International Journal of Engineering Research
Volume No.5, Issue Special 1 pp : 80-84
ISSN:2319-6890(online),2347-5013(print)
8 & 9 Jan 2016

Design of Coastal Road in Mumbai City

Anuj Pawar, Ganesh Patil, Sayali Salunke
Department of Civil Engineering, Sardar Patel College of Engineering, Andheri (W), Mumbai, India.
Email: anuj.p1992@gmail.com, ganeshrjpt858@gmail.com, sayalisalunke18@gmail.com

Abstract : The Western Freeway is a transportation infrastructure project in Mumbai, India that envisions the construction of multiple bridges over the Arabian Sea to reduce traffic-congestion between the Western Suburbs and the island city. The freeway will stretch from Marine Drive in South Mumbai to Kandivli in the north, a distance of 35.6 km. This study is carried out to develop alternative roads by Coastal Routes and to increase average travel speed of vehicles in Mumbai City. This research aims to assess the influence of increase in traffic intensity in Mumbai city. In this paper we estimated the total length of coastal road to examine the various options in the construction of a coastal road including road on stilt or sea link in Mumbai and find out most economical options towards composition of coastal freeway, we also collected the data related to traffic intensities at different locations on the proposed coastal road and for that traffic intensity we design the flexible pavement.

Keywords: coastal freeway, flexible pavement, Mumbai, traffic intensity.

1. Introduction

Mumbai is reckoned as the financial capital of India. It houses a population of 12.4million besides a large floating population in a small area of 437sqkm. As surrounded by sea and has nowhere to expand. The constraints of the geography and the inability of the city to expand have already made it the densest metropolis of the world. High growth in the number of vehicles in the last 20 years has resulted in extreme traffic congestion. This has lead to long commute times and a serious impact on the productivity in the city as well as defining quality of life of its citizens. The extreme traffic congestion has also resulted in Mumbai witnessing the worst kind of transport related pollution. Comprehensive Traffic Studies (CTS) were carried out for the island city along with its suburbs to identify transportation requirements to eliminate existing problems and plan for future growth. CTS identified requirement of new arterial road along the Western Coast as part of transportation networks. Therefore, Municipal Corporation of Greater Mumbai (MCGM) has proposed to construct a Coastal Road on Western side of the city. The report concentrates on feasibility of the proposed Coastal road.

1.1 History of reclamation of Mumbai

It took over 150 years to join the original seven islands of Mumbai. These seven islands were lush green thickly wooded, and dotted with 22 hills, with the Arabian Sea washing through them at high tide. The original island of Mumbai was only 24 km long and 4 km wide from Dongri to Malabar Hill (at its broadest point) and the other six were Colaba, Old Woman's island, Mahim, Parel, Worli, Mazgaon as presented in Figure 1. After the British arrival, the demand for land steadily increased, and by 1730; it was becoming impossible to accommodate the entire population of Mumbai inside the Fort. The sea was making inroads at Worli, Mahim and Mahalaxmi, which turned the ground between the islands into a swamp, making travel between Mumbai islands hazardous. The first major reclamation took place in 1708, to construct the causeway between Mahim and Sion. The second major reclamation took place in 1772, to stop the ingress of water and the consequent flooding of central Mumbai, and to connect Mahalaxmi and Worli. This causeway was named Hornby Vellard, sealing the Great Breach (Breach Candy) between Dongri, Malabar hill and Worli. At the fortified Dongri hill, an esplanade and parade ground was cleared, from the walls of the Fort to the present day Crawford market. The flat lands from Mahalakshmi to Kamathipura were reclaimed only after the completion of construction at Breach Candy by Hornby in 1784. In 1803, Mumbai was connected to Salsette by a causeway from Sion.

Figure 1. Seven Islands of Mumbai

The Thane and Colaba causeway were built during the tenure of Sir Robert Grant, the Governor of Mumbai. He was also responsible for the construction of a number of roads between Mumbai and the hinterland. The Colaba Causeway was completed in 1838 joining Colaba, Old Woman's island and the H-shaped island of Mumbai together. Land prices shot up and Colaba became the centre of commerce. The Causeway was widened and strengthened from 1861 to1863 (CusrowBaug is built on the causeway).The horse drawn tramcars revolutionised transport in Colaba. The Prongs Lighthouse was constructed off the island in 1875 and in the same year the Sassoon Docks were built by David Sassoon on reclaimed land. The BB & CI (Bombay and Central India) Railways established a terminus at Colaba. 90,000 sq. yards of land was reclaimed on the western

shore of Colaba by the City Improvement Trust, the work was completed in 1905. A seaside promenade (Cuffe Parade) was completed the next year.
The next reclamation came in 1836, when the development of the Mumbai port had already begun. Major quarrying had already begun in 1870. The hills of Chinchpokli and Byculla were quarried and dumped into the sea, to fill the land near the railway line, the swamps and also the port to prevent the accumulation of stagnant water. The first railway line was laid down in 1855 from BoriBunder to Thane. By 1862 the town became widespread and the constructions that took place began to give rise to the modern city of Mumbai. This became a regular feature in the succeeding years. The Fort walls were demolished and the tanks up to Parel were filled. From 1870 to 1970, industrial and commercial development prospered, which increased the spate of reclamation that ended with the famous Backbay reclamation. The first Backbay Reclamation Company (BRC) was formed in the 1860s with the express purpose to reclaim the whole of Backbay. With the end of the American Civil War in 1865, land prices fell. The government took over the narrow strip of land created by the BRC and gave it to the BB & CI Railways (Bombay Baroda and Central India) to construct a new line between Churchgate and Colaba. A proposal was made in 1917 to reclaim 607 hectares of land between Colaba and Backbay. The project was taken over by the Development Directorate who planned to reclaim 463 hectares and would have to relocate the Colaba terminus, which was moved to Bombay Central. The work continued till 1945. Eventually 177 hectares was developed by 1929 of which 94 hectares was sold to the military and 6 hectares was incorporated into the Marine Drive and its sea wall. Independence did not end the reclamation work but a third Backbay Reclamation was put into effect and yielded the acreage on which stand the high rise buildings of Nariman Point and Cuffe Parade. East of the Naval Dockyards some land was reclaimed and work was done to the north too. Coastal Regulation Zone (CRZ) was introduced in 1990 banning reclamation for commercial activities.

1.2 Need of coastal freeway for Mumbai

As regards the road transport mode, CTS comments that increase in cars (137%), increase in two wheelers(306%), increase in autos(420%) and increase in taxis (125%) during the 1991-2005 period has created a lethal dose of traffic congestion which has categorised Mumbai urban agglomeration as one of the most congested regions in the world. The observed speeds on some of the major corridors in the study area during 1990 to 2005 indicate that the overall speeds are decreasing with time and the most probable reason is the increasing trend of traffic levels Over a period of fifteen years, minimum average travel speed in Island city has fallen from 18to 8 kmph**,** in spite of major capacity expansion programs underway. Maximum average travel speed has shown marginal increase from 25 to 30 kmph, primarily due to construction of flyovers reducing location specific (and movement specific) delays. Most of the network remains, however, highly congested. In the suburbs of Greater Mumbai, Minimum average travel speed has fallen from 30 to 5 kmph, although maximum travel speed increased from 40 to 45 kmph. The CTS also brings out a significant growth in the private vehicles in the city over the fifteen years period between 1991 and 2005. The growth of motorized vehicles has been reported to be about 9.7% per annum in this report and the CTS attributes this high growth of private vehicles in MMR to highly intolerable crowding levels in sub-urban trains, increasing income levels, and easy availability of loans. Limited land mass with rapid increase in population in the city has compounded this growth.

1.3 Committee for coastal freeway:

As explained above, Mumbai, being an island surrounded on the east, south and the west sides by the Arabian Sea has no room to expand. Unlike other cities of the country, Mumbai does not have a ring road on its periphery to take traffic from one part to the other speedily. To provide better connectivity, sea links are planned on the western flank and the trans-harbour link on the east to connect the island city to the main land. One of the prime reasons sea links were planned as bridges (into the sea, about five hundred meters away from the coast) was the restriction placed by the earlier Coastal Regulatory Zones (CRZ) regulations preventing reclamation or stilt roads in the CRZ areas. The CRZ notification 2011 issued by the Ministry of Environment and Forests, Government of India (MOEF, GOI) now makes it possible to envisage coastal roads on stilts. During the meeting held in Mumbai on 15th April 2011 by the Hon. Minister MOEF, GOI, the proposal of a reclamation-based coastal road encircling Mumbai was presented to the Hon. Minister. The proposal envisioned a coastal road on reclamation which not only provided a speedy connectivity but also enhanced the quality of the city environment through the reduction in pollution and respiratory diseases and provision of excellent green space adjoining the road on either side and thus providing a much needed recreational space in addition to the road that connects the various parts of the city. The proposal of a coastal road based on stilts as permitted by the recent MOEF notification was also discussed. As discussed in the following chapters of this report, this is not a suitable option for Mumbai. The cost aspects of a sea link *vis a vis* a coastal road based on stilts and reclamation also came up for discussion in this meeting. Hon. Union Minister (MOEF) suggested that the proposal needed a closer examination through a committee whose recommendations could be made available to the Government for taking up further action in the matter.

2. Traffic Survey Analysis by STUP Consultancy:

Traffic Surveys were planned along the major highways at locations of inner cordon lines of CTS. This is to relate the current traffic with the CTS and update its impact on the project roads. 12 locations were identified on the nodes of these inner cordon lines with existing atterial roads. Following Traffic

doi : 10.17950/ijer/v5i1/018

surveys have been conducted along these nodes of cordon lines crossing major highways.

- Three days video classified traffic volume count and four days manual count at 12 interchanges locations

2.1 Recommendations of STUP Consultancy and its Drawbacks:

With the assumed data of CBR value, number of buses and traffic growth rate of 3 %, Vehicle Damage Factor for bus is considered as 1.31, for LCV- 0.79, for two axle truck- 4.53, for three axle truck- 8.01 and MAV-5.5, the cumulative number of standard axel comes out to be 100 msa for 15 years of design life. If the pavement is designed for Ns= 100 msa and CBR = 8%, the thickness of various layers as per the IRC:37-2001 is shown in table 1

For calculation of design traffic following equation has been used:

N_s = ————————

$A=p\ (1+R)^{x}$

Where

N_s=the cumulative number of standard axles to be catered in the design

P=total traffic in terms of PCU

A=initial traffic in the year of completion of construction

R= annual growth rate of commercial vehicles (3%)

n= design life in years (5 years)

x=construction period (5 years)

D=lane distribution factor (0.5)

F=vehicle damage factor. (1.31)

2.3 Proposed design approach according to IRC: 37-2001

STUP consultants assumed traffic growth rate of 3 %. Actually, it may be more than 3 % also. The cumulative number of standard axle is calculated based on assumption of 2000 buses per day. But in actual practice it may be more. Considering the above drawbacks of the report presented by STUP consultant, the pavement is designed for 5 years. The vehicular data is converted in to PCU and then cumulative number of standard axle (Ns) is calculated. It is different at different sections. Lane distribution factor is considered as 0.75, Vehicle damage factor is considered as 1.5 and Traffic growth rate of 8% has been considered for all categories of vehicle.

For calculation of design traffic following equation has been used:

N_s = ————————

$A=p\ (1+R)^{x}$

- One day Origin – Destination survey at 12 interchanges locations
- Speed and Delay Surveys.

Traffic data for 12 interchanges separately for the base year 2014 is studied.

Where

N_s=the cumulative number of standard axles to be catered in the design

P=total traffic in terms of PCU

A=initial traffic in the year of completion of construction

R= annual growth rate of commercial vehicles (8%)

n= design life in years (5 years)

x=construction period (5 years)

D=lane distribution factor (0.75)

F=vehicle damage factor (1.5)

Table 2 shows the cumulative number of standard axle during the design life of 5 years, corresponding thickness of various layers and total thickness of pavement.

Conclusion

The traffic volume on coastal road is more as compared to state or national highways. This results in Cumulative no of Standard axle (Ns) crossing the limit stated by IRC: 37 – 2001- "Guidelines for the Design of Flexible Pavements" i.e. 150 Msa. Hence to overcome this problem, it has been recommended to take the design life as 5 years based on the current traffic scenarios.

3. References

i. STUP Consultants Pvt. Ltd Ernst& Young Pvt Ltd Municipal Corporation of Greater Mumbai mcgm.gov.in

ii. . Joint technical committee Govt. of Maharashtra COASTAL ROAD IN MUMBAI CITY http://www.mcgm.gov.in/irj/portalapps/com.mcgm.RTI_GMDA/docs/Costal%20road.pdf

iii. IRC: 92-1985 (Guidelines for the design of Interchanges in Urban Areas)

iv. . IRC: SP: 41-1994 (Guidelines for the Design of At- Grade Intersections in Rural and Urban Areas

v. . IRC: 37 – 2001- "Guidelines for the Design of Flexible Pavements"

vi. . Arnab Chakraborty, Bev Wilson, Shakil bin Kashem Department of Urban and Regional Planning, University of Illinois at Urbana–Champaign, United States. Chakraborty, A., Kaza, N., Knaap, G. J., & Deal, B. (2011). Robust plans and contingent plans: Scenario planning for an uncertain world. Journal of the American Planning Association, 77(3), 251–266. Journal homepage: www.elsevier.com/locate/cities

vii. . M.C. Bramati a, *, F. Musella b, G. Alleva a a Sapienza University of Rome, Dpt. Methods and Models for Economics, Territory and Finance, Via del Castro Laurenziano 9, I-00161 Rome, Italy b University of Roma Tre, Dpt. of Economics, Via S. D'Amico, 77 I-00145 Rome, Italy journal homepage: www.elsevier.com/locate/ocecoaman

ISSN:2319-6890(online),2347-5013(print)
8 & 9 Jan 2016

Table1. Traffic Data in base year of 2014.

Section	1	2	3	4	5	6	7	8	9	10	11	12
Interchange locations	Jagannath Bhosle marg Interchane	Ameson garden Interchange	Haji Ali Interchange	Bandra Worli Sea Link (worli) Interchage	Bandra Worli Sea Link (Bandra) Interchage	Otters Club Intrchange	Carter Road Interchange	Ritumbra College Interchange	MADH Island Interchange	Oshiwara Intrchange	Malad Interchange	Kandivali Interchange
Traffic (ADT in PCU) 2014	11378	21069	31933	33421	34090	31904	31904	29253	26602	24602	20506	16410

Table 2: Thickness of Flexible Pavements at Different Sections

Traffic (cvpd)	Cumulative no. Of Standard axle (Ns) in Msa	Grannular sub Base (GSB) (mm)	Grannular Base (mm)	Dense Bituminous Macadam (DBM) (mm)	Bituminous concrete (BC) (mm)	Sub grade (mm)	Total Thickness(mm)
2014	2014						
2000	100	200	250	120	50	500	1120

Section	Interchange locations	Trafic (ADT in PCU) 2014	Cumulative no. Of Standard axle (Ns) in msa 2014	Grannular sub Base (GSB) (mm)	Grannular Base (mm)	Dense Bituminous Macadam (DBM) (mm)	Bituminous concrete (BC) (mm)	Sub grade (mm)	Total Thickness(mm)
1	Jagannath Bhosle marg Interchane	11378	40.27	200	250	100	40	500	1090
2	Ameson garden Interchange	21069	74.57	200	250	110	50	500	1110
3	Haji Ali Interchange	31933	113.02	200	250	120	50	500	1120
4	Bandra Worli Sea Link (worli) Interchage	33421	118.29	200	250	125	50	500	1125
5	Bandra Worli Sea Link (Bandra) Interchage	34090	120.66	200	250	125	50	500	1120
6	Otters Club Intrchange	31904	112.92	200	250	120	50	500	1120
7	Carter Road Interchange	31904	112.92	200	250	120	50	500	1120
8	Ritumbra College Interchange	29253	103.54	200	250	120	50	500	1120
9	MADH Island Interchange	26602	94.16	200	250	115	50	500	1115
10	Oshiwara Intrchange	24602	87.08	200	250	115	50	500	1115
11	Malad Interchange	20506	72.58	200	250	115	50	500	1115
12	Kandivali Interchange	16410	57.13	200	250	105	50	500	1105