# CHAPTER 3

## BRIDGE ADMINISTRATION AND ENGINEERING

# CHAPTER 3

# BRIDGE ADMINISTRATION AND ENGINEERING

## 3.1 LAW AND REGULATION ON ROADS AND BRIDGES

### 3.1.1 Legal Framework

In many countries including the Philippines, any action (or non-action) of the government agencies is taken on the legal basis. As for the road administration, there are usually three (3) major areas to be covered.

- The definition of public roads and classification of roads,
- Authority and responsibility of road administration organizations, and
- Financing for roads and bridges

In addition to these, the following types of law and regulations are pertinent to project implementation and roads and bridges maintenance.

- Laws/regulations on environmental impact assessment
- Laws/regulations on land acquisition/relocation
- Laws/regulations on vehicle dimension and trucking industry.

### 3.1.2 Relevant Laws

#### (a) Republic Act 917, "Philippine Highway Act", 1953 Executive Order 113, 1955

Usually, these subjects are stipulated in the basic laws for road such as "road law". In case of the Philippines, Republic Act (RA) No. 917, 1953 (The Highway Act) and Presidential Decree No. 17, 1972 (Revised Highway Act) are generally regarded as the basic laws.

Executive order NO. 113, 1955 has established the classification of the corresponding responsible agencies as follows:

| Road Classification | Responsible Agency |
|---|---|
| National Road | Public Works and CommunicationDepartment |
| Provincial Road | Provincial Government |
| City Road | City Government |
| Municipal Road | Municipal Government |

**(b) Presidential Decree No. 17, "Revised Highway Act", 1972**

Presidential Decree No. 17 came into effect in 1972 revising RA 917 that institutionalized EMK (Equivalent Maintenance Kilometer) as basis for apportionment of Maintenance funds for all districts and cities in the country. The allocation of maintenance fund based on the EMK for each road category is shown below:

| Road Category | Maintenance Fund Allocation |
|---|---|
| National Road | Basic EMK Cost x Total EMK |
| Provincial Road | Basic EMK Cost x 25% of physical road length in km |
| City Road | Basic EMK Cost x 50% of physical road length in km |
| Municipal Road | Basic EMK Cost x 50% of physical road length in km |

**(c) Presidential Decree No. 711, 1975**

The Presidential Decree abolished all special funds including Highway Special Fund sourced from the fuel tax. The revenue from the fuel tax was incorporated into the general fund. With this, the funding requirements (construction component and maintenance) were allocated from the general fund through the annual budgeting process.

**(d) Republic Act 7160, "Local Government Code", 1991**

This law covers a wide spectrum of the authorities and functions of local government units (provincial, city and municipal governments), including revenue, election and organization. Section 17 of this Act identified the functions and responsibilities of LGUs on roads, among others, as follows:

- Province : (Provision of) Infrastructure facilities intended to service the needs of the residents of the province and which are funded out of provincial funds including, but not limited to, provincial roads and bridges.
- Municipality : (Provision of) Infrastructure facilities intended primarily to service the needs of the residents of the municipality and which are funded out of municipal funds, including, but not limited to, municipal roads and bridges.
- City : Same to province and municipality
- Barangay : Maintenance of barangay roads and bridges.

The law did not specify that the barangay is responsible for construction and improvement of barangay roads.

### (e) Republic Act 8794 "Motor Vehicle Users Charge Act", 2000

RA No. 8794 known as the Motors Vehicle Users Charge (MVUC) Act was enacted in June 2000 as part of a package of major reforms in the road sector under the medium-term Philippine Development Plan 1999-2004. The act provided among others that the management and financing of national roads be carried out using money users pay for the road services they receive, and be involved in the decisions as to where and how the funds are spent.

The MVUC Act provides for : (a) an annual MVUC, which increases by 25% each year from 2001 to 2004; (b) four (4) dedicated special Funds (trust accounts in the National Treasury) to receive revenue from the MVUC; and (c) a Road Board to implement the efficient management and utilization of the special funds.

### (f) Republic Acts 8974 and 8975 "Facilitate Acquisition of Right-of-Way", 2000

The law provides new process of right-of-way acquisition for government infrastructure projects by introducing:

- BIR Zonal Value concept as a basis of compensation of land;
- Fair Market Value concept to finally determine compensation of land;
- Replacement cost concept for compensation of structures and other improvements
- Deposit of 100% escrow money upon filing expropriation proceedings and
- Prohibition of lower courts from issuing Temporary Restraining Order against expropriation.

The objective of the law is to provide adequate compensation to people affected by government infrastructure projects.

The legal framework for road administration is shown in **Figure 3.1.2-1.**

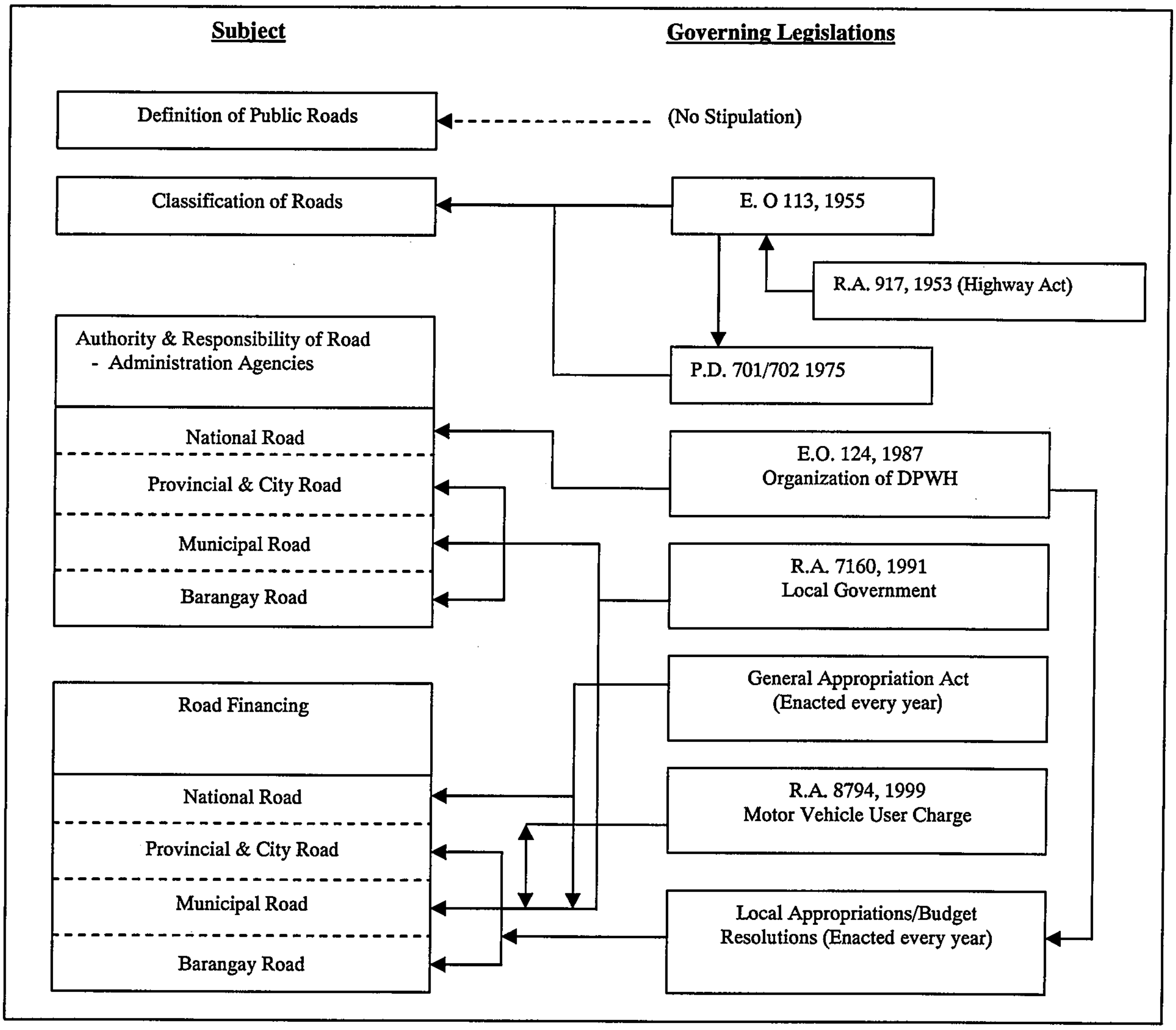


Figure 3.1.2-1 Legal Framework for Road Administration

## 3.2 ADMINISTRATION AND ORGANIZATION ON ROADS AND BRIDGES

### 3.2.1 General

The bridges on the national roads are being administered by the DPWH while the bridges on the local roads, by the LGU's in accordance with the administrative classifications of the roads and bridges.

The 17 bridges in this study were principally administered by the DPWH being located on the national roads. The administration system and organization of the DPWH below is described roughly in this section.

### 3.2.2 History of DPWH

The origin of DPWH is considered to date back during the Spanish colonial era. The history of modern DPWH started in 1954 when the Bureau of Public Highways (BPH) was established under the Department of Public Works and Communications by virtue of R.A. 1192.

As the role of roads in the transportation of the Philippines increased, the BPH was expanded and became the Department of Public Highways (DPH) in 1974. DPH continued to be an independent department until it merged with the Ministry of Public Works and became the Ministry of Public Works and Highways in 1981.

A major event in the recent history of DPWH was the enactment of E.O. No. 124 of 1987 series, which defined the basic structure and function of the present DPWH.

**Table 3.2.2-1** shows the history of DPWH in the modern times.

Table 3.2.2-1 History of Department of Public Work and Highways

| Year | Milestone Events |
|---|---|
| 1951 | Department of Public Works and Communication was reconstituted as Department of Public Works, Transportation and Communications (DPWTC) |
| 1954 | Bureau of Public Highways (BPH) was created and placed under DPWTC (R.A. No. 1192) |
| 1974 | BPH was expanded as Department of Public Highways (DPH) (A.O. No. 2) |
| 1976 | DPWTC was renamed as Ministry of Public Works, Transportation and Communication. DPH was separated from MPWTC and was renamed as Ministry of Public Highways (MPH) (All "Departments" were renamed as "Ministry(ies)".) |
| 1979 | MPWTC was restructured into two separate Ministries; Ministry of Transportation and Communication (MTC) and Ministry of Public Works (MPW) (E.O. No. 546) |
| 1981 | MPW and MPH were merged to become Ministry of Public Works and Highways (MPWH) (E.O. No. 710) |
| 1987 | MPWH was recognized and renamed as Department of Public Works and Highways (DPWH) (E.O. No. 124) |

**Figure 3.2.2-1** shows the present organization of DPWH (as of April 2002). The Central Office consists of six "Services", five "Bureaus" and two "Offices". Under the Central Office, there are 16 Regional Offices, 146 District Offices, 25 Sub-District Offices, 24 Project Management Offices, 16 Regional Equipment Services and 66 Area Equipment Shops (As of April 2002). **Figure 3.2.2-2** shows typical organizational charts of the Regional and District Offices.

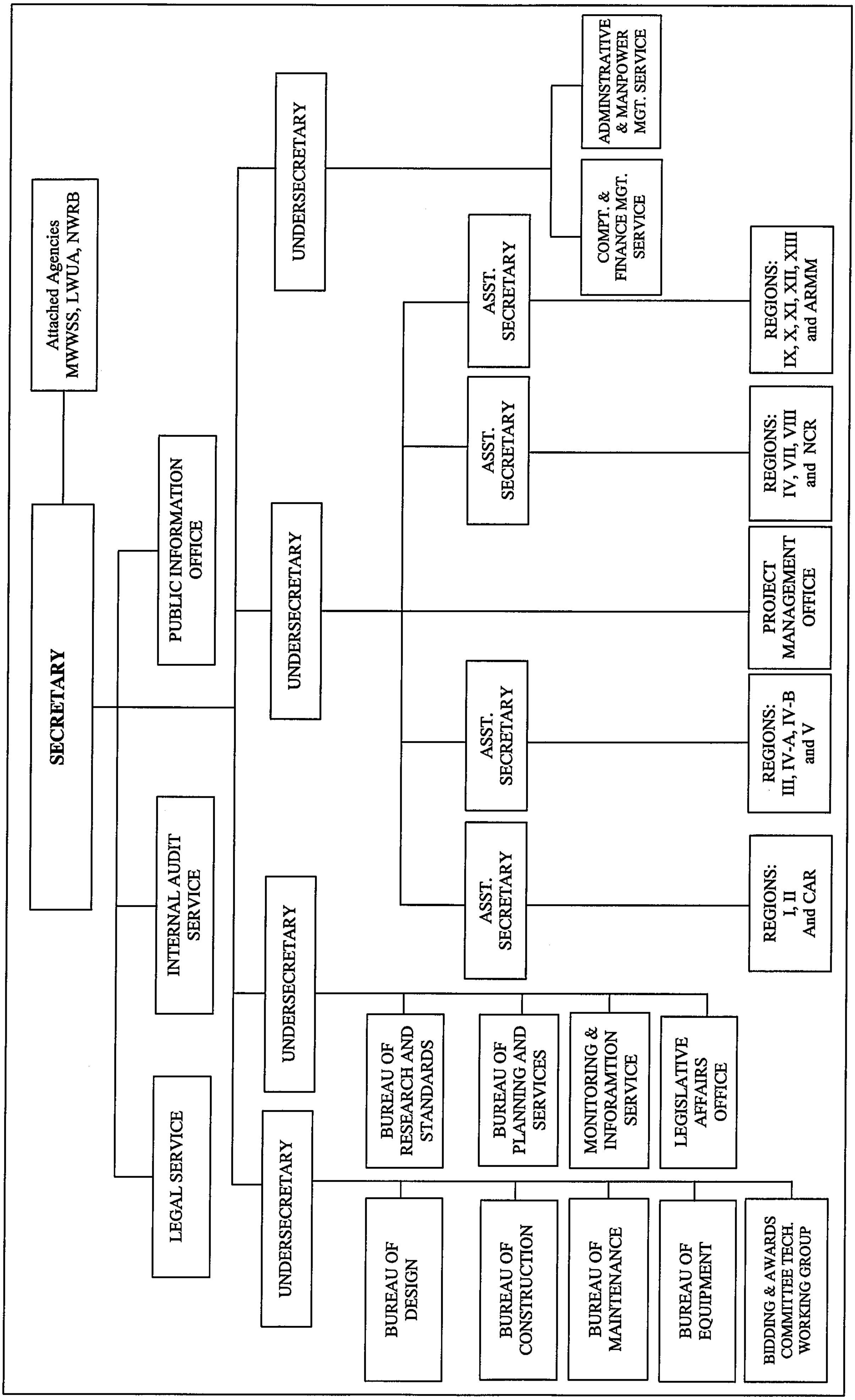


Figure 3.2.2-1 Organization of DPWH

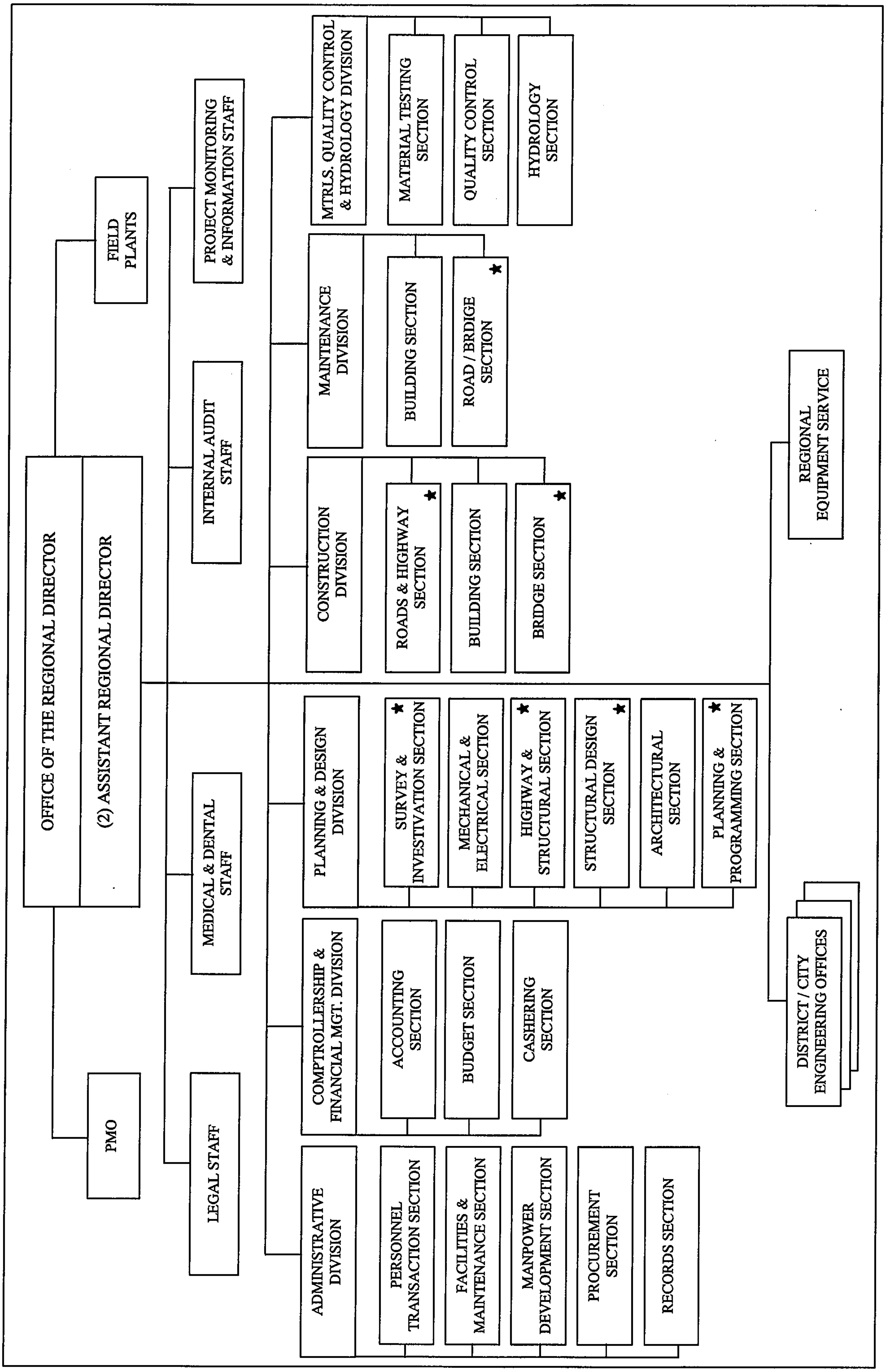


**Figure 3.2.2-2 Typical Organization Chart of Regional Office**

## 3.3 FINANCIAL SYSTEM AND BUDGET ON BRIDGES

### 3.3.1 Past Budgets of DPWH

The total annual appropriations of the DPWH over the past years are summarized in **Table 3.3.1-1** together with the amounts allocated for road works including bridge works. The largest appropriation for road works, inclusive of new investments and maintenance, reached its highest level in 1998. In nominal terms, the appropriation for road works at that time represented about 1.2% of GNP. Since then, road budget continuously declined in nominal value and reached its lowest level in 2001. Beginning in 2002, however, the budget for road works appears to be recovering both in terms of nominal value and as percentage of GNP.

Table 3.3.1-1 Historical Budgets of DPWH

(Billion Pesos)

| Budget Items | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| Total DPWH Annual Appropriations/1 | 15.93 | 40.37 | 53.82 | 61.82 | 37.72 | 52.37 | 52.37 | 47.99 | 52.95 |
| General Administration /2 | 3.09 | 3.47 | 4.06 | 4.76 | 4.25 | 5.11 | 4.24 | 4.65 | 3.73 |
| Road/Bridge Investment /3 | 6.44 | 15.43 | 22.72 | 29.73 | 24.22 | 21.47 | 15.36 | 15.98 | 25.86 |
| Foreign-Assisted | 1.13 | 8.37 | 8.41 | 11.80 | 12.63 | 12.22 | 9.76 | 10.05 | 14.57 |
| Locally Funded | 5.31 | 7.06 | 14.31 | 17.93 | 11.59 | 9.25 | 5.60 | 5.93 | 11.29 |
| Road/Bridge Maintenance | 3.24 | 3.40 | 3.59 | 3.70 | 3.79 | 4.34 | 4.69 | 4.24 | 5.27 |
| GNP /4 | 1,958.60 | 2,261.30 | 2,528.30 | 2,802.10 | 3,136.20 | 3,496.20 | 3,853.30 | 4,223.60 | 4,647.90 |
| Total Road Budget | 9.68 | 18.83 | 26.31 | 33.43 | 28.01 | 25.81 | 20.06 | 20.22 | 31.13 |
| Percentage of Total Road Budget to GNP | 0.49% | 0.83% | 1.04% | 1.19% | 0.89% | 0.74% | 0.52% | 0.48% | 0.67% |

Source: DPWH, DBM
Legend:
/1 General Appropriations, including all infrastructure projects of DPWH
/2 Includes all Current Operating Expenditures less Road Maintenance Budget
/3 Capital Investments for Roads and Bridges
/4 GNP for 2002 is a provisional estimate, GNP for 2003 is average official target

The percentage of road investment to the total infrastructure capital budget of DPWH is shown in **Table 3.3.1-2**. The proportion of the total infrastructure investment allocated to road/bridge works reached its highest level in 1998 and exhibits a declining trend in the subsequent years. The low levels in 2000-2002 were characterized by substantial budgetary allocations made to other infrastructure projects identified by congressional representatives. Under the current expenditure program of the DPWH, the proportion of budget allocated to road investment has increased.

Table 3.3.1-2 Percentage of Road/Bridge Budget to Total Infrastructure Program

(Amounts in Billion Pesos)

| Budget Year | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| Total Infrastructure Program | 23.60 | 31.30 | 41.30 | 33.60 | 29.70 | 44.70 | 36.70 | 39.30 | 42.40 |
| Road/Bridge Investment | 6.92 | 15.43 | 22.72 | 29.73 | 24.22 | 21.47 | 15.36 | 15.98 | 25.86 |
| Road/Bridge Investment as Percentage of Total DPWH Infrastructure Budget | 29% | 49% | 55% | 88% | 82% | 48% | 42% | 41% | 61% |

Source: DPWH

### 3.3.2 Trend of Decrease in the Road Budget

As seen in **Table 3.3.1-2**, the road budget has decreased from 1999, but slightly recovered in the years 2002 and 2003.

In terms of percentage to the GNP, the budget of the entire government generally decreased from the 1998 nominal level but shows some signs of stability. Compared with fiscal year's budget. The historical record of government budget in relation to GNP is presented in **Table 3.3.2-1.**

Table 3.3.2-1 Government Budget as a Percentage of GNP

(Amount in Billion Pesos)

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| National Government | 387.4 | 394.9 | 433.8 | 546.7 | 585.1 | 665.1 | 665.1 | 575.1 | 609.614 |
| GNP | 1958.6 | 2261.3 | 2528.3 | 2802.1 | 3136.2 | 3496.9 | 3853.3 | 4223.6 | 4647.9 |
| Percentage to GNP | 19.8% | 17.5% | 17.2% | 19.5% | 18.7% | 19.0% | 17.3% | 13.6% | 13.1% |

Source: DBM, NEDA

The decrease in the road budget is can be attributed to the following factors;

- Apportionment to other priority thrust of the government,
- Increase in IRA, and
- Increase in the debt services.

### 3.3.3 Sources of Funds for Road/Bridge Investments and Maintenance

#### (a) Foreign and Local Sources

Funds for the construction of roads are derived from foreign and local sources. **Table 3.3.3-1** summarizes the amounts allocated for road projects since 1995. For the last five years, more than 50% of the total investments for roads were accounted for by foreign assistance.

Table 3.3.3-1 Sources of DPWH Road Funds

(Amounts in Billion Pesos)

| Sources | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| TOTAL DPWH ANNUAL APPROPRIATONS | 15.93 | 40.37 | 53.82 | 61.82 | 37.72 | 52.37 | 52.37 | 47.99 | 52.95 |
| Road/Bridge Investment (Amounts in Billion Pesos) | 6.44 | 15.43 | 22.72 | 29.73 | 24.22 | 21.47 | 4.24 | 15.98 | 25.86 |
| Foreign-Assistance | 1.13 | 8.37 | 8.41 | 11.80 | 12.63 | 12.22 | 9.76 | 10.05 | 14.57 |
| Locally Funds | 5.31 | 7.06 | 14.31 | 17.93 | 11.59 | 9.25 | 5.60 | 5.93 | 11.29 |
| Road/Bridge Investment (Percentage Distribution) | | | | | | | | | |
| Foreign Assistance | 18% | 54% | 37% | 40% | 52% | 57% | 64% | 63% | 56% |
| Local Funds | 82% | 46% | 63% | 60% | 48% | 43% | 36% | 37% | 44% |

Source: GAA

The sources of foreign assistance for the last six years are summarized in **Table 3.3.3-2**. Over the same period, JBIC provided the largest amount of foreign financial assistance to the DPWH's Road Investment Program.

Table 3.3.3-2 Sources of Foreign Assistance

(Amounts in Billion Pesos)

| Sources | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | TOTAL | PERCENTAGE |
|---|---|---|---|---|---|---|---|---|
| JBIC | 5.0 | 5.6 | 7.7 | 8.2 | 6.7 | 3.8 | 37.0 | 58% |
| IBRD | 1.5 | 1.4 | 1.5 | 1.1 | 2.2 | 2.9 | 10.6 | 17% |
| ADB | 1.2 | 0.8 | 1.6 | 2.7 | 3.5 | 2.4 | 12.2 | 19% |
| Others | 0.7 | 0.5 | 1.0 | 0.6 | 0.1 | 0.6 | 3.5 | 6% |
| Total Foreign Assistance | 8.3 | 8.4 | 11.8 | 12.6 | 12.5 | 9.8 | 63.4 | 100% |

Source: DPWH

### (b) Congressional Initiative Funds

Included in the budget of the DPWH are funds for the implementation of various infrastructure projects (commonly referred to as "Congressional Initiatives") , covering mostly local roads identified by Congressional Representatives. The amount has fluctuated over the past years, reaching the highest nominal allocation of about PhP 19 Billion in 1997. In terms of the percentage to the total infrastructure program of the DPWH, allocation amounts to PhP 11 Billion, representing about 25% of the total infrastructure program of the DPWH. The historical record of allocations for congressional initiatives is seen in **Table 3.3.3-3**. By comparing with **Table 3.3.3-2** it is seen that the amount of the Congressional Initiative is in the same order of digits with the foreign assistance.

Table 3.3.3-3 Congressional Initiatives

(Amounts in Billion Pesos)

| Budget Item | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|
| Various Infrastructure Projects | 1.44 | 12.73 | 18.72 | 61.82 | 0.61 | 15.00 | 6.74 | 18.32 | 10.81 |
| Total Infrastructure Program | 23.6 | 31.3 | 22.72 | 41.3 | 29.7 | 44.7 | 36.7 | 39.3 | 42.4 |
| Percentage of Total Infrastructure Program | 6% | 41% | 63% | 45% | 2% | 34% | 18% | 47% | 25% |

Source: DPWH

### (c) Road/Bridge Maintenance Funds

**Table 3.3.3-4** shows the historical maintenance budget fund for the maintenance of national roads and bridges which is sourced from the general fund pursuant to the yearly enacted General Appropriations Act.

Table 3.3.3-4 Historical Maintenance Budget

| Year | Basic Cost (pesos) | Total EMK | Maintenance Budget at Current Price (million pesos) | Def/ Inflatro (1996-100) | Basic Cost At 1996 Constant Price (pesos) | Maintenance Budget at 1996 Constant Price (million pesos) |
|---|---|---|---|---|---|---|
| 1987 | 14,475 | 55,220 | 814.222 | 2.418 | 35,653 | 1,986.674 |
| 1988 | 17,104 | 50,635 | 866.077 | 2.281 | 39,014 | 1,975.521 |
| 1989 | 17,104 | 40,364 | 864.840 | 2.003 | 34,772 | 1,758.199 |
| 1990 | 20,500 | 49,881 | 1,022.585 | 1.781 | 36'511 | 1,820.855 |
| 1991 | 20,500 | 49,802 | 1,020.952 | 1.501 | 30,771 | 1,532.099 |
| 1992 | 28,049 | 49,401 | 1,385.464 | 1.377 | 38,623 | 1,908.610 |
| 1993 | 31,517 | 51,394 | 1,661.377 | 1.280 | 40,342 | 2,126.699 |
| 1994 | 33,500 | 51,613 | 1,767.464 | 1.174 | 39,329 | 2,074.928 |
| 1995 | 62,463 | 51,828 | 3,237.316 | 1.086 | 67,835 | 3,516.341 |
| 1996 | 63,351 | 53,585 | 3,399.183 | 1.00 | 63,351 | 3,399.183 |
| 1997 | 66,835 | 53,636 | 3,586.099 | 0.94 | 62,825 | 3,383.112 |
| 1998 | 70,511 | 52,417 | 3,695.994 | 0.86 | 60,369 | 3,289.421 |
| 1999 | 70,511 | 53,703 | 3,786.652 | 0.81 | 57,114 | 3,067.188 |
| 2000 | 75,447 | 54,418 | 4,105.667 | 0.77 | 58,094 | 3,161.363 |
| 2001 | 75,226 | 54,418 | 4,093.667 | 0.73 | 54,915 | 2,988.377 |
| 2002* | 70,798 | 57,824 | 4,080.371 | 0.71 | 50,266 | 2,897.063 |
| 2003 | 82,799<br>(15,000[1])<br>(67,799[2]) | 56,157 | 4,649.743<br>(842,355[1])<br>(3,807,388[2]) | | | |

*: Re-enacted amount from year 2001
1: Amount allocated from General Fund 2: Amount allocated from Special Fund
Source : Bureau of Maintenance, DPWH

An attempt was made to negotiate with the Department of Budget and Management (DBM) to update the basic EMK cost (refer to **Section 3.5**) annually, considering the increase in the cost of labor, materials and equipment. However, the DBM started imposing budgetary ceilings prior to budget preparation since 1999, hence, the shaded portion of the process in **Figure 3.3.3-1** is not currently practiced.

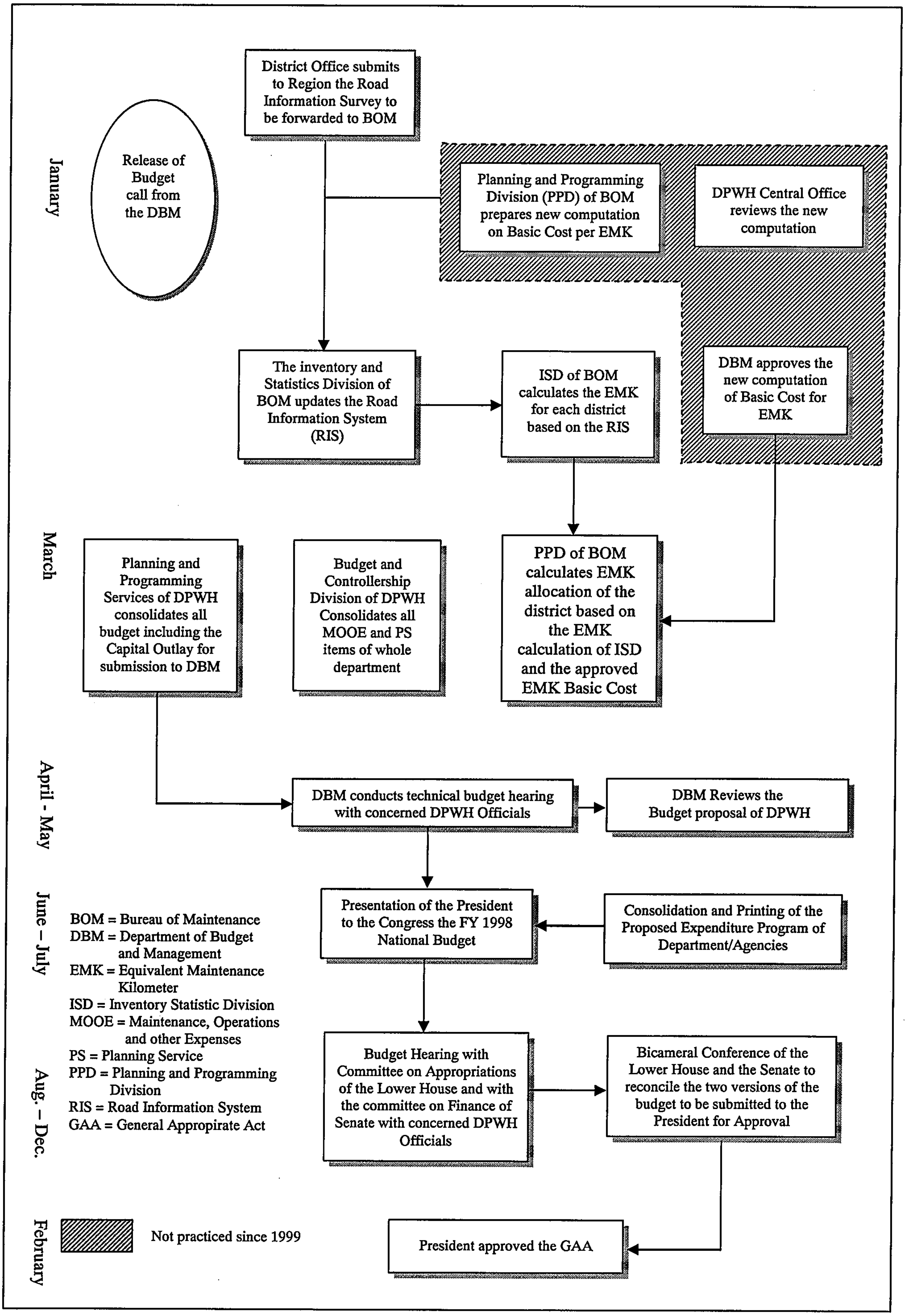


Figure 3.3.3-1 Progress in Determining the Maintenance Budget

## 3.4 BRIDGE DESIGN CRITERIA AND STANDARDS

### 3.4.1 Chronology of Design Criteria

Bridge design practice in the Philippines adopts the AASHTO Design Guidelines as its basic core of design code from the early design of bridges to the present practice. Thus, by studying the chronology of the AASHTO Design Guidelines, it links to knowing the design code used for the bridge at the time of design. In this study, the lack of technical information for a particular bridge is a compensated by presumption of structural design considering the governing codes at the time of design, as-built drawings and inspection results.

**Tables 3.4.1-1** and **3.4.1-2** show the chronology of AASHTO Code regarding the seismic design code and general specifications, respectively.

However, before the AASHTO 1961 edition, there is no mention of seismic design. The seismic design for the bridges constructed before 1961 such as Quezon Bridge, Jones Bridge, Mc Arthur Bridge, Ayala Bridge and Rosario Bridge was carried out by using seismic force coefficient.

Table 3.4.1-1 Chronology of Seismic Load Specification in AASHTO

| AASHTO SPECS | DESIGN POLICY | LATERAL FORCES | FORCE COEFFICIENT | MEMBER DESIGN | MATERIAL |
|---|---|---|---|---|---|
| 1961 | Provision for lateral forces under earthquake is considered using an equivalent static lateral force | Equivalent Static Force using Seismic Force Coefficient $F_{EQ} = K_h W$ (W = Structure Weight) | Kh : 0.02 for hard soil<br>: 0.04 for soft soil<br>: 0.06 on piles | Service Load Design | 33 1/3% Increase of basic allowable stresses |
| 1965 | Same as above | Same as above | Same as above | Same as above | Same as above |
| 1977 | Response to earthquake should consider:<br>(a) site distance to fault<br>(b) soil seismic response<br>(c) structure dynamic characteristic | Equivalent Static Force Method $F_{EQ} = C F W$ (W = Structure Weight) | CF > 0.10 For bedrock accel., A> 0.30g<br>CF (MAX) = 0.18 (at A = 0.4g) | Service Load Design or Load Factor Design | 33 1/3% Increase of basic allowable stresses for Service Load Design |
| 1992 | (1) Small to moderate earthquake resisted within elastic range<br>(2) Realistic ground motion intensities and forces are used<br>(3) No collapse on large earthquake, damages can be repaired. | (1) Elastic forces and displacements determined by single or multimode spectral analysis using response spectrum<br>(2) Design forces obtained by combining orthogonal forces and using Response Modification Factor | For short periods (T<0.5sec) and A = 0.4g<br>Kh = 0.333 (R = 3)<br>= 0.20 (R = 5) | Service Load Design or Load Factor Design with Factor = 1 Substructure and Superstructure use column capacity for design | 50% Increase for Steel and 33 1/3% for Concrete under Service Load Design<br>Ultimate Strength For Load Factor and Capacity Design |
| 1995 | Same as above | Same as above | Same as above | Same as above | Same as above |
| 1998 | Same as above | Same as above | Same as above | Load and Resistance Factor Design (LRFD) | Structural components are proportioned to satisfy the service, fatigue, strength and extreme event linit states |

## Table 3.4.1-2 Chronology of General Specifications in AASHTO

| AASHTO | Design Truck. Max. | REINFORCED CONCRETE | | | | PRESTRESSED CONCRETE | | | | STEEL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Concrete | | Reinforcement | | Concrete | | Prestress Strands | | I-Beam | Plate Girder | Yield |
| | | fc (N/mm2) | f'c (N/mm2) | fs (N/mm2) | fy (N/mm2) | fc (N/mm2) | f'c (N/mm2) | fs (N/mm2) | fu (N/mm2) | fs (N/mm2) | fs (N/mm2) | fy (N/mm2) |
| 1918 | | - | - | - | - | - | - | - | - | 110.5 | - | - |
| 1926 | | - | - | - | - | - | - | - | - | 110.5 | - | - |
| 1931 | | 5.52 | 13.8 | 110.5 | - | - | - | - | - | 100.5LL<br>165.7DL | - | - |
| 1935 | 13.6 – 18 Ton Truck Train | 6.22 | 15.6 | 110.5 | - | - | - | - | - | 124.3 | - | - |
| 1941 | 13.6 – 18 Ton Truck Train | 6.91 | 17.2 | 124.3 | - | - | - | - | - | 124.3 | - | - |
| 1944 | 32 Ton Semi-Trailer | 6.91 | 17.2 | 138.1 | - | - | - | - | - | 124.3<br>165.7<br>207.2 | - | - |
| 1949 | 32 Ton Semi-Trailer | - | - | - | - | - | - | - | - | 124.3<br>165.6<br>186.5 | - | - |
| 1953 | 32 Ton Semi-Trailer | 8.29 | 21 | 138.1 | - | - | - | - | - | 124.3<br>165.6<br>186.5 | 124.3<br>165.6<br>186.5 | - |
| 1957 | 32 Ton Semi-Trailer | 8.29 | 21 | 138.1 | - | - | - | - | - | 124.3<br>165.6<br>186.5 | 124.3<br>165.6<br>186.5 | - |
| 1959 | 32 Ton Semi-Trailer | 8.29 | 21 | 138.1 | - | - | - | - | - | - | - | - |
| 1961 | 32 Ton Semi-Trailer | 8.29 | 21 | 124.3<br>138.1 | Structural<br>Intermediate | 13.8 | 34.5 | 1035 | 1725 | 124.3<br>186.5 | 152<br>166<br>186 | 290<br>317<br>345 |
| 1965 | 32 Ton Semi-Trailer | 8.29 | 21 | 124.3<br>138.1 | 228<br>276<br>345 | 13.8 | 34.5 | 1035 | 1725 | 138.1<br>186.5 | 124.3<br>151.9<br>186.5 | 228<br>259<br>345 |
| 1969 | 32 Ton Semi-Trailer | 8.29 | 21 | - | - | 13.8 | 34.5 | 1035 | 1725 | - | 151.9<br>186.5<br>379.8 | 290<br>310<br>345 |
| 1973 | 32 Ton Semi-Trailer | 8.29 | 21 | 165.8 | - | - | - | - | - | - | 138.1<br>151.9<br>186.5 | - |
| 1977 | 32 Ton Semi-Trailer | 12.43 | 31 | 137.9<br>165.5 | 276<br>414 | 13.8 | 34.5 | 1035 | 1725 | 138.1<br>186.5<br>379.8 | 138<br>186<br>317 | 248<br>345<br>620 |
| 1983 | 32 Ton Semi-Trailer | 12.43 | 31 | 137.9<br>165.5 | 276<br>414 | - | - | - | - | - | 138.1<br>186.5 | - |
| 1992 | 32 Ton Semi-Trailer | 11.05 | 28 | 137.9<br>165.5 | 276<br>414 | 13.8 | 34.5 | 1035 | 1725 | 138.1<br>186.5<br>262.4 | 138.1<br>262.4<br>379.8 | 248<br>345<br>483 |
| 1996 | 32 Ton Semi-Trailer | 11.05 | 28 | 137.9<br>165.5 | 276<br>414 | 16.4 | 41 | 1300 | 1860 | 138.1<br>186.5<br>262.4 | 138.1<br>262.4<br>379.8 | 248<br>345<br>483 |
| 1998 to Present | 32 Ton Semi-Trailer with Option to Increase by 25% | 11.05 | 28 | 137.9<br>165.5 | 276<br>420<br>520 | 16.4 | 41 | 1300 | 1860 | LFRD | LFRD | 250<br>345<br>485<br>620 |

The 1971 San Fernando earthquake was a major turning point in the development of seismic design criteria for bridges in the United States. Prior to 1971, the AASHTO specifications for seismic design of bridges were based in part on the lateral force requirements for building developed by the Structural Engineers Association of California. In 1973 the California Department of Transportation introduced the new seismic design criteria for bridges, which includes the relationship of site to active faults, the seismic response of soil at the site and the dynamic response characteristics of the bridge. In 1975, AASHTO adopted the Interim Specifications which were slightly modified version of the 1973 CalTrans provisions, and made them applicable to all regions of the United States. In addition to these code changes the 1971 San Fernando Earthquake stimulated research on seismic related to bridges.

### 3.4.2 Design Criteria and Standards for Bridge Design

The design criteria and standards established in this section will be used for strengthening design and construction design. As far as rehabilitation design is concerned, the latest design requirements shall follow the latest design criteria and standards.

#### (1) Units

The SI Unit System shall apply.

Angles shall be given in the 360 degree system for structural works.

The co-ordinate system used shall be the Philippine Transverse Mercator (PTM) Co-ordinate System.

All levels shall refer to Mean Sea Level, Philippine Coast and Geodetic Survey System.

#### (2) Codes and Standards

(a) Principal

- AASHTO Standard Specification for Highway Bridges, 17th Edition, 2002; including Division 1A, Seismic Design.
- DPWH Design Guidelines, Criteria and Standards for Public Works and Highways, Volume II, Bureau of Design, DPWH.
- National Structural Code of the Philippines; Volume II, Bridges, 2nd Edition, 1997.

(b) Specials and Supplementary

- Specifications for highway Bridges, Part IV, Japan Road Association 1994.

- Department orders of DPWH.

(c) Other References

- Bridge Engineering, Design, Rehabilitation, and Maintenance of Modern Highway Bridges, by Demetrios E. Tonias, P.E.

- Seismic Design and Retrofit of Bridges, 1996 by M.J.N. Priestley, F. Seible and G.M. Calvi.

### (3) Clearances and Deflection Criteria

#### (a) Vertical Clearance to RHT/DFL

The navigational clearance between the Recorded Highest Tide (RHT, 12.1m) or the Design Flood Level (DFL) and the girder of the superstructure shall not be less than 3.75 meters.

#### (b) Vertical Deflection

The vertical deflection due to service live load plus impact shall not exceed 1/800 of the span for members having simple and continuous spans. Uncracked concrete section properties shall be used in calculating vertical deflection.

#### (c) Horizontal Displacement

The maximum design horizontal displacement of abutments due to design earthquake load shall in generally be 100mm longitudinal and transversely otherwise specified. Concrete Section properties shall be used in calculating horizontal deflection.

### (4) Loads and Forces

#### (a) General

The following loads and forces shall be considered in the design of the substructures. Worst case loading will be analyzed to determine the maximum forces.

| | | |
|---|---|---|
| DL | = | Dead Load |
| LL | = | Live Load |
| I | = | Impact |
| $(LL + I)_n$ | = | AASHTO Truck/Lane/Military Loading including sidewalk LL w/o impact |
| $(LL + I)_p$ | = | Permit Live Load plus impact including sidewalk LL w/o impact |
| EQ | = | Earthquake or Seismic Load |
| SF | = | Stream Flow Pressure |

### (b) Permanent Loads

**Dead Load**

The Dead Load shall consist of the weight of the entire structure, including the roadway, sidewalks, car tracks, pipes, conduits, cables, and other public utility services. The table below gives the unit weights of materials used in the design.

| Materials | Unit Weight (KN/m³) |
|---|---|
| Reinforced Concrete | 24.5 |
| Asphalt Wearing Coarse | 22.0 |
| Steel | 77.0 |
| Earth, Compacted | 19.0 |
| Loose soil | 16.0 |
| Others | As indicated |

**Superimposed Dead Load**

A superimposed dead load of 1.10 kN/m$^2$ shall be applied to the entire roadway surface on the bridge deck to account for the future application of deck surfacing as part of a maintenance program. The superimposed dead load shall only be applied if it creates an adverse effect for the element under consideration.

**Earth Pressures**

Seat type abutments shall be designated for horizontal earth pressure assuming:

Soil friction angle Ø = 30 deg.

Wall to soil friction angle d = 0 deg.

The Mononobe-Okabe method of analysis shall be used for computing lateral active soil pressures during seismic loading for seat type abutments. Wingwalls to abutments shall be designed to carry maximum active pressure for seat type abutment from the retained fill.

### (c) Highway Load

**Highway Live Load**

The highway live loading on the roadway of bridges shall be AASHTO MS-18 as shown in **Figure 3.4.2-1.**

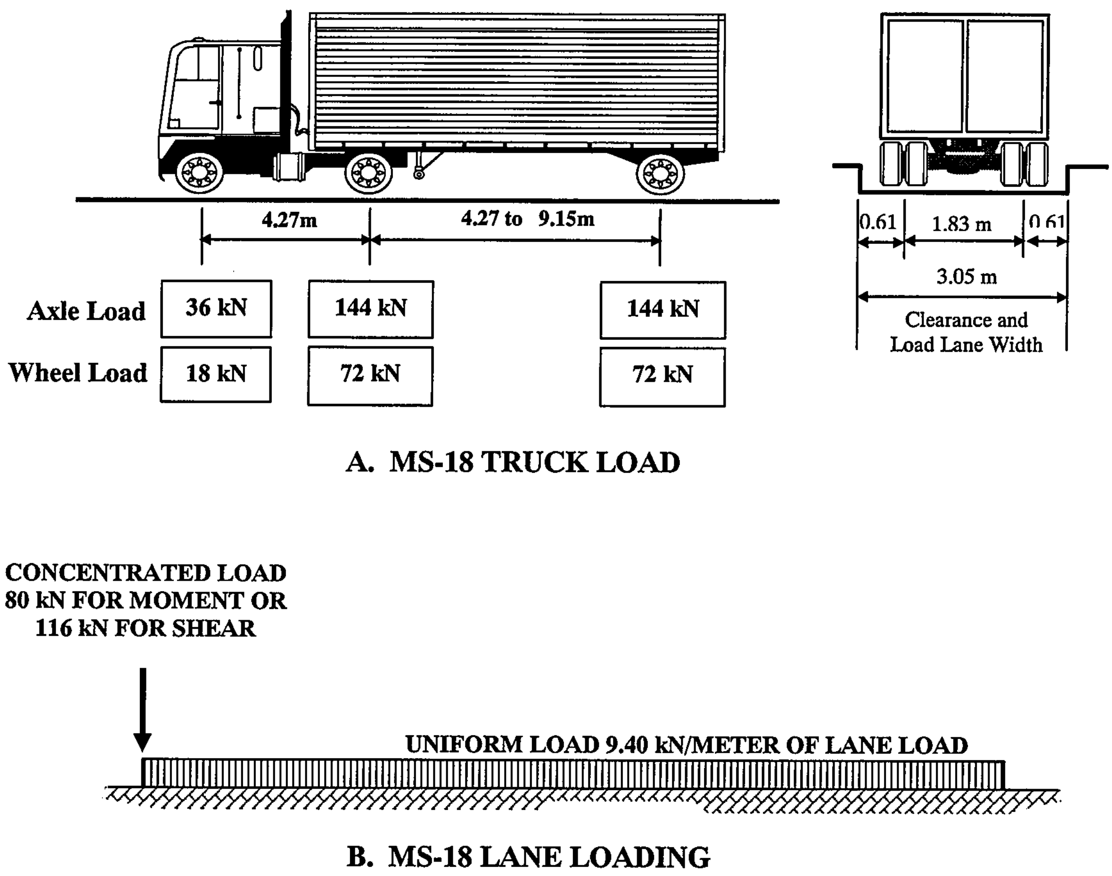


Figure 3.4.2-1 AASHTO Live Load

## Live Load Impact (I)

Live load stresses produced by MS loadings shall be increased by an allowance stated below for dynamic, vibratory and impact effects.

Impact shall be applied to:

- Superstructure, including steel or concrete supporting columns, steel towers, legs of rigid frames and generally those portions of the structures which extend down to the main foundation.

- The portion above the ground line of concrete or steel piles which are very rigidly connected to the superstructure as in rigid frames or continuous design.

The amount of impact expressed as a fraction of live load shall be:

$$I = 15.24 / L + 38$$

where L : span in meters

## Sidewalk

Sidewalk loading shall be 4.07 kN/m$^2$ applied to the full sidewalk area of the bridge deck span for bridge spans up to 40m.

For bridge span over 40m, sidewalk loading shall be 2.50 kN/m$^2$.

The highway design load on the railing, P, shall be 45 kN.

**Stream flow Load**

The effect of flowing water on piers shall be calculated by the formula:

$$P = 515\ KV^2$$

Where :

P = pressure in Pa from the flowing water
V = velocity of water in m/sec
K = 2/3 for circular piers

The velocity of water at a particular bridge will be determined from hydraulic analysis.

**Environmental Loads**

The effects of temperature and wind shall not be considered for short to medium span structures. For long span bridges or special structures due account shall be taken of temperature and wind loads if these create critical effects.

**(d) Seismic Force**

The seismic design procedure for the proposed bridge structures shall be discussed in the following items:

**Preliminary Design**

Preliminary design for member sizes will be done after establishing the span lengths and column heights.

**Seismic Coefficient**

A seismic coefficient of 0.4g will be used as a zone factor. (Refer to **Figure 3.4.2-2**).

**Importance Classification**

The proposed bridge falls under classification I since the structure is classified as essential bridge.

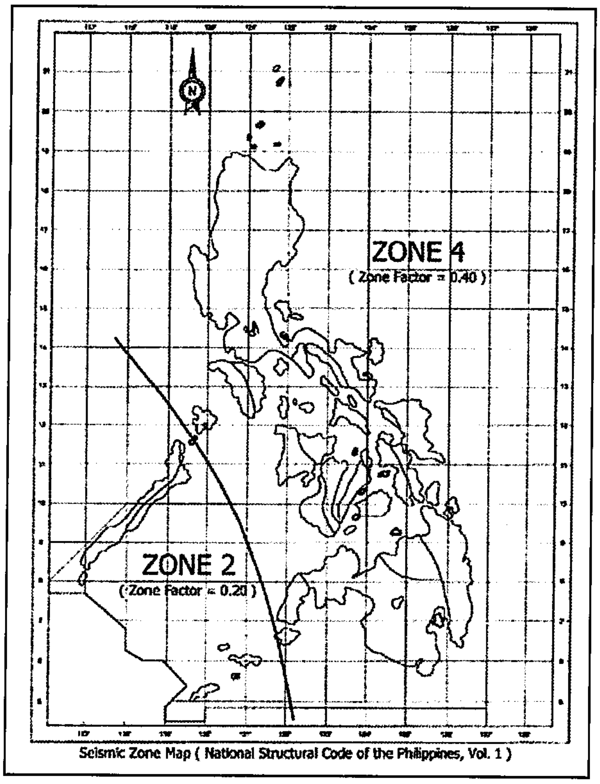


Figure 3.4.2-2 Philippine Seismic Zoning Map

## Seismic Performance Category

The structure falls under category D for it is an essential bridge and with a minimum acceleration coefficient A=0.4.

## Site Coefficient

A site coefficient S will be selected based on the soil profile type as shown in **Figure 3.4.2-3**. In the course of this study, Soil Type 2 is taken as the prevailing soil condition within Metro Manila.

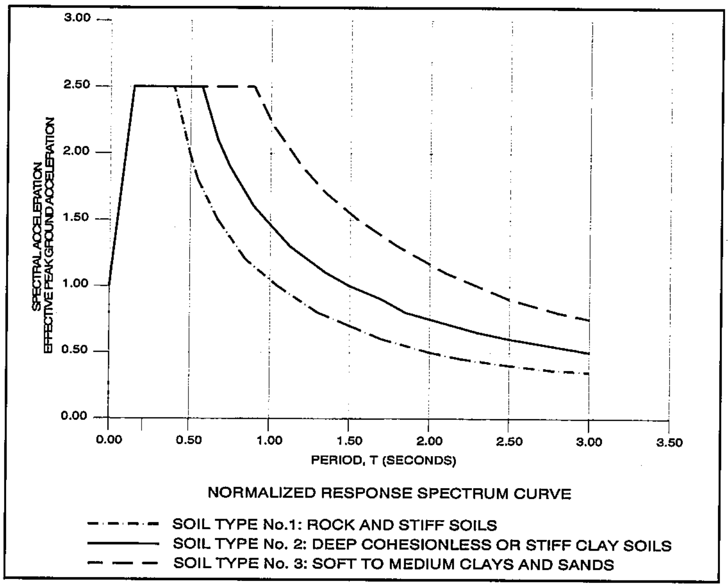


Figure 3.4.2-3 Response Spectrum for Three Soil Type

## Response Modification Factor

Seismic design forces for individual members and connections of bridges are determined by dividing the elastic forces by the appropriate Response Modification Factor (R). For multiple column bent pier, R=5, and for single column, R=3.

## Analysis Procedure

Multimode Spectral Method will be used in the analysis of the existing and proposed bridge. A general purpose finite element software will be used for this analysis.

## Abutment and Retaining Wall Design Forces

The components connecting the superstructure to an abutment (e.g., bearings, shear, keys, etc.) shall be designed to resist the forces specified in Art. 7.2.1 of AASHTO DIV 1A.

For retaining walls/rigid frame walls that may displace horizontally, the pseudo static Mononobe-Okabe Method of analysis is recommended for computing the lateral active soil pressures during seismic loading.

## Free Standing Abutments

For free standing abutments or retaining walls which may displace horizontally without significant restraint (e.g., Superstructure supported by sliding bearings), the pseudo-static Mononobe-Okabe method of analysis is recommended for computing lateral active soil pressures during seismic loading. A seismic coefficient equal to one-half the acceleration coefficient ($k_h = A/2$) is recommended. Abutment displacements up to 250 A (mm) may be expected.

### (5) Material Properties

#### (a) Concrete

Specified compressive strength of reinforced concrete for new structures shall be:

fc' = 21 Mpa (3000psi) Superstructure
fc' = 41 Mpa (6000psi) Prestressed Concrete
fc' = 28 Mpa (4000psi) Substructure

Concrete strength for existing bridges shall be taken from the as-built drawings or the results of field and laboratory tests of samples taken from the structure.

#### (b) Reinforcing Steel

Reinforcing steel for new structures shall conform to AASHTO M31 (ASTM A615), and shall be deformed bars.

Reinforcement shall be Grade 60, 414 Mpa (60,000 psi).

The strength and classification of steel reinforcement of existing bridges shall be based on as-built drawings or taken from field and laboratory tests.

#### (c) Structural Steel

Structural steel for new structures shall conform to the following:

- Steel plates and rolled shapes AASHTO M270 (ASTM A36)
- Bolts AASHTO M164 (ASTM A325)
- Welds AWS D1.1 – 183, E70XX Series
- Mechanical property of steel material for superstructure

Field tests shall be conducted to determine the actual strength of structural steel for existing structures.

#### (d) Elastometric Bearings Pad

Electrometric bearing pads for new structures shall be 100% virgin chloroprene (neoprene) pads with durometer hardness 60 and shall be laminated with mild steel sheets.

Bearing supports for existing structures shall be verified on site.

### (e) Geotechnical Criteria

When seismic load effects have been derived from single mode or multimode spectral analysis, the design of the footing shall make reference to the loads and ultimate bearing capacities as provided in the Strength Design Method.

When seismic load effects have been derived from the Mononobe-Okabe method of analysis, the design of the footing shall make reference to the service and factored bearing capacities provided in the Service Load Design Method.

Factors of Safety (Service Load Design Method

| Stability of Foundations | | Group-I Loading | Group-VII Loading |
|---|---|---|---|
| Pile Foundations | Bearing Capacity | 3 | 2 |
| | Pull-Out Capacity | 6 | 3 |

## (6) Analysis Methodology

### (a) General

Structural analysis shall be performed using accepted software with 3D beam models.

The effects of support and structure stiffness provided by the abutments in resisting horizontal (earthquake) effects, shall be considered in the analysis.

### (b) Pile Group Analysis

The analysis of pile groups shall follow the recommendations given in Articles 9.7 of Specification for highway bridges, Part IV, Japan on Road Association.

## (7) Design Methodology

### (a) Superstructure

Design of Concrete and steel shall be by Load Factor Design and Working Stress Design Method respectively.

### (b) Substructure

Design of Substructure shall be by Load Factor Design.

- Superimposed Dead Load: This refers to the dead load applied to the structure other than its own weight.
- Live Load: This refers to the AASHTO design trucks, military loading or lane loads that is equivalent to truck trains which represents the worst case loading condition.
- The ultimate moment capacity is checked by Load Factor Design using ultimate strength theory for loads at the factored level.
- Shear design is based on strength using ultimate strength theory for loads at the factored level.

### 3.4.3 Aesthetic Design

Aesthetic Design basically refers to the aesthetic appearance of the bridge. The use of patterns, colors, textures or relief can make a bridge appearance more attractive and compatible with local surroundings.

In this study, it is customary that the aesthetic aspects of existing bridges be given importance. Several bridges built during the period 1940-1960 were considered as part of National History as declared by the National Historical Institute. Jones Bridge, Quezon Bridge and McArthur Bridge fall in this category. These bridges were declared as part of National History and thereby being protected as to the change of its configuration as far as the rehabilitation and strengthening of the above-mentioned bridges are concerned.

#### (1) Aesthetic Design Process

The process in aesthetic design is anchored on two (2) basic principles:

**(b) The Corridor Type**

This is the basic unit in aesthetic design and can be clearly seen when all the parts of the bridge fit and are compatible with their surroundings.

**(c) Interdisciplinary Teams**

Through the effort of a number of disciplines from which area of expertise contributes to the overall quality and character of the finished project.

From the above stand-point, the design generally would possess these characteristics:

① Structural Permanency

The aesthetic appearance of the bridge shall be increased by its long-standing use.

② Distinctive Urban Quality

The major reconstructions or rehabilitations have varying degrees of potential to change the appearance of structure and the opportunity for aesthetic improvement. The appropriate use of patterns, colors, texture, relief and pleasing properties results to an attractive bridge and its sophisticated shape makes the residents to be proud of, as a common property.

③ Harmony with Urban Environment

Travelers see the corridor which is the basic unit in aesthetic design, the highway in its setting, before they see the parts such as bridge, lights and landscape features. Thus the structure should harmonize with the natural environment, as well as historical and cultural background.

**(2) Basic Techniques Used in Aesthetic Design**

**(a) Evaluation of aesthetic aspects through the use of the following factors:**

① Functionality

Rationality in terms of geometrical alignment and traffic function

② Engineering Characteristics

Influence on the surrounding area.

③ Design Scenery and Permanency

Shapes and sizes of the elements dominate the appearance of a bridge, side slope and vegetation.

④ Project Effectiveness

Construction cost, maintenance cost and lifecycle cost. Safety improvement is and will continue to be a critical goal of the design.

**(b) Identification of Corridor Type**

The goal is to create a unified look within the corridor.

**(c) Consolidation of All Needed Skills**

Interdisciplinary team is needed in this aspect to integrate skills and viewpoints of engineers, landscape architects and artists needed to achieve and improve visual quality. The goal of interdisciplinary team is to ensure that varied points of view and expertise are successfully incorporated into the project.

**(d) Community Involvement and Community Participation**

On highly visible projects the members of the community will be partners in the development process.

The Study Team closely coordinated with the Pasig River Rehabilitation Commission which is composed of multi-sectors delegated by the Office of the President in ensuring that the waterway (Pasig River and Marikina River) is rehabilitated to its historically pristine condition conducive to transport, recreation and tourism.

The study bridges, which are incidentally located within the scope of the PRRC have to be in harmony with the sectoral development plans of the government and non-government agencies. That is, the Environmental Preservation Areas or the 10-meter easement along the Pasig Riverbanks including development of linear parks (as shown in **Photo 3.4.3-1**) which are part of PRRC master plan are taken seriously during the Study.

Photo 3.4.3-1 Linear Park at West Side of Ayala Bridge

The Study Team also sought the advice of the National Historical Institute as to the Historical Importance of several bridges included in the study. As mentioned, Jones Bridge, Quezon Bridge and McArthur Bridge are part of the National History.

Lastly the socio-economic team held meetings (as shown in **Photos 3.4.3-2** and **3.4.3-3**) with the families living under the bridge included in the study.

Photo 3.4.3-2 Consultation Meeting with Barangay Leader at Quezon Bridge

Photo 3.4.3-3 Consultation Meeting with Families Living Under Lambingan Bridge

## 3.5 PRACTICE OF INSPECTION ON BRIDGE CONDITION

The Department of Public Works and Highways (DPWH) is responsible for implementation of infrastructures including highways and bridge projects. The present practice of DPWH on bridge inspection is briefly reviewed hereunder.

### 3.5.1 Highway and Bridge Maintenance Standards

#### (a) Highway Maintenance Management Manual

Highway Maintenance Management Manual was prepared under 4th IBRD Highway Loan by the Ministry of Public Works and Highways, Bureau of Maintenance, in 1983, covering the following major items:

- Planning
- Scheduling
- Directing
- Reporting
- Control

This Manual mainly focuses on the administrative matters with the minimum engineering discussion on bridge inspection method.

#### (b) Inspection and Maintenance Report

Inspection and Maintenance Report was drafted under the Feasibility Study on Rehabilitation and Maintenance of Bridges along Arterial Roads, JICA in 1989.

This Report discusses the systematic process of the inspection and maintenance in consideration with the Philippines bridge feature, design standard and organization of the DPWH etc., encompassing the following discussion.

- Methodology for the utilization of data provided by bridge inspection relating to the computer-used data base.
- Strategy for systematic inspection.
- Techniques for detailed assessment of structures and evaluation of load carrying capacity
- Identification of major preventive and corrective maintenance and rehabilitation work.
- Compilation of ideas and methods used in bridge maintenance and rehabilitation work.
- Recommendation of organization, management and training for bridge inspection and maintenance.

### (c) Pavement Management System / Bridge Management System and Bridge Inspection Manual

Pavement Management System/Bridge Management System and Bridge Inspection Manual were developed to provide a computer based system for the management of national bridges within the Philippines, under ADB in 2002. This project that has the overall objective to improve the quality and delivery of DPWH services in the provision and management of the road system.

The following are the extraction of the Manual:

- **Scope of Manual**

  A Bridge Management System (BMS) has being established within the DPWH to provide a computer based system for the management of Philippine national bridges.

  The BMS relies on the availability of inventory and annual condition information on each bridge to provide reference data, track the deterioration of bridges and hence to enable the management of the national bridge stock. Without accurate and timely data, the BMS cannot fulfill this function.

  The main purpose of the bridge inspection manual is to provide bridge inspectors and other with guidelines and procedure to undertake an effective bridge inspection.

- **Types of Inspection**

  The types of bridge inspection undertaken by the DPWH and its corresponding responsibility are listed in **Table 3.5.1-1.**

  Scheduled bridge inspections are those inspections required to be undertaken on a set frequency (eg. annually) to supply data for DPWH functions. Non-scheduled inspections are those inspections undertaken only when required because of the addition of new national bridges or occurrence of natural calamities.

- **Bridge Master Plan**

  The DPWH bridge master plan is maintained within the DPWH Development Planning Division, Planning Service.

  The procedure for the selection and prioritization of road and bridge project is explained in the DPWH publication Investment Prioritization Criteria as shown in **Table 3.5.1-2.**

## 3.5.2 Organization

The DPWH is established into Central, Regional (16) and Districts (176) with a well developed structure at all levels to undertake all function allocated to the Department.

The bureaus of the DPWH Central Office in-charge of bridge management are;

- Planning Service (PS)
- Bureau of Design (BOD)
- Bureau of Maintenance (BOM)
- Bureau of Research and Standards (BORS)

Table 3.5.1-1 Bridge Inspection Types and Responsibility

| Type | Name | Frequency | Purpose | Responsibility | Reporting |
|---|---|---|---|---|---|
| *Scheduled Bridge Inspections* | | | | | |
| 1 | Routine | Monthly | Scheduling of routine maintenance, check on bridge condition to ensure the safety of bridges | Eng. District Office | Brief report to BOM |
| 2 | Maintenance | Quarterly | QA review of routine maintenance activities and level of service provided by bridges | BOM/Regional Office | Report to BOM |
| 3 | Condition | Annual | To obtain condition data on and major maintenance needs of the bridges for operation of the BMS | Regional Office or Contractor | Report to PS (BMS) |
| 4 | Engineering | As required | To investigate the major maintenance needs of defective bridge identified by a condition or other inspection | Regional Office to arrange appropriate provider | Report to PS (BMS) |
| 5 | Detail | Ten Year | To review the bridges in the light of traffic, load capacity and current requirements | Regional Office to arrange appropriate provider | Report to PS |
| *Non-Scheduled Bridge Inspections* | | | | | |
| 6 | Emergency | As required | To determine emergency work to bridges following calamities, ensure safety of bridges | Eng. District Office | Report to BOM |
| 7 | Inventory | As required | To obtain/update bridge inventory data for the RBIA and the BMS | Regional Office or Contractor | Report to PS (RBIA) |

QA - Quarterly
BMS - Bridge Management System
RBIA - Road and Bridge Information Applications
BOM - Bureau of Maintenance
PS - Planning Service

Table 3.5.1-2 DPWH Publication Investment Prioritization Criteria

| Prioritization Criteria | Indicators | Comment | Score |
|---|---|---|---|
| Status | Completed/on-going<br>Programmed/committed<br>Left over from NEDA list<br>Left over from DWPH list<br>New project with RDC endorsement<br>New proposal w/o RDC endorsement | Gives priority of bridge project in involvement in master plan | 10<br>8<br>6<br>4<br>2<br>0 |
| Condition | Total replacement/reconstruction<br>Major repair/partial replacement<br>Minor repair<br>Routine maintenance | Gives proposed work to the bridge | 2<br>0<br>0<br>0 |
| Road Integrity (Classification) | North-South backbone<br>East-West lateral (existing)<br>East-West lateral (new link)<br>Other roads (agr'l. devt. support road)<br>Other roads (connects primary centers)<br>National secondary road | Gives proposed work to the bridge | 10<br>8<br>6<br>4<br>2<br>0 |
| Development Policy | Provides access to basic services<br>Develop economically/socially depressed areas<br>Support agricultural development<br>Support industrialization | Indication of activity supported by the bridge | Meets 4 areas – 8 points<br>Meets 3 areas – 6 points<br>Meets 2 areas – 4 points<br>Meets 1 areas – 2 points<br>Meets none – 0 points |
| Social Development Support | Within one of the declared 20 depressed or underdeveloped provinces<br>Not within one of these provinces | | 2<br>0 |
| Environmental Aspect | With ECC<br>Without ECC | Environmental Compliance Certificate from DENR<br>Certificate of Exemption (COE) From DENR | 2<br>0 |
| Locational Endowment | 1st Class<br>2nd Class<br>3rd Class<br>4th Class<br>5th Class<br>6th Class | Allows for average income/ head in each municipality based on classification advised by National Statistics Office | 10<br>8<br>6<br>4<br>2<br>0 |

NEDA - National Economic Development Authority
RDC - Regional Development Council
ECC - Environmental Compliance Certification
DENR – Department of Environment and Natural Resources

The Central Office assumes direct control of very large and complex project generally projects with a value in excess of Pesos 30 million, while the Regional and District Offices renders the services to be provided on a local basis.

The Regional Offices oversee the operation of District Offices and assume control of large and complex projects in the region, generally projects with value in excess of Pesos 15 million.

**Table 3.5.2-1** shows the highway data available in DPWH.

Table 3.5.2-1 Highway Data Currently Available in DPWH

| Type of Data | Agency in Charge of Data Storage | Agency in Charge of Data Collection | Frequency of Date Update | Data Utilization |
|---|---|---|---|---|
| Road Straight Line Diagram | BOM | District Office | Annual | General Highway Information |
| Highway Inventory<br>• Roadway Data<br>• Structure Data<br>• Pavement Marking and Road Signs | BOM | District Office | Annual | Computation of EMK |
| Road Condition Data | BOM | BOM Inspectorate Division | Quarterly | Verification of Maintenance Performance |
| Traffic Volume | Planning Service, Traffic Division | Regional/ District Office | Annual | Computation of EMK |

## Road Straight Line Diagram

Highway information is graphically shown on A2 size paper with two parallel straight lines that indicate carriageway of the road. Pavement type is indicated between two parallel lines by hatching, shading, and or dotting, Information indicated in the Road Straight Line Diagram is pavement type, kilometer station, name and location of municipalities and major barangays, name, location and type of bridges and type and location of pipe and box culverts along the road. Road condition and type of topography are not usually indicated.

The Road Straight Line Diagram is most frequently used as a basic data for planning and programming purposes. Data processing using computer is not possible.

## Highway Inventory Data

Highway inventory data is stored in three categories namely, Roadway, Highway Structure (bridge, pipe culvert and box culvert) and Highway Signs and Pavement Markings. Highway information such as location, type and size of road assets are stored in spreadsheet format. The Highway Inventory Data is utilized as a basic information for computing EMK.

**Road Condition Data**

Condition of carriageway, shoulder, vegetation and drainage facility is recorded every kilometer of a road with "Good", "Fair" and "Poor" ratings and stored in spreadsheet format. The data is primarily used for verification of maintenance performance of District offices.

The accuracy of Road Inventory Data and Condition Data should be carefully examined prior to actual use, since both data are primarily used for derivation of EMK and verification of maintenance performance only, and not utilized for planning and programming purposes. For example, a score of "Good" condition in road condition data is remarkably high compared with the actual condition observed.

Establishment of synthesized Highway Database is under process by RIMSS Study.

**(d) Traffic Volume Data**

Traffic count data gathered from the following counting stations are recorded by 7 vehicle types.

| | |
|---|---|
| Seasonal Stations (56 locations) | (Once in every month, 24 hours for one week) |
| Control Stations (115 locations) | (Once in every three month, 24 hours for one week) |
| Coverage Stations (1,222 locations) | (Once in every 5 years, 12 hours for two days) |

Traffic count data is utilized not only for EMK computation but also for numerous purposes in planning, programming and design works.

Establishment of New Traffic Counting System is also under process under RIMSS Study. Introduction of automatic counting system with increase number of counting stations has been proposed.

The BOM is headed by a Director who is assisted by an Assistant Director.

It is composed of five (5) Divisions, namely:

- Planning and Programming Division
- Inspectorate Division
- Inventory and Statistics Division
- Monitoring and Methods Division

The BOM has a complement of 108 technical personnel and 51 non-technical personnel or a total of 159 personnel.

The role of each division is as follows:

**Programming and Planning Division (PPD)**

- Preparation of work program;
- Preparation and review of maintenance budget;
- Evaluation of maintenance methods and performance standards;
- Determine the Basic Cost per unit of EMK, and
- Computation of the EMK allocation for all Districts and sub-Districts.

**Inventory and Statistics Division (ISD)**

- Preparation and updating of the National Road and Bridges Inventory;
- Calculation of EMK for each District, and
- Conduct field inspection to verify conflicting data on Road Inventory Summary (RIS)

**The Inspectorate Division (ID)**

- Conduct field inspection to evaluate and assess the implementation of the maintenance management system of national roads and bridges, and
- Conduct regular inspection to establish the road condition rating of Districts/sub-Districts.

**The Monitoring and Method Division (MMD)**

- Develop and update a reporting system on routine, periodic and special maintenance projects;
- Review and evaluate performance reports for progress and expenditures on maintenance/repair projects as submitted by the Regional Offices, and
- Conduct regular inspection to verify status of accomplishment.

**Figure 3.5.2-1** shows the organizational chart of the BOM responsible for the implementation of the maintenance functions of the DPWH.

The objectives of the BOM has the following objectives:

- To reduce the rate of deterioration of the structure and thus prolong their service life.
- To provide convenient and safe public utilization of the structures.
- To reduce structure utilization costs by providing high standards of serviceability.

**Employment of Monthly/Daily – Waged Personnel Under BOM**

In compliance with the General Appropriations Act of 1999, 70% of the Annual Maintenance Funds was allocated for Maintenance by Contract (MBC), while 30% was allocated for Maintenance by Administration (MBA) to support expenses for labor, materials and equipments.

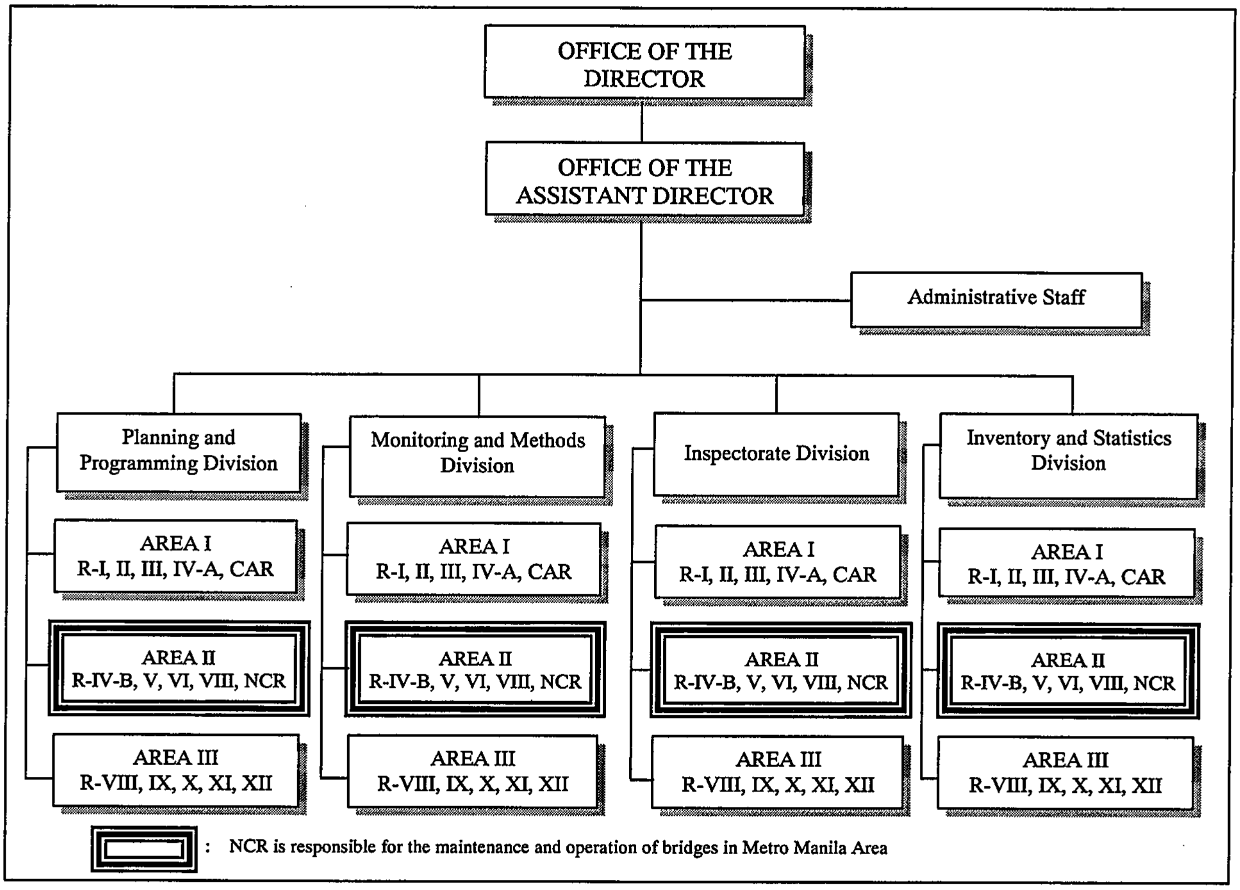


Figure 3.5.2-1 Bureau of Maintenance Organization Chart

**Table 3.5.2-2** shows the Comparison of Planned and Actual Employment of Daily-Waged personnel for Maintenance By Administration of National Roads & Bridges for CY-2002

Table 3.5.2-2 Comparison of Planned and Actual Employment for CY2002

| *REGION* | PLANNED EMPLOYMENT | | ACTUAL EMPLOYMENT | | DIFFERENCE (PLANNED-ACTUAL) | |
|---|---|---|---|---|---|---|
| | NO. OF PERSONNEL | MANDAYS | NO. OF PERSONNEL | MANDAYS | NO. OF PERSONNEL | MANDAYS |
| | A | B | C | D | E=C-A | F=D-B |
| NCR | 181 | 41,255 | 323 | 78,671 | 142 | 37,416 |
| CAR | 397 | 91,308 | 418 | 106,275 | 21 | 14,967 |
| I | 175 | 36,112 | 204 | 50,348 | 29 | 14,236 |
| II | 230 | 53,515 | 267 | 65,134 | 37 | 11,619 |
| III | 226 | 48,457 | 220 | 47,591 | -6 | -866 |
| IV-A | 446 | 98,630 | 408 | 101,015 | -38 | 2,385 |
| IV-B | 256 | 59,950 | 304 | 74,635 | 48 | 14,685 |
| V | 361 | 87,923 | 520 | 132,467 | 159 | 44,544 |
| VI | 699 | 149,361 | 831 | 192,833 | 132 | 43,472 |
| VII | 341 | 76,507 | 347 | 82,872 | 6 | 6,365 |
| VIII | 382 | 89,781 | 731 | 166,604 | 349 | 76,823 |
| IX | 265 | 58,951 | 401 | 92,306 | 136 | 33,355 |
| X | 334 | 71,389 | 387 | 87,378 | 53 | 15,989 |
| XI | 255 | 57,792 | 402 | 95,771 | 147 | 37,979 |
| XII | 264 | 58,898 | 315 | 77,423 | 51 | 18,525 |
| XIII | 352 | 76,768 | 649 | 135,861 | 297 | 59,093 |
| *TOTAL* | 5,164 | 1,156,597 | 6,727 | 1,587,184 | 1,563 | 430,587 |

### 3.5.3 Road and Bridge Funding

All bridge projects on national roads are implemented using foreign assistance, while all locally funded bridge projects are located on local roads. The DPWH prepares an Annual Infrastructure Program (AIP) as part of the budget process for each financial year.

Funding for bridges on National roads is allocated in the AIP by several methods:

- Routine and periodic maintenance to be funded through the EMK system.

  This funding is based on a fixed allocation to each district based on the equivalent length of national roads and bridges in the district.

- Local funding for capital projects including both major maintenance and new projects. All projects are ranked according to standard procedures that favor new projects.

- Bilateral and multilateral funded projects.

These projects generally cover upgrading of a particular road link including bridges. The project includes bridge maintenance and/or replacement based on feasibility studies undertaken as part of the projects. These projects may be grant or loan projects with a local contribution.

**Road/Bridge Maintenance Budget**

Maintenance budget for the roads and bridges is summarized in **Table 3.5.3-1.** The maintenance budget is classified into the following activities:

- Maintenance by administration
  - Philippine Maintenance Management System (PHMMS)

- Maintenance by contract
  - MBC program
  - PHMMS

- Intermediate response fund

- Central office retention

The road/bridge maintenance budget has been gradually increased because of the labor and material cost inflation, but has not covered enough.

Table 3.5.3-1 Maintenance Budget Allocation for Roads and Bridges by Year

Unit: P'000

| Activity | | 1999 | 2000 | 2001 | 2002 | 2001/1999 |
|---|---|---|---|---|---|---|
| 1 | Maintenance by Administration | | | | | |
| | 1.1 PHHMS | | | | | |
| | 1.1.1 Routine Maintenance | 1,001,469 | 1,035,990 | 1,085,905 | 1,109,650 | 1.108 |
| | 1.1.2 Periodic/Special | 0 | 43,402 | 34,833 | 131,824 | - |
| | Sub-Total | 1,001,469 | 1,079,392 | 1,120,738 | 1,241,474 | 1.240 |
| 2 | Maintenance by Contract | | | | | |
| | 2.1 MBC Program | | | | | |
| | 2.1.1 Routine Maintenance | 972,716 | 956,359 | 1,136,257 | 922,776 | 0.949 |
| | 2.1.2 Periodic/Special | 730,334 | 861,205 | 682,570 | 830,886 | 1.138 |
| | 2.2 PHMMS | | | | | |
| | 2.2.1 Periodic/Special | 772,491 | 780,203 | 744,734 | 677,198 | 0.877 |
| | Sub-Total | 2,475,541 | 2,597,767 | 2,563,561 | 2,430,860 | 0.982 |
| 3 | Immediate Response Fund | 189,333 | 204,683 | 204,683 | 204,019 | 1.078 |
| 4 | Central Office Retention | 120,309 | 201,280 | 204,684 | 204,018 | 1.696 |
| Grand Total | | 3,786,652 | 4,083,122 | 4,093,666 | 4,080,371 | 1.078 |

Source : DPWH Bureau of Maintenance Year End Report

Notes: 1) Budget Allocation basis
2) Figures in 2000 is based on reviced annual allocation amount

**The EMK System**

The EMK allocation is made on an annual basis to all districts through the amount allocated may be less than the funding required to undertake all routine and periodic maintenance in each district. The EMK formula allocates a fixed sum to each district and the distribution of these funds to maintenance activities on roads and bridges is at the discretion of the District Engineer. In many districts, due to the shortfall in funding, money is diverted from periodic bridge maintenance to other areas.

Fund requirement for national road maintenance is determined using the Equivalent Maintenance Kilometer (EMK) method introduced in 1972 under Presidential Decree No. 17 revising the Philippine Highway Act of 1953 or RA 917.

The EMK is calculated based on a formula using the following EMK factors.

1. EMK Factor for Width
   Variant with pavement type (paved/unpaved) and carriageway width.
2. EMK Factor for Surface Type
   Variant with pavement type and thickness and traffic volume.
3. EMK Factor for Bridge Type
   Variant with bridge type

The formula calculates EMK is as follows:

EMK = Length of Road (Km) x (EMK Factor for Width) x (EMK Factor for Surface Type)
+ Bridge Length (m) x (EMK Factor for Bridge Type)

The EMK factors used for bridges by DPWH are shown in **Table 3.5.3-2.**

EMK factor for surface type varies with traffic volume, the higher traffic volume the higher EMK factor.

Table 3.5.3-2 Bridge EMK Factor

| Bridge Type | EMK Factor |
|---|---|
| Concrete | 0.010 |
| Steel | 0.035 |
| Temporary Bailey Timber | 0.100 |

The data on road and bridge parameters that is used to determine EMK factor is sourced from the inventories conducted and submitted by each district engineering office. The Regional Office undertakes the analysis and verification, if needed, of the submitted field data.

The road inventory is updated annually by the District Offices through the submission of the Road Inventory Summary (RIS), which include all the data that are used in the annual computation of the EMK.

**Table 3.5.3-3** shows the inventory of national roads and bridges with corresponding EMK.

The maintenance allocation apportioned to all districts and cities in the Philippines is determined on the bases of the sum of the total EMK in each district/city multiplied by the basic cost of maintaining one kilometer of standard EMK as follows;

Maintenance Fund of District Office = Total EMK of the District x Basic Cost of Unit EMK

For year under report, a total of 29,327.142 kilometers of national roads and bridges were subjected for repair and maintenance, broken down as follows:

| Category | Type of Pavement & Bridge Classification | Length (kms.) | EMK |
|---|---|---|---|
| ROADS | Concrete<br>Asphalt<br>Gravel<br>Earth<br>TOTAL (Roads) | 10,336.090<br>6,683.808<br>11,424.003<br>611.948<br>29,055.849 | 51,172,381 |
| BRIDGES | Permanent<br>Temporary<br>TOTAL (Bridges) | 242.815<br>28.478<br>271.293 | 6,648,846 |
| TOTAL (ROADS AND BRIDGES) | | 29,327.142 | 57,821,227 |

## Table 3.5.3-3 Inventory of National Roads and Bridges with Corresponding EMK As of December 31, 2000 Funded CY 2002

| Region | Type of Pavement | | | | Roads | | Types of Bridges | | Bridges | | Total Roads and Bridges | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Paved | | Unpaved | | | | | | | | | |
| | Concrete | Asphalt | Gravel | Earth Abandoned | Length (km) | EMK | Permanent (km) | Temporary | Length (km) | EMK | Length (km) | EMK |
| NCR | 627.718 | 256.491 | - | - | 884.209 | 2,411.842 | 8.213 | | 8.213 | 186.492 | 892.422 | 2,598.334 |
| CAR | 372.128 | 92.080 | 1,311.014 | 104.830 | 1,880.052 | 3,351.094 | 6.153 | 2.564 | 8.717 | 354.504 | 1,888.769 | 3,705.598 |
| I | 730.620 | 572.737 | 204.716 | 104.046 | 1,612.119 | 2,306.756 | 23.772 | 0.413 | 24.185 | 482.252 | 1,636.304 | 2,789.008 |
| II | 813.546 | 218.405 | 772.512 | 29.013 | 1,833.476 | 2,802.514 | 20.201 | 0.936 | 21.137 | 473.744 | 1,854.613 | 3,276.258 |
| III | 891.338 | 687.622 | 126.927 | 36.579 | 1,742.466 | 2,512.169 | 20.968 | 0.055 | 21.023 | 259.634 | 1,763.489 | 2,771.803 |
| IV-A | 875.187 | 983.133 | 627.395 | 62.543 | 2,548.258 | 4,851.027 | 16.273 | 0.614 | 16.887 | 285.847 | 2,565.145 | 5,136.874 |
| IV-B | 257.398 | 447.764 | 1,400.249 | 52.373 | 2,157.784 | 3,358.573 | 15.322 | 4.631 | 19.953 | 674.050 | 2,177.737 | 4,032.623 |
| V | 894.196 | 382.918 | 946.595 | - | 2,223.709 | 3,386.717 | 15.373 | 1.325 | 16.698 | 320.179 | 2,240.407 | 3,706.896 |
| VI | 699.132 | 949.415 | 1,252.613 | 30.984 | 2,932.144 | 6,072.185 | 23.090 | 4.418 | 27.508 | 811.855 | 2,959.652 | 6,884.040 |
| VII | 607.949 | 817.491 | 443.398 | 4.787 | 1,873.625 | 3,087.338 | 14.945 | 1.035 | 15.980 | 361.366 | 1,889.605 | 3,448.704 |
| VIII | 1,203.721 | 223.409 | 861.405 | 38.104 | 2,326.639 | 3,147.518 | 26.708 | 5.268 | 31.976 | 938.506 | 2,358.615 | 4,086.024 |
| IX | 238.134 | 289.611 | 632.046 | 7.300 | 1,167.091 | 2,348.977 | 9.375 | 0.663 | 10.038 | 201.774 | 1,177.129 | 2,550.751 |
| X | 436.973 | 348.093 | 592.663 | 9.700 | 1,387.429 | 3,108.513 | 10.921 | 0.701 | 11.622 | 237.935 | 1,399.051 | 3,346.448 |
| XI | 713.768 | 300.890 | 900.452 | 61.700 | 1,976.810 | 3,665.038 | 13.021 | 1.001 | 14.022 | 265.638 | 1,990.832 | 3,930.676 |
| XII | 434.782 | 100.616 | 524.452 | 68.402 | 1,128.252 | 1,998.404 | 7.170 | 0.924 | 8.094 | 201.704 | 1,136.346 | 2,200.108 |
| XII | 539.500 | 13.133 | 837.566 | 1.587 | 1,381.786 | 2,763.716 | 11.310 | 3.929 | 15.240 | 593.366 | 1,397.026 | 3,357.082 |
| **TOTAL** | **10,336.090** | **6,683.808** | **11,424.003** | **611.948** | **29,055.549** | **51,172.381** | **242.815** | **28.478** | **271.293** | **6,648.846** | **29,327.142** | **57,821.227** |

NOTE: Length includes Earth/Abandoned roads but excluded in the computation of EMK
EMK of Flyovers are included but the corresponding length not included in the total length.

The total nationwide EMK for CY 2002 was 57,821 and the basic unit cost per EMK was ₱70,798 thus the total maintenance budget of the DPWH for National Roads and Bridges was ₱4,080 million.

The basic cost is updated annually in proportion to increase in labor cost, material cost, and equipment cost nationwide. Despite the effort of the DPWH to increase the EMK basic cost, the amount has not been increased since 1995, but practically in real terms.

## Roads and Bridge Maintenance Expenditure in NCR

Using the basic cost and EMK, the road and bridge maintenance fund is appropriated to each region and the actual maintenance fund of expenditure basis by year is shown in **Table 3.5.2-4.**

Table 3.5.2-4 Road and Bridge Maintenance Expenditure by Regions

Unit: P'000

| | 1999 | | 2000 | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|
| | Amount | % | Amount | % | Amount | % | Amount | % |
| NCR | 147,316 | 4.4 | 151,835 | 4.2 | 151,835 | 4.2 | 157,575 | 4.8 |
| CAR | 239,276 | 7.2 | 234,810 | 6.5 | 234,810 | 6.5 | 183,612 | 5.5 |
| I | 150,995 | 4.6 | 175,710 | 4.8 | 175,710 | 4.8 | 166,073 | 5.0 |
| II | 205,531 | 6.2 | 208,065 | 5.7 | 208,065 | 5.7 | 154,587 | 4.7 |
| III | 180,533 | 5.4 | 195,359 | 5.4 | 195,359 | 5.4 | 151,681 | 4.6 |
| IV-A | 307,500 | 9.3 | 341,474 | 9.4 | 341,474 | 9.4 | 317,149 | 9.6 |
| IV-B | 186,685 | 5.6 | 211,881 | 5.8 | 211,881 | 5.8 | 255,149 | 7.7 |
| V | 199,164 | 6.0 | 226,554 | 6.2 | 226,554 | 6.2 | 202,290 | 6.1 |
| VI | 389,388 | 11.8 | 418,277 | 11.5 | 481,277 | 11.5 | 344,793 | 10.4 |
| VII | 194,718 | 5.9 | 210,655 | 5.8 | 210,655 | 5.8 | 212,358 | 6.4 |
| VIII | 230,857 | 7.0 | 261,671 | 7.2 | 261,671 | 7.2 | 234,553 | 7.1 |
| IX | 129,727 | 3.9 | 155,429 | 4.3 | 155,429 | 4.3 | 133,431 | 4.0 |
| X | 190,026 | 5.7 | 231,351 | 6.4 | 231,351 | 6.4 | 225,274 | 6.8 |
| XI | 224,057 | 6.8 | 243,684 | 6.7 | 243,684 | 6.7 | 193,076 | 5.8 |
| XII | 141,191 | 4.3 | 144,387 | 4.0 | 144,387 | 4.0 | 173,170 | 5.2 |
| XIII | 196,745 | 5.9 | 229,191 | 6.3 | 229,191 | 6.3 | 207,008 | 6.3 |
| Total | 3,313,709 | 100.0 | 3,640,333 | 100.0 | 3,640,333 | 100.0 | 3,311,779 | 100.0 |

Source: DPWH Bureau of Maintenance Year End Report

**Table 3.5.2-5** shows the road and bridge expenditure of National Capital Region (NCR) including Metro Manila. From this table, the following observations can be said:

- In 2002 the road and bridge maintenance expenditure in NCR was P157 million with share of 4.8% to total expenditure.
- The amount of MBA (Maintenance by Administration) is ₱ 60 million (38%) while that of MBC (Maintenance by Contract) is ₱ 98 million (62%).
- The maintenance budget is mainly utilized as the routine maintenance, but a little utilized as the periodic/special maintenance.

Table 3.5.3-5 Maintenance Budget Expenditure of NCR for Roads and Bridges by Year

Unit: P'000

| Activity | | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|
| 1 | Maintenance by Administration (MBA) | | | | |
| | 1.1 PHHMS | | | | |
| | 1.1.1 Routine Maintenance | 46,847 | 46,655 | 46,655 | 59,906 |
| | 1.1.2 Periodic/Special | 0 | 0 | 0 | 0 |
| | Sub-Total | 46,847 | 46,655 | 46,655 | 59,906 |
| 2 | Maintenance by Contract (MBC) | | | | |
| | 2.1 MBC Program | | | | |
| | 2.1.1 Routine Maintenance | 64,997 | 71,335 | 71,335 | 59,364 |
| | 2.1.2 Periodic/Special | 1,178 | 1,866 | 1,866 | 7,285 |
| | 2.2 PHMMS | | | | |
| | 2.2.1 Periodic/Special | 27,986 | 29,791 | 29,791 | 31,020 |
| | Sub-Total | 94,161 | 102,992 | 102,992 | 97,669 |
| 3 | Immediate Response Fund | 6,308 | 2,188 | 2,188 | 0 |
| Grand Total | | 147,316 | 151,835 | 151,835 | 157,575 |

Soure: DPWH Bureau of Maintenance Year End Report
Notes: Actual expenditure basis