| Central Road (one-way) | |
|---|---|
| Vp12Hr | 13,478 |
| PCU | 15,873 |
| Peak Hr PCU | 1,698 |
| HVR | 21.6% |
| Peak coming | 1,698 |
| Peak outgoing | - |

| Technical Junction | |
|---|---|
| Vp12hr | 19,990 |
| PCU | 28,043 |
| Peak Hr PCU | 2,577 |
| HVR | 36.7% |
| Peak coming | 1,454 |
| Peak outgoing | 1,288 |

| Sugatadasa Stadium | |
|---|---|
| Vp12hr | 33,321 |
| PCU | 46,912 |
| Peak Hr PCU | 4,495 |
| HVR | 31.5% |
| Peak coming | 2,869 |
| Peak outgoing | 2,456 |

| Lake house | |
|---|---|
| Vp12hr | 24,218 |
| PCU | 25,849 |
| Peak Hr PCU | 2,596 |
| HVR | 11.4% |
| Peak coming | 1,837 |
| Peak outgoing | 1,446 |

| Orugodawatta | |
|---|---|
| Vp12hr | 62,035 |
| PCU | 75,594 |
| Peak Hr PCU | 7,124 |
| HVR | 17.4% |
| Peak coming | 4,360 |
| Peak outgoing | 4,076 |

| Trans Asia | |
|---|---|
| Vp12hr | 45,430 |
| PCU | 45,880 |
| Peak Hr PCU | 4,706 |
| HVR | 8.6% |
| Peak coming | 2,582 |
| Peak outgoing | 2,145 |

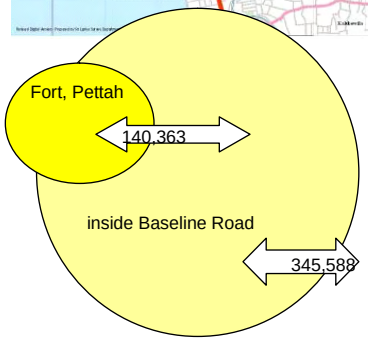
| Kotte Road | |
|---|---|
| Vp12hr | 60,083 |
| PCU | 59,797 |
| Peak Hr PCU | 6,393 |
| HVR | 5.8% |
| Peak coming | 4,145 |
| Peak outgoing | 4,083 |

| Galle Face | |
|---|---|
| Vp12hr | 38,595 |
| PCU | 40,386 |
| Peak Hr PCU | 4,081 |
| HVR | 10.4% |
| Peak coming | 2,427 |
| Peak outgoing | 2,026 |

| Polhengoda | |
|---|---|
| Vp12hr | 30,731 |
| PCU | 35,484 |
| Peak Hr PCU | 3,342 |
| HVR | 13.0% |
| Peak coming | 2,388 |
| Peak outgoing | 1,884 |

| Havelock Road | |
|---|---|
| VP12hr | 54,154 |
| PCU | 56,872 |
| Peak Hr PCU | 5,650 |
| HVR | 9.8% |
| Peak coming | 3,772 |
| Peak outgoing | 3,775 |

| Wellawatta | |
|---|---|
| Vp12hr | 42,894 |
| PCU | 46,210 |
| Peak Hr PCU | 4,542 |
| HVR | 12.0% |
| Peak coming | 3,003 |
| Peak outgoing | 2,767 |

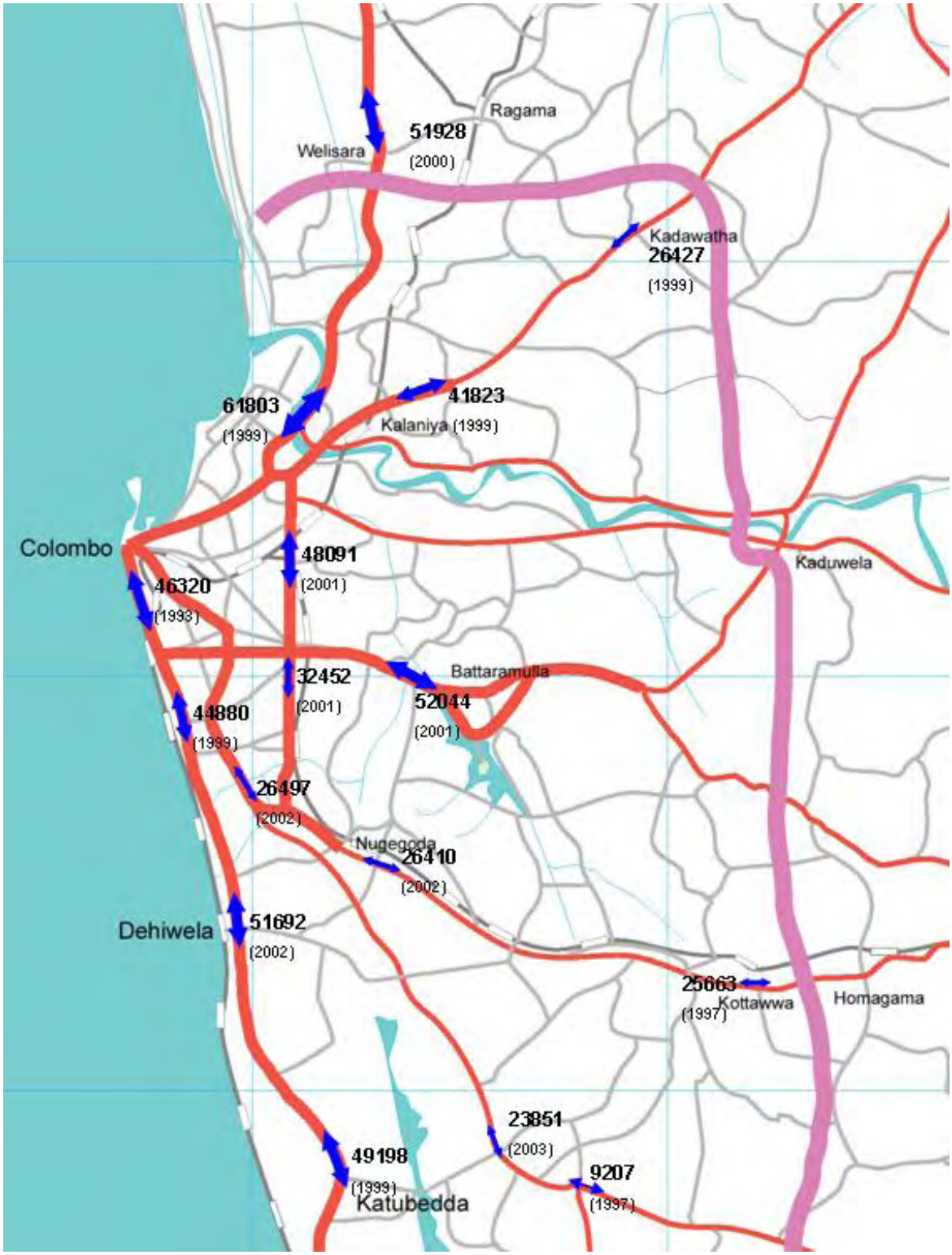



Inner screen
Vp12hr 127,035
PCU 140,363

Outer screen
Vp12hr 307,137
PCU 345,588

Source: This study

**Figure 5.7 Summary of Screen Traffic Survey**




Source: This Study

**Figure 5.8 Average Daily Traffic Volumes on Major CMR Roads**

*Mixed Traffic*

There is a wide array of vehicles on Sri Lanka's roadways – lorries, buses, private cars, three-wheelers, motorcycles, tractors, bicycles, animal carts and pedestrians characterize traffic flow in the study area. They share the same road space creating unsafe and inefficient traffic conditions.[8] Accident rates are high, mainly due to faster vehicles attempting to overtake the slower vehicles on roads that lack proper passing lanes.

*Traffic Composition in Major Corridors and CMR*

Table 5.8 summarizes traffic composition along these corridors.[9] The table shows that:

- A Class roads carry more passenger cars than B Class roads, and B Class roads in Colombo District carry more passenger cars than in Gampaha District;
- The share of motorcycles and tractors on B Class roads is largest in Gampaha;
- Buses comprise 5-7% of vehicles on each road type; and
- A relatively high percentage of three-wheelers is found on all road classes.

**Table 5.8 Composition of Traffic by Road Class (2004)**

| | Cars | MC | Vans | Trac -tors | 3W | Bus | | Goods Vehicles | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Med | Hvy. | Light | Med. | Hvy. | |
| A Class Road | 29.7 | 14.8 | 17.5 | 0.08 | 17.7 | 1.8 | 4.9 | 6.1 | 6.4 | 1.1 | 100.0 |
| B-Colombo | 19.8 | 20.0 | 15.7 | 0.20 | 24.9 | 1.8 | 5.3 | 6.1 | 4.9 | 1.2 | 100.0 |
| B-Gampaha | 10.7 | 34.6 | 13.9 | 0.57 | 17.5 | 2.1 | 3.1 | 6.8 | 10.4 | 0.4 | 100.0 |

Source: RDA
MC = Motorcycle and 3W = Three-wheeler

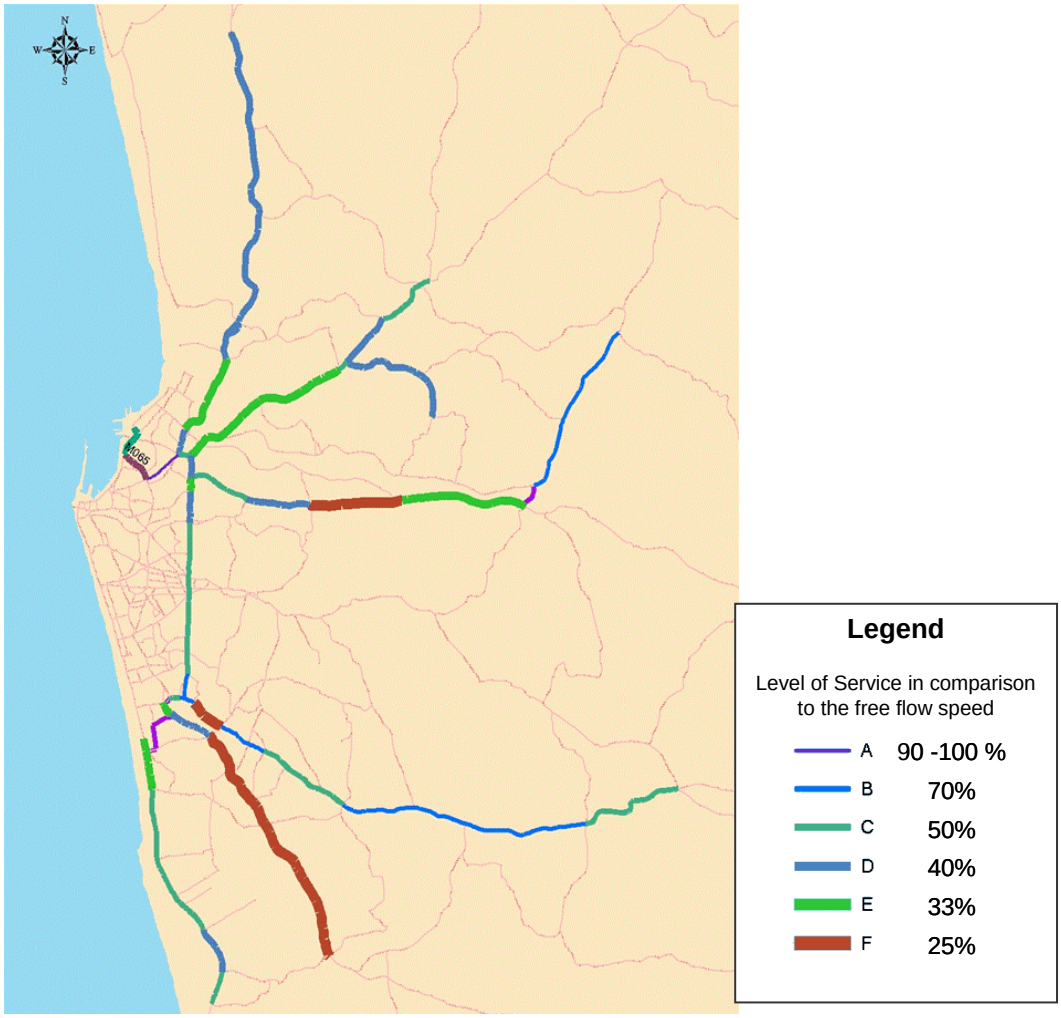
Traffic characteristics vary by area within CMR, as seen below, which include:[10]

- Over 20% of heavy vehicles (all buses and trucks over medium classes) are found along Negombo Road and Baseline Road and in the Nugegoda area. Highly concentrated freight movements occur among the Kandana – Kelaniya – Nugegoda areas;[11]
- The concentration of vans and buses are relatively similar throughout the surveyed area;
- High Level Road and Kotte Road (southeastern corridors) had the highest passenger car concentration, 30-50% of vehicles, due to the recent high- and middle-income residential development; and
- Hilly areas in Gampaha District had the highest concentration of motorcycles.

[8] Three-wheelers are ubiquitous in the study area, both in urban and rural areas. Their size, maneuverability, and slow speed contribute to the disorderly traffic flow. Normal lane widths are too wide for them, but they still use the lane, which results in a platoon of vehicles behind them. They also ignore lane markings and block intersections.
[9] Based on RDA's manual counting results at 41 locations in Colombo and Gampaha Districts (2004).
[10] See Appendix 8 for detailed data and analysis.
[11] Section 3.4 reviews freight travel patterns

### (2) Levels of Service

Figure 5.9 shows level of service, which is a tool to evaluate traffic congestion.[12] Figure 5.9 was prepared by an observation survey conducted in 2004. High Level Road presents good level of service, while Galle and Baseline Roads are categorized as medium. Horana, Avissawella, Kandy and Negombo Roads exhibit poor levels of service. For Kandy and Negombo Roads, congestion level increase as distance to Colombo decreases as the congestion is due to high traffic volumes. On Horana Road, the level of service is due to deteriorated pavement which affects travel speeds. On Avissawella Road, the narrow bridges are the culprit and on Baseline Road, the lack of synchronized signals hampers throughput.




Source: UoM and This study

**Figure 5.9 Service Levels of CMC Roads (2004)**

[12] Level A means free flow without any congestion and Level F means that vehicles run at 25-30% of free flow speeds.

### (3) Volume Capacity Ratio Analysis for Major Corridors

*Traffic for 12-Hour Span*

Table 5.9 shows volume and capacity data for five major corridors during an average twelve hour time period.[13] As all corridors' volume/capacity (V/C) ratios are less than 1.0, each has sufficient capacity.

**Table 5.9 Volume and Capacity Data for Major Corridors during a 12-Hour Span**

| ***Corridor*** | **North** | **North** | **East** | **South-East** | **South** |
|---|---|---|---|---|---|
| ***Location*** | **Sugathadasa** | **Orugodawatte** | **Kotte** | **Havelock** | **Wellawatte** |
| a. Number of Lanes | 4 | 6 | 6 | 4 | 4 |
| b. Road capacity | 5,200 | 7,800 | 7,800 | 5,200 | 5,200 |
| c. 12-hour traffic (pcu) in Jan 2006 | 46,912 | 75,594 | 59,797 | 56,872 | 46,210 |
| d. Present V/C Ratio (c/b*12) | 0.75 | 0.81 | 0.64 | 0.91 | 0.74 |

Source: This Study

*Peak Hour Traffic*

Following table shows the V/C ratio along the same five corridors for inbound peak period traffic. Peak V/C ratios should be less than 2.0 to provide an acceptable level of service. The present V/C shows reasonable conditions.

**Table 5.10 Volume and Capacity Data for Major Corridors during the Peak Period**

| ***Corridor*** | **North** | **North** | **East** | **South-East** | **South** |
|---|---|---|---|---|---|
| ***Location*** | **Sugathadasa** | **Orugodawatte** | **Kotte** | **Havelock** | **Wellawatte** |
| a. Number of Lanes | 4 | 6 | 6 | 4 | 4 |
| b. Directional Road Capacity | 2,600 | 3,900 | 3,900 | 2,600 | 2,600 |
| c. Peak inbound traffic (pcu/hour) | 2,869 | 4,360 | 4,145 | 3,772 | 3,003 |
| d. Present V/C Ratio (c/b*12) | 1.10 | 1.12 | 1.06 | 1.45 | 1.16 |

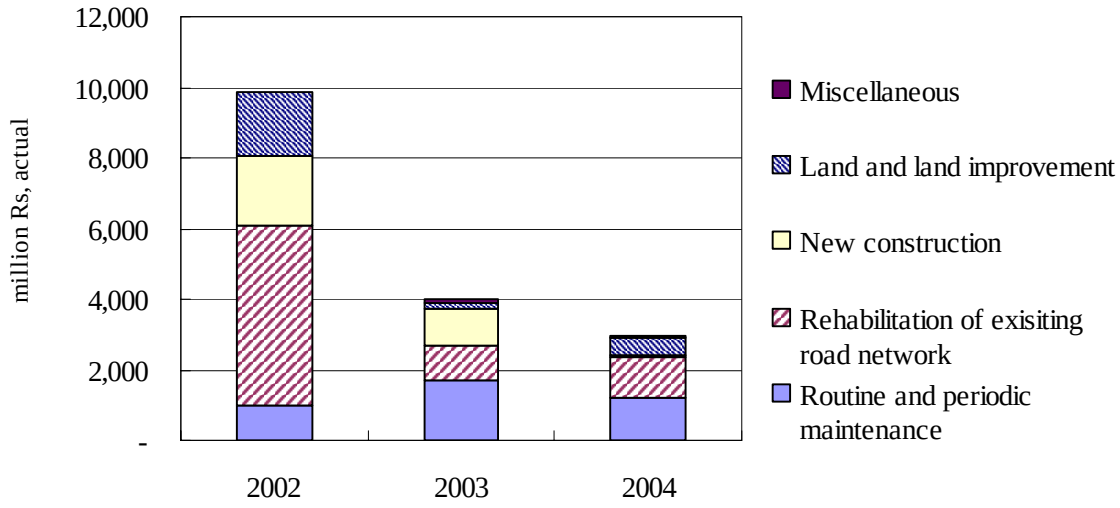
Source: This Study

## 5.4 Funding for Urban Road

### (1) RDA Budget

RDA's annual national road development budget in 2004 was about Rs. 3 billion, with details shown in Figure 5.10. There has been a downward trend from 2002 onwards, especially after the large investments in 2001-02 that were allocated for new construction and rehabilitation due to political interests. With the reduction, most new construction is funded by overseas donors. In 2003 and 2004, the routine maintenance and rehabilitation budget comprised at least 50% of the budget.

[13] Applied 1300 pcu/per lane/per hour because shoulder condition in Colombo are not ideal




Source: RDA Annual Reports (2002-04)

**Figure 5.10 RDA Annual Budget**

### (2) RDA Budget for Western Province

The following table shows RDA's 2006 annual budget for WP. The total is Rs. 552 million, mainly earmarked for maintenance expenditures. The amount for signals, marking improvements, and road furniture is only 2.0%.

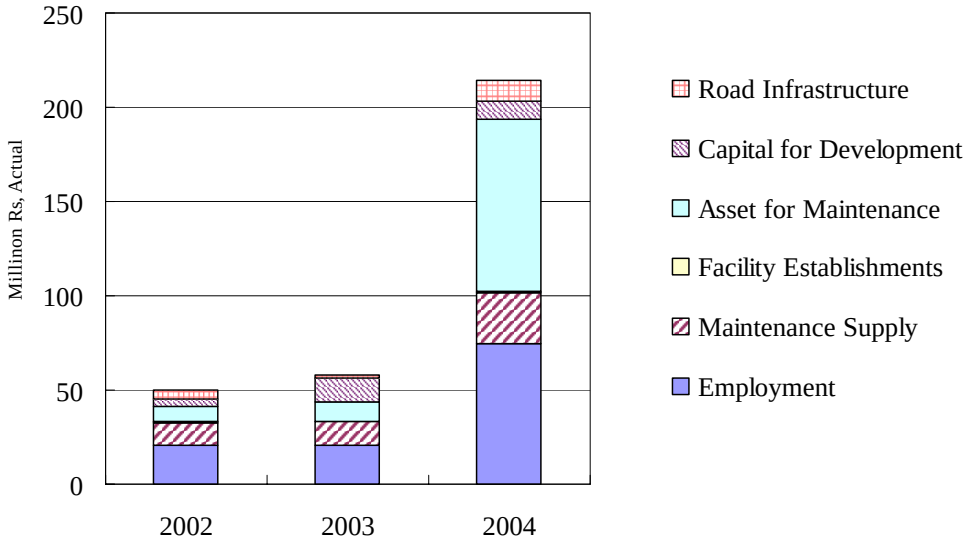
**Table 5.11 RDA Budget Details for Western Province**

| Items | Rs. Mn. | Percentage |
|---|---|---|
| Liabilities | 57.4 | 10.4% |
| Routine Maintenance | 114.5 | 20.7% |
| ADB maintenance | 3.27 | 0.6% |
| Patching/drain/shoulder repair | 263.07 | 47.6% |
| Sand sealing | 62.5 | 11.3% |
| Bridge maintenance | 15.35 | 2.8% |
| Signal, marking, road furniture | 11.11 | 2.0% |
| Lighting | 25 | 4.5% |
| Total | 552.2 | |

Source: UoM and RDA

### (3) CMC Budget for Road Infrastructure

The following figure shows expenditures for CMC's Road Design and Road Safety Unit over the past three years. CMC's road maintenance work is not subcontracted, as is typical in other cities, so maintenance employment and services are direct expenditures. It is estimated that total expenditures for daily maintenance is Rs. 100 million for all CMC roads (480 km). Other items include equipment purchasing, new road development, and land acquisition. In 2004 there was a large increase, particularly in employment and maintenance supplies. The increase of asset maintenance is mainly expenditures for traffic controls measures, including signal development.




Source: CMC

**Figure 5.11 Expenditures of CMC Road Design and Road Safety Unit (2002-04)**

Based on Table 5.10 and Figure 5.11, the total annual investment for maintenance in the CMR is between Rs. 700-800 million.

## 5.5 Planned Road Construction Projects

Major planned road projects that were recommended in earlier studies are listed below. The location of these projects can be seen in Figure 5.12.


Source: RDA and UDA

**Figure 5.12 Planned Project Alignments**

## 5.6 Pedestrian Facilities

Sidewalks exist on most major roads in CMC, but they are not sufficient on secondary roads, as well as on major roads outside of central Colombo. Pedestrian facility issues in the CMR are:

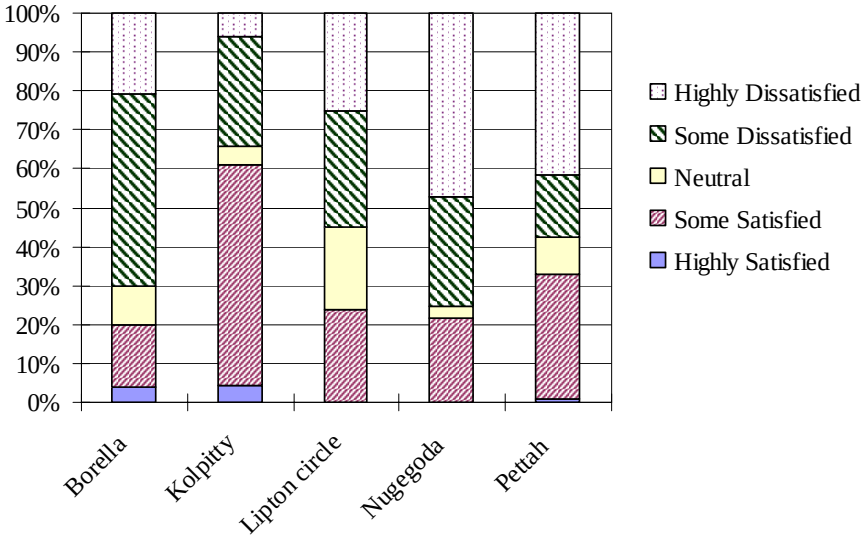
- Shortage of pedestrian space in terminals;
- Low quality; and
- Lack of coordination with other facility providers.

Each of the above issues is explored below.

### (1) Shortage of Pedestrian Space in Terminals

The pedestrian network at major bus terminals and stations has been improperly provided, with the result being a low satisfaction of users. Missing links are common and there are safety, and quantitative balances. Because of the capacity shortages on the existing sidewalks, pedestrians are forced to walk on the roadway, reducing traffic capacity and endangering the pedestrians.

In order to understand the current environment, a pedestrian satisfaction survey was conducted in this Study in January 2006. Figure 5.13 shows the survey results.




Source: This Study

**Figure 5.13 Level of Satisfaction of Sidewalks by Location**

It is important to note that the satisfactory level at Kolpitty is higher than at other locations, perhaps because the sidewalks are wide and continuous along Galle Road. Bus stops and the railway station are also relatively well connected and are encapsulated in a small area, which reduces walking distances. At Borella, where there is a pedestrian subway and a series of wide sidewalks along Baseline Road, dissatisfaction was high, which can be attributed to the overwhelming number of sidewalk retail establishments. Those surveyed at Pettah and Nugegoda expressed the highest dissatisfaction, mainly because the pedestrian demand far exceeds sidewalk capacity and the public transport terminals are not closely aligned.

### (2) Low Quality

Low quality sidewalks are related to design and construction issues. In the former set of issues, sidewalk capacity has been reduced by bus bays, trees, electricity boxes, and drainage boxes. When the sidewalks were constructed, different materials were used and the area was not made level, so the sidewalks are now uneven. Flood water and vehicle sidewalk parking has also affected the pavement quality.

Both RDA and CMC set the minimum allowable sidewalk width to 1.8 m, with the maximum limits set depending on pedestrian volumes. The maximum width should be between 2.5-3.0 m, but current land availability constraints result in a reduced width.

### (3) Lack of Coordination with Other Facility Providers

There has been limited coordination among facility providers, as well as a lack of enforcement along the sidewalks. For example, electricity boxes are placed in such a way that inhibits pedestrian through access and retail establishments routinely set up shop on the sidewalk, with no threat of eviction. There have been a few cases of integrated sidewalk development between building owners and road developers, but that is not the norm. RDA standards indicate that anyone wanting to install permanent facilities on a sidewalk must obtain prior approval. They have specific guidelines for such installments and they provide the necessary detailed information to the service provider.

## 5.7 Road Maintenance

### (1) Present Conditions

*Standard Activities*

Maintenance activities are carried out as per RDA's Standard Specifications for Construction and Maintenance of Roads and Bridges. International best practice indicates that maintenance of cross sectional elements and other components such as drains should be done in parallel and that isolating or postponing maintenance activities results in higher maintenance requirements in the future. In general, poor maintenance practices have been implemented on most Sri Lankan roads. The following table identifies the types of maintenance practices.

**Table 5.12 Maintenance Practices**

| Practice | Definition |
|---|---|
| Routine Maintenance | Regular activities that are short-term or cyclic in nature and are needed to keep the road in good condition. Includes signal maintenance, pothole patching, drainage maintenance, shoulder maintenance, sweeping, and cleaning the road surface. |
| Preventive Maintenance | Identifies a defect at very early stages in order to prevent more expensive maintenance later. Includes sealing cracks |
| Periodic Maintenance | Repairs problems caused by wear and tear. Includes surface dressing by sand sealing, slurry sealing, Single Bituminous and Surface Treatment (SBST), or Double Bituminous and Surface Treatment (DBST) |
| Urgent Maintenance | Urgent activities needed to prevent the road from becoming unusable. Includes removing materials from the road surface (i.e. landslides) |

Source: RDA, Geometric Design Standards of Roads

*Low Surface Conditions on B Class Roads*

Current pavement roughness values, shown in mm/km, in Colombo and the CMR area are shown in Figure 5.14. Standards are characterized in Table 5.13. Both Baseline and Negombo Roads exhibit good conditions due to recent improvements and most other CMC road pavements are estimated to be of fair conditions. Sections with poor conditions in the CMC area are located in the port area and along Low Level Road. In the CMR area, most of B class roads are poor.

**Table 5.13 Colombo and CMR Pavement Roughness Standards**

| Condition | IRI (m/km) | Roughness (mm/km) |
|---|---|---|
| Very Good | 4.0 | <2,000 |
| Good | 6.0 | <4,000 |
| Fair | 9.0 | <8,000 |
| Poor | 12.0 | > 8,000 |

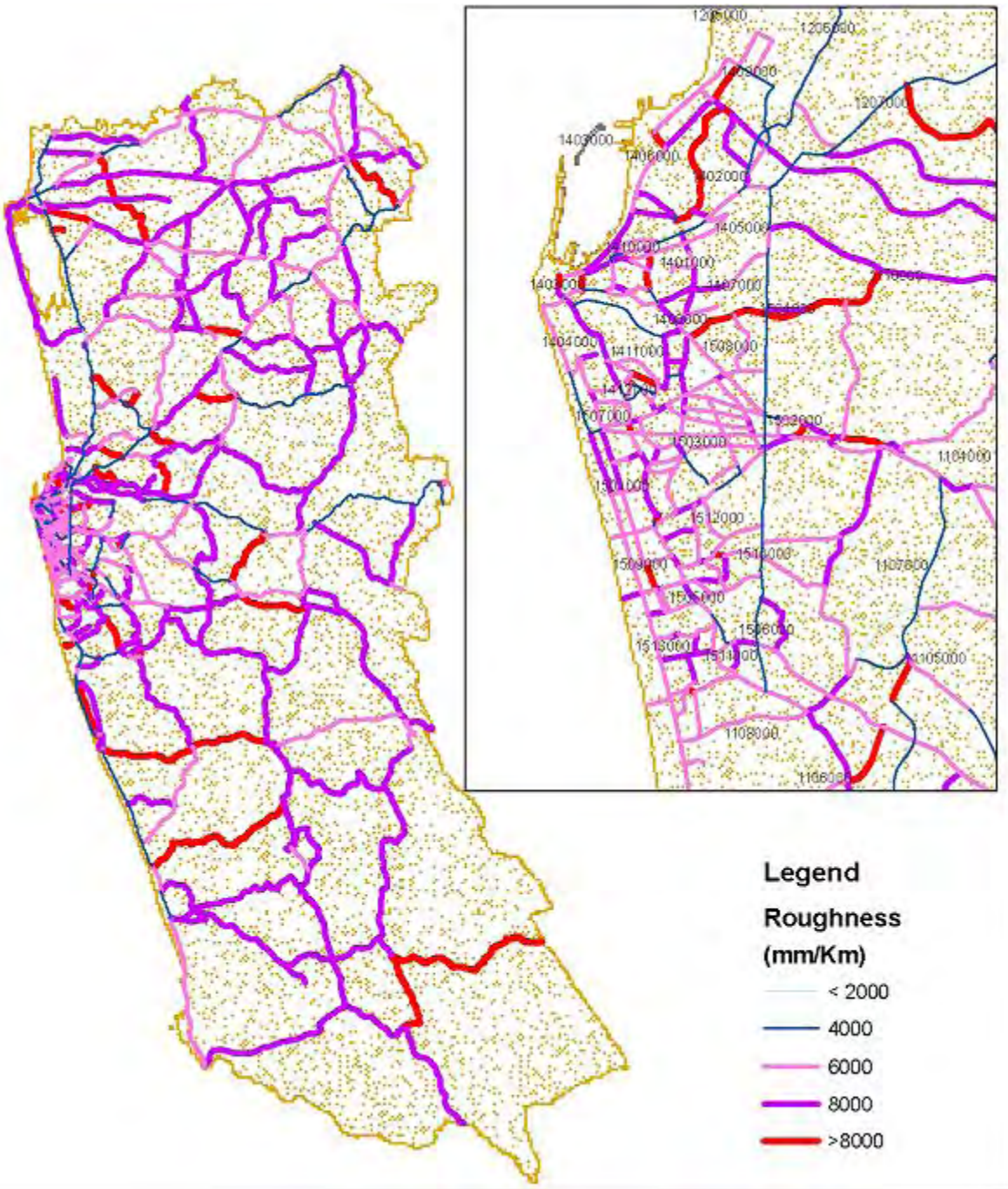
Source: UoM

**(2) Planning and Activities**

*Lack of Measurement Capacity*

Making an engineering assessment of road conditions uses the International Roughness Index measurement (IRI). Bump integrator equipment is used and measurements are measured in m/km, which indicates the vertical deflection along one km of roadway. Standardized equipment and vehicles are necessary to undertake this exercise, but only RDA and UoM currently have access to these tools. A few foreign-funded projects have conducted IRI measurements on a number of national roads.

It is difficult to take these measurements continuously throughout the CMR due to limited resource capacity of RDA. Therefore, it would be reasonable to establish a visual condition survey manual based on actual measurements done on the national road network. This manual and visual condition pictures could be utilized at the regional level to establish IRI values for the regional network. The results could then be used to prioritize future development.




Source: UoM

**Figure 5.14 CMR Road Pavement Roughness (2004-05)**

## 5.8 Summary of Issues

This section summarizes issues related to CMR's road network development many of which were discussed in the Working Group.

### (1) Road Network Issues

*Unclear Road Hierarchy*

This issue was raised by the WG members and related issues are discussed in Chapter 6. In the CMR, there is no clear separation between roads and streets. Tertiary streets act as feeders to Class A and B roads. Significant roadside commercial development exists along Class A and B roads, lessening their capacity.[14]

*Low Road Development in Suburban Colombo and Gampaha*

As shown previously, CMR's overall road development is lower than other Asian capital's metropolitan areas. Particularly, the length and width per population in suburban Colombo District and Gampaha District are extremely low.

*Lack of Pedestrian Facilities*

As shown in section 5.7, pedestrian facility conditions are poor. Because the bus sector is fragmented and major areas have both a private and public terminal that serve the same routes, pedestrian access between them is important. However, footpaths or sidewalks are lacking in these areas, as well as in those areas where intermodal connections are necessary, such as between rail and bus stations. Therefore, the level of pedestrians' satisfaction with access and facility quality is quite low. This could be one of the leading reasons that 40% of those surveyed jaywalk routinely.

### (2) Operation, Maintenance and Management Issues

*Small Variety of Road Operations*

Within the CMR, all roads serve the same purpose and there is no variety of road operations. There is little hierarchy in the road network and no access controlled expressways. Exclusive lanes for public transport and high occupancy vehicles are lacking, although there is an exclusive lane for lorries accessing the port.

*Lack of Drainage Management*

This issue was raised by WG since the lack of drainage capacity always hampers traffic flows during the rainy season. Lack of drainage management measures also stimulates deterioration of pavements and road structures.

*Lack of Coordination with Other Infrastructure*

As indicated by the WG, since there are no utility boxes along major radial roads, utility maintenance crews perform their maintenance work (telephone, water, electricity, drainage) on the roadway, which reduces the roadways' capacity. There is no coordination to oversee utility maintenance to help minimize site work or lower the traffic implications of such work.

[14] The difference between road and street is that roads will be used mainly for intercity traffic, while streets are in urban areas and serve mixed traffic with multiple functions.

*Low Aesthetic Quality*

Although resolutions to the issue will not directly impact traffic congestion, it does impact on the long-term direction of the city's growth, especially if the goal of Colombo is to be a Tropical Garden City or an oasis of aspiration, heritage, recreation and gracious living (Chapter 4).

**(3) Standards and Planning Issues**

*No Urban Street Concept*

As shown previously, standards need to be created to clarify the concept of urban streets as the RDA road classification system does not currently cover such a concept. A first step would be to create a new standard that clearly differentiates between urban and rural roads.

*Low Hierarchy and Access Control*

The road network in the study area lacks a functional hierarchy of primary roads, secondary roads, and tertiary roads. Each road should represent a certain function in the urban environment, although that is not currently the case in Colombo.

*Right of Way Needs are Not Properly Established*

This issue was raised by the WG and covers both the need of RDA and CMC to plan in advance to acquire land for road development, especially along current rights-of-way. They also need to plan to obtain more land for intersections to insure proper capacity. Delays caused by land acquisition are the biggest bottlenecks to improving and widening roads.

**(4) Budget and Administrative Issues**

*Insufficient Funds*

As shown in the funding section above, yearly road budgets are not stable and therefore development and maintenance cannot be properly planned.

*Low Capacity of Provincial RDA*

Some WG participants indicated that provincial roads should be handed over to national RDA because the provincial RDA capacity is quite low. However, as Sri Lanka has focused on decentralizing many functions, including roads and transport, this is counter to the current environment.

*Delay of Implementing Land Acquisition System in Urban Areas*

Land acquisition is one of bottlenecks for road development activities, particularly in urban areas, as land values have been increasing rapidly. As some proposed road widening projects will run through high and middle income areas in southern Colombo, it is important to begin to work with current residents to ensure efficient urban transport in the future. The Asian Development Bank (ADB) recently revised its compensation system as a result of the development of the Southern Highway, although this system is mainly focused on low-income residents.

*Low Enforcement of Land Use Controls*

Roadway encroachment from private permanent housing on road rights of way is a serious problem in Sri Lanka. This can be seen along the major roads in the suburban areas, as well as along local roads in the CMC area. Lack of land use controls along arterials is another example,

as small commercial stores operate along major arterials, creating parking problems on the roadway.

### (5) Priority of Issues

Based on RDPWG discussions, the road network development issues can be classified in Table 5.14. Most RDPWG participants recommended that the softer solutions, such as developing a road fund and coordination bodies, be undertaken immediately. With regards to long-term projects, road development was prioritized, although most participants favor prioritizing traffic management rather than new road development.

**Table 5.14 Prioritization of Issues for Road Development**

| Priority | Short-Term Issues | Long-Term Issues |
|---|---|---|
| High | • Existence of Bottlenecks and Missing Links<br>• Unclear Road Hierarchy<br>• Lack of Road Fund<br>• Delay of Road Acquisition in Urban Areas<br>• Lack of Coordination Body<br>• Weak Land Use Controls<br>• Lack of Drainage Management | • Lack of Road Development in Suburban Colombo and Gampaha<br>• Low level of Pedestrian Facilities<br>• No Concept of Urban Streets |
| Lower | • Low Aesthetic Quality<br>• Small Capacity of Provincial RDA Function | • Small Variety of Road Operations<br>• Low Design Standards |

Source: This Study

# Chapter 6 Traffic Management and Safety

## 6.1 Introduction

In this chapter, the existing traffic conditions in terms of traffic operations, traffic management facilities, and traffic control practices are discussed followed by a review of previously recommended, planned, and ongoing traffic management projects. Following, parking management, as one of the most important components of traffic management, will be examined. Organizations and laws, regulations, and standards are also addressed. Finally, the issues are outlined, as prioritized by the Traffic Management and Safety Working Group (TMSWG).

## 6.2 Road Traffic Operations

### (1) Roadway

As described previously, traffic flow in the study area is characterized by the mixture of different types of vehicles of different levels of performance. Their free flow speeds also vary, which results in a platoon of vehicles led by a slow- moving car. Higher-speed vehicles try to overtake the slow vehicle anywhere along the roadway, with little regard for safety, including when there are short gaps in the opposing traffic. The overtaking vehicle often crosses the center line forcing the opposing vehicle and the vehicle being overtaken to take defensive actions and swerve to the left to avoid a collision.

Roadside friction is high at many sections even along High Mobility Corridors (HMC), such as Galle Road, Kandy Road, and others, due to several factors, such as (i) parked vehicles (illegal or otherwise), (ii) pedestrians in the carriageway, (iii) obstacles placed close to carriageway, and (iv) commercial activities on the sidewalk. Additionally, vehicles operating in the leftmost lane tend to hug the right side of the lane, impacting those in the right lane, because of the large roadside friction. All of these features contribute to the inefficient and unsafe traffic in the study area.

### (2) Signalized Intersections

At signalized intersections, conflicts between opposing traffic streams are regulated by traffic signals which define the use of the intersection for conflicting movements. Observation of traffic movements of traffic operations at signalized intersections in the study area revealed the following in terms of intersection layout and operation.

- Generally signals are operating normally and malfunctioning signals are few. But the signals' conditions, in particular, lights are dim due to aging. More significant problem is that signal phasings and timings do not follow traffic demand, which results in a long queue along one approach while there is no queue on other approaches.
- Signals are installed without intersection layout modifications to reflect new modes of operation. For example, widening lanes near the intersection or providing right turn pockets can reduce the delay and improve the throughput of intersection. Intersection geometry such as corner radii and stop line and pedestrian crossing location is not optimized for traffic control.
- Drivers observe signals during the day when traffic volume is moderate to large, but they tend to ignore during night time.

- Right turn movements are problematic at signalized intersections. The concept of priority does not exist in Colombo, such that priority rule is not established between right turning vehicles and opposing through traffic. Instead of giving priority to through vehicles, right turning vehicles initiate the movement immediately when the signal turns green. They proceed to make their turn, blocking the forward movement of the opposing through traffic. This creates an unsafe and inefficient situation.

**(3) Non-signalized Intersections**

Like the signalized intersections, many non-signalized intersections typically have two or more approach roads without appropriate traffic engineering consideration. As a result, deficiencies such as irregular curb layout, uneven widths of traffic lanes on opposite sides of the intersection, and large undefined areas within intersections are common. Moreover, no stop signs and yield signs are installed at approaches, so priority is not defined on the intersecting roads.

As there is no priority road defined, vehicles enter the intersection in a free-for-all manner and the system works on a first come first serve basis. Such practice greatly reduces intersection capacity, while increasing the risk of accidents as the operation relies on the drivers to take defensive actions to avoid accidents.

**(4) Roundabouts**

Other Southeast Asian cities have converted roundabouts to intersections to attain higher traffic operating efficiencies. Roundabouts are efficient when traffic volumes are lower than a certain level, but once volumes exceed a certain threshold, they do not function well because there are few gaps in the traffic stream. The size of roundabouts varies by the size of the center island – from a few meters to a large roundabout such as is found at the intersection of Negombo Road and Kandy Road.

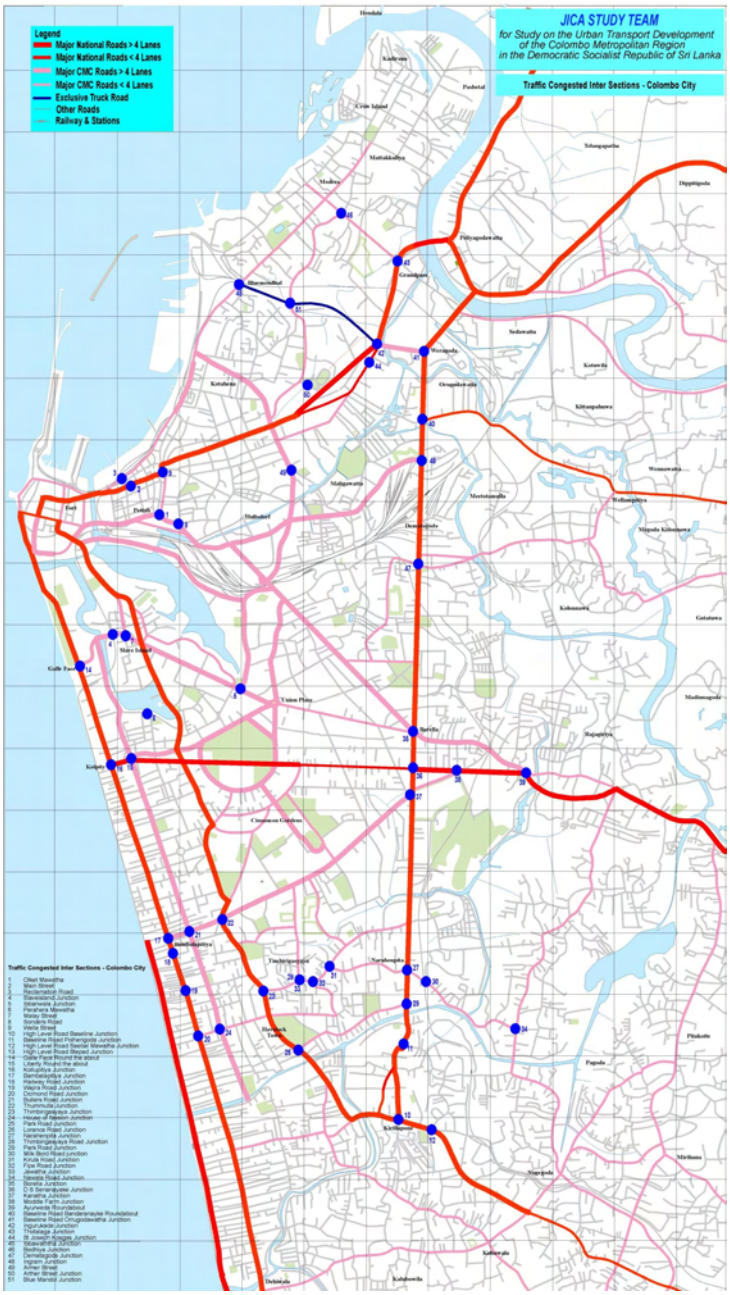
Traffic handling capabilities of roundabouts increase with the size of the center island and the number of circulating lanes, which means that the larger the roundabout, the higher the throughput. The existing roundabouts in the study area, however, are not large enough in light of current traffic conditions. Gridlock conditions, in which vehicles block each other inside the roundabout, are common. The problem cannot be solved by reducing the size of the center island to provide more circulating lanes. However, one measure that has been used is to signalize the roundabout.

An example of inadequate improvement work is found at the roundabout of Kelani New Bridge Road and Kandy Road. The roundabout has three approaches and all of them carry large traffic volumes with many heavy vehicles. To decongest the roundabout, recently the center island was reduced. Unfortunately, this has made the situation worse as traffic becomes connected. Instead, signalization should be implemented at this roundabout.

Priority should be given for vehicles already in the roundabout, as opposed to those approaching the facility. But this is not respected in Colombo. Like non-signalized intersections, roundabouts operate on a first-come-first-serve basis. As a result, interlocking occurs when traffic volumes are higher than a certain threshold. As stated above, a small center island is one reason. If the volume is larger than the roundabout's capacity, the center island must be expanded or the roundabout must be converted to a signalized intersection.

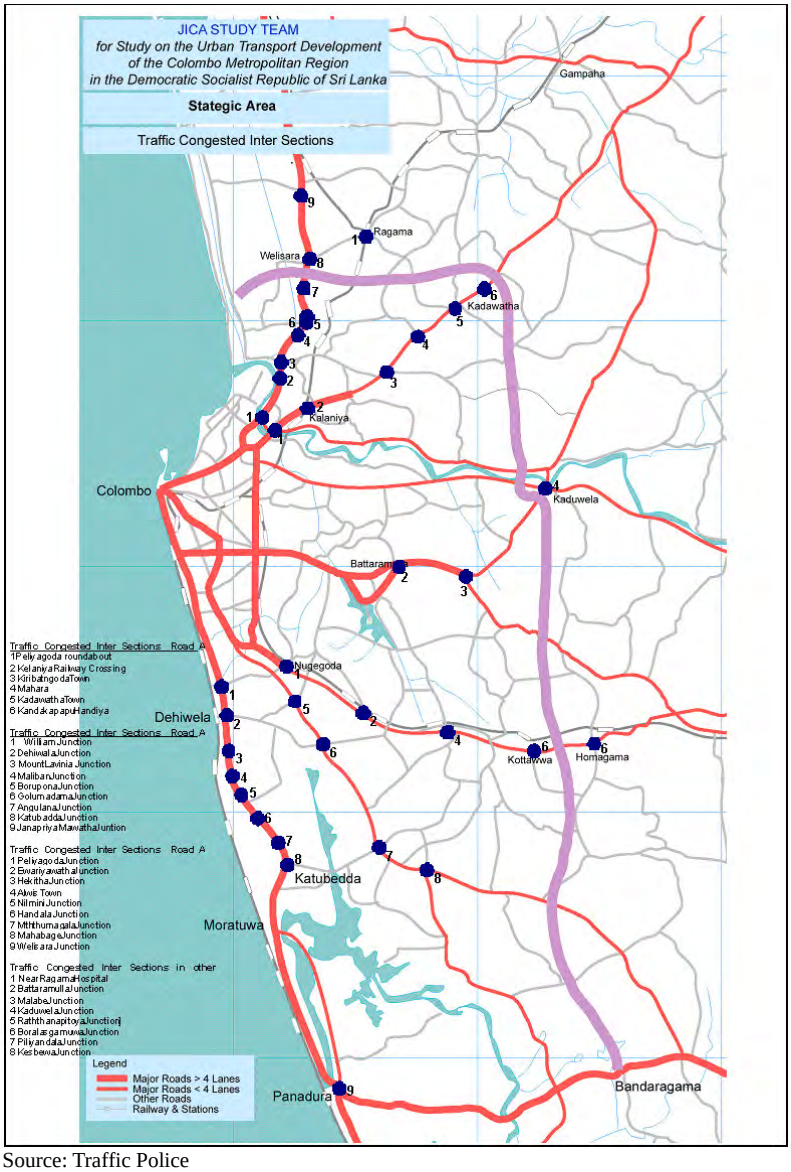
### (5) Congestion

In comparison with other Asian capitals, Colombo is smaller in size and streets are less congested; however, traffic congestion is increasingly becoming a serious problem. This is partly due to the insufficient amount of roads and inappropriate traffic management. Congested locations were identified at the meetings of TMSWG. The identified congested locations inside Colombo are shown in Figures 6.1, with those outside Colombo in Figure 6.2. Not all of the congested intersections are where two primary roads meet; instead some congested roads are performing the functions of a primary road, while lacking the necessary design standards.




Source: Traffic Police

**Figure 6.1 Congested Locations in Colombo**




Source: Traffic Police

**Figure 6.2 Congested Locations in Western Province**

## 6.3 Traffic Management Facilities

### (1) Signaling System

*Existing Signals*

Traffic signals in Colombo are not consistent in engineering standards, which is the result of piecemeal approach that has lacked systematic consideration and a long-term vision. Two agencies, the Road Development Authority (RDA), a national government agency, and the Colombo Municipal Council (CMC), a local government, are tasked with designing, installing, and operating signals in the study area. Signals managed by two agencies are shown in Figure 6.3 and list of signals is given in Appendix 9.


Source: CMC and RDA

**Figure 6.3 Existing Signals in Colombo and Vicinity**

As shown in the figure, RDA manages signals along Baseline Road and Olcott Mawatha in Colombo. All other signals are managed by CMC. According to the two agencies, the signals on Baseline Road and Olcott Mawatha were supposed to be transferred to CMC, but since they are not in a good condition, CMC does not want to accept them. RDA accepts this as valid and they are trying to improve the operation of these signals with better signal timing plans, but no definite deadline has been set.

*Signal Equipment*

Different types of signal controllers from various manufacturers are in operation in the study area. All of the existing controllers are multi-pattern controllers with the capability of applying different timing parameters set according to the time of day, but lack other control functions such as vehicle actuation, recall, and cableless linking are provided.

Corresponding to the local controller, old imported signal heads are used for the old signals, while locally made signal heads are used for locally made signals. They use halogen lamps as the light source. In addition, locally developed light emitting diodes (LED) signals replaced some old signal heads recently, the quality of which are low because unlit LED elements are visible on the signal. They have yet to be improved.

*Signal Design*

There are no design standards for traffic signals in Sri Lanka. As a result, many of the existing signals are not performing under optimal conditions in terms of both hardware and software (signal phasing and timing).

*Operation and Maintenance*

All signals operate in a stand alone fashion, without being coordinated with neighboring signals. Although they have time-of-day functionality, timing plans are not well tuned to adapt to the different traffic demand. As a result, signal operations are not efficient and cause unnecessary delays at intersections. An attempt is being made by RDA to update the timing plans, but they are uncertain when it will be completed as they lack the necessary professional capacity.

(i) RDA-Installed Signals: RDA installed signals are maintained by the State Development and Construction Corporation (SDCC). Currently, a total of 42 traffic signals are maintained by SDCC, of which 38 are in CMC. To maintain these locations, RDA made a contractual agreement with SDCC a year ago to operate a 24/7 on-call maintenance system. The contact numbers are listed on traffic light poles for road users to report any malfunction of signals. Three mobile units are set up to make daily visits, which are necessary as the signals are seven years old and frequently break down. One problem associated with signal maintenance is slow payment. SDCC indicated that RDA's billing process takes a long time to settle, which hampers timely and high quality maintenance work.

(ii) CMC-Installed Signals: CMC-installed signals are maintained by Digital Control Systems (Pvt) Ltd (DCS). They negotiate an annual maintenance contract with CMC at an increase of 3-5% per year because there were no other bidders. Maintenance work covers only preventive and corrective maintenance of local controllers. Damage repairs, bulb replacements, and painting are done by CMC.

There is no periodical timing review program. When traffic police notice abnormal or unbalanced traffic conditions, they inform CMC who then instructs DCS to check the abnormality. If it is a hardware problem, DCS fixes it, but if it is some other abnormality, CMC is informed and fixes it.

Modification of existing signal timings is supposed to be prepared by CMC and RDA for the signals under their management; however, there are no established procedures for calculating timings and designs are arbitrary. Consequently, signal timings have not been adjusted in a long time due to a lack of initiative, which has resulted in inefficient signal operations.

*Signalization Project*

RDA is undertaking a signalization project at several intersections shown in Table 6.1. Proposed locations for new signal are shown in Table 6.2.

**Table 6.1 Ongoing RDA Signalization Projects**

| No. | Location | Road | Fund |
|---|---|---|---|
| 1 | Gamsaba Junction | CRWB Road | RDA |
| 2 | Delkanda Junction | CRWB Road | RDA |
| 3 | Bellantota Junction | | RDA |
| 4 | Malabe Junction | | RDA |
| 5 | Kottawa Junction | CRWB Road | RDA |
| 6 | Templers Junction | CGHW Road | Ministry of Transport |
| 7 | Miriswatta Junction | Colombo – Horana Road | Ministry of Transport |
| 8 | Pamankade | Colombo – Horana Road | Ministry of Transport |
| 9 | Puwakgashandiya | Colombo – Horana Road | Ministry of Transport |
| 10 | Piliyandala Junction | Colombo – Horana Road | Ministry of Transport |
| 11 | Wijerama Junction | CRWB Road | Ministry of Transport |
| 12 | Wellampitiya Junction | | Ministry of Transport |
| 13 | Belummahara Junction | Colombo – Horana Road | Ministry of Transport |
| 14 | Yakkala Junction | Colombo – Horana Road | Ministry of Transport |

Source: RDA

**Table 6.2 RDA Proposed Signalization Locations**

| No. | Location | Road | Fund |
|---|---|---|---|
| 1 | Boralesgamua Junctioin | | RDA |
| 2 | Kohuwela Junction | | RDA |
| 3 | Moraketiya Junction | | RDA |
| 4 | Rajagiriya (Welikada) Junction | | RDA |
| 5 | Battaramulla Junction | CRWB Road | RDA |
| 6 | Navinna Junction | CRWB Road | RDA |
| 7 | Maharagama Junction | CRWB Road | RDA |
| 8 | Pannipitiya Junction | CRWB Road | RDA |
| 9 | Homagama Junction | | RDA |
| 10 | Nugegoda Supermarket Junction | | RDA |
| 11 | Maliban Junction | | RDA |
| 12 | Windsor Junction (Jaffna) | | RDA |
| 13 | Kalutara Police Station | Pelican crossing | RDA |
| 14 | Wellampitiya | Pelican crossing | RDA |
| 15 | Ratmalam-Borupuna Junction in front of Blind and Deaf School | Pelican crossing | RDA |

Source: RDA

### (2) Traffic Signs, Pavement Markings, and Other Devices

Like other traffic control devices, RDA and CMC are responsible for traffic signs and pavement markings on roads outside of Colombo City and within Colombo City, respectively. Reflective sheets are not used for traffic signs which result in poor visibility at night. Both agencies use reflective thermoplastic marking materials for pavement markings. The quality of materials seems to be acceptable, but laboratory tests would be necessary to confirm this. Conditions of these devices vary depending on the road. Primary roads such as Galle Road and Baseline Road are generally in better condition than secondary and tertiary roads.

Previously at RDA, there was no pavement marking project to systematically apply them to the roads. A plan was formulated to apply markings to all roads under RDA management in Western Province (WP) within fiscal year 2005. As the funds were insufficient, markings were applied

only a certain distance from intersections. By November 2005, the project was about 50% complete.

CMC directly undertakes pavement marking work. The marking application machine and vehicle were donated by JICA in early 90's under a technical assistance program. A short-term expert was dispatched to CMC to train local staff. The machine was, in fact, donated to the police, but they were not capable of undertaking pavement work and the facilities were transferred to CMC. Major repairs to the application machine were done two years ago and it is still working. Due to the many years of use; however, it is reaching the end of its life. Marking material is imported from Malaysia.

Delineator and reflective sheets are intensively used along some primary roads, such as Galle Road, and Baseline Road, where running speeds are relatively high. They are effective in guiding vehicles and warning of obstacles.

### (3) Intersection Improvement and Fly-over

Flyover projects are underway by RDA at 3 locations. The location and status of the flyover projects are summarized below.

**Table 6.3 Flyover Projects Under Consideration**

| | Location | Status |
|---|---|---|
| 1. | Flyovers at **Gampaha** on Gampaha-Minuwangoda Road | on-going |
| 2. | Flyovers at **Pannipitiya** on Battaramulla-Pannipitiya Road | on-going |
| 3. | Flyover at **Orugodawatta** on Orugodawatta-Ambatale Road | on-going |
| 4. | Flyover at **Nugegoda** Junction on High Level Road | Design & Construction works to be done under Chinese Grant |
| 5. | Flyover on Colombo-Kandy Road across the Main Railway Line at **Kelaniya.** | Design in progress |
| 6. | Flyover on Veyangoda-Nittambuwa Ruwanwell Road across the Main Railway Line at **Veyangoda.** | Design Completed |
| 7. | Flyover at **Kohuwala** Hunction on Colombo-Horana Road | Design in Progress |
| 8. | Flyover across High Level Road for the right turning traffic from the High Level Road to the Stafford Avenue at **Kirulapana** Junction | Design in Progress |
| 9. | Flyover at **Dehiwala** Junction on Colombo-Galle Road | Design completed since land acquisition is involved, other options are being studied. |
| 10. | Flyover along Baseline Road across High Level Road and Baseline Road extension at Edmonton Road. | Design Completed |
| 11. | Flyover at **Boralesgamuwa** Junction on Colombo –Horana Road | Feasibility Studies to be carried out and if found viable, Designs to be undertaken. |
| 12. | Flyover along Duplication Road across Coastal Railway line at **Slave Island** near Beira Lake in the City of Colombo. | |
| 13. | Interchange at **Welikada-Rajagiriya** Junction on State Drive to the Parliament. | |
| 14. | Interchange at **Orugodawatta** Junction on Baseline Road. | |
| 15. | Interchange at **Panchkawatta** Roundabout on Colombo-Kandy Road | |
| 16. | Interchange at **Lipton Circle** at Eye Hospital Junction extending roundabout. | |
| 17. | Flyover across Chatham Street and Hilton Roundabout. | |
| 18. | Flyover across **Station Road** at Bambalapitiya. | |
| 19. | Flyover at **Kanatta Junction** along Bauddhaloka Mawatha towards Devi Balika Vidyalaya. | |
| 20. | Flyover across D.S Senanayake Junction and Kinsey Road Junction. | |

Source: Ministry of Highway (status in May 2006)