Evaluation of National Highway by Geographical Information System

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ABSTRACT: The objective for the development of digital map of Dhaka Sylhet National Highway (N2) is to facilitate the highway transportation organizations. The Dhaka Sylhet National Highway (N2) is 284.9 km. On the basis of International Roughness Index (IRI), it's 90.8% is good, 7.4% is Fair. The percent of poor section is 1.2 and has a bad section of 0.56%. The Dhaka Sylhet National Highway (N2) has four different pavement widths. Road-length of 272.3 km has a pavement width of 7.5 m. Pavement width 14 m has a road length of 10.4 km. Pavement width 10.2 m and Pavement width 10.3 m each has a road length of 1.1 km. In our study, three major bridges of N2 were suggested to easy traffic movement and safe handling of future traffic.

Key words: International Roughness Index, National highways, Pavement width, GIS

INTRODUCTION

Many authors worked on evaluation of existing highway using GIS (Haas and Hudson, 1978; Sood *et al.,* 2000; Karandikar *et al.,* 2002; Yoagentharan and Jayakumar, 2002; Roger *et al.,* 1990; Wahadj *et al.,* 2007; Monavari and Mirsaeed, 2008). For rapid economic, industrial and cultural growth of any country, a good system of road is very essential. Transportation system comprises of good network of roads, railways, well-developed waterways, and airways. Good system of roads serves as feeder line for other modes of transport and thus helps directly in their development. Roads are every community's economic lifelines. Facilitating the constant movement of people and goods for travel to and from work, for services, for social and recreational purposes, and many other activities, roads are essential to modern living. In order to provide stable and even surface for the traffic, the roadway should be provided with a suitably designed and constructed pavement structure. Roads & Highways Department (RHD) is responsible to develop and maintain the major road network of Bangladesh. This road network

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is grouped into three categories namely National Highways, Regional Highways, Zilla Roads. To evaluate the condition of high way some parameters are essential such as International Roughness Index, Pavement width, Shoulder width, Annual average daily traffic (motorized and non motorized vehicle).

GIS is an advanced technology that can help any organization in decision-making process. GIS is applied globally in both public and private sectors. The application areas include monitoring change in land resources, resource management (e.g. refuse collection mapping), transport network manage (e.g. provision and maintenance of highways), public protection and within emergency services. Many authors worked on evaluation of existing highways by remote sensing and geographical information system. Saarenketo and Scukion (2000) applied ground penetrating radar (GPR) for evaluation of existing highways in Scandinavia. They identified soil type, thickness of overburden, compressibility, and frost susceptibility of sub-grade soil. They also measured layer thickness, subsurface defect using GPR. Shrestha *et al.* (2003) used airborne laser

swath mapping technology to map coastal and highway in Florida. In another study, Hans et al. (2003) used LIDAR based elevation data for evaluation of highway condition. But those methods are costly. This study is strictly conducted on Dhaka Sylhet National Highway (N2), which connects Dhaka with northeast region of Bangladesh. GIS can helpful in developing and monitoring a good transportation system. GIS is an effective tool to provide information to decision makers not only in tabular form but also in digital form. So in this study, the condition of N2 by using GIS which gives decision makers huge amount of data regarding road condition in tabular form and from easily understandable maps, one can easily take decision on maintenance of highway.

MATERIALS & METHODS

The overall methodology used for the study is presented in the flow chart (Fig.1).

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┌─────────────────────────────┐
│  Scanning National Highway  │
│  (N2) Map of Bangladesh     │
│  From RHD                   │
└─────────────────────────────┘
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              ▼
┌─────────────────────────────┐
│  Separate the N2 from Map   │
│  Using Adobe Photoshop.6    │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Digitize in ARCVIEW 3.1    │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Input Data from Annual     │
│  Report 2005 of RHD         │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Add Bridges                │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Use Query Function and Edit│
│  Legend of ARCVIEW 3.1      │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│  Evaluated Road Condition   │
│  of N2 In 2005              │
└─────────────────────────────┘
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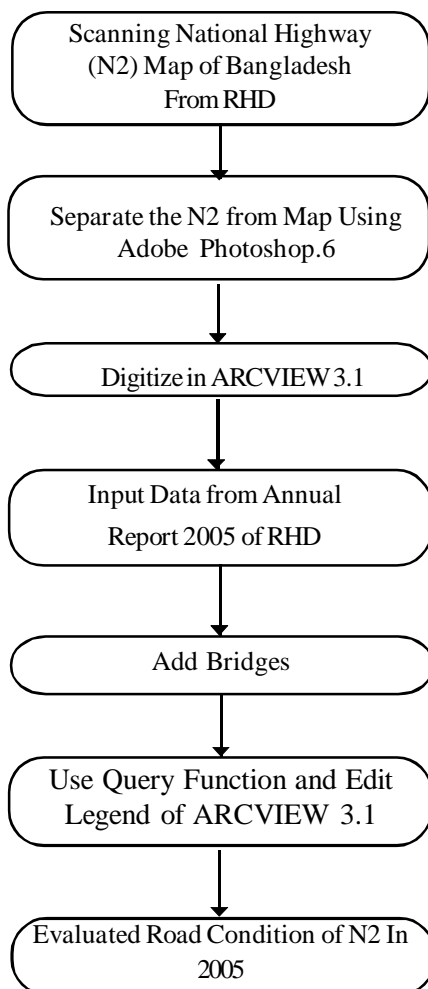
Fig. 1. Flow Chart of Methodology

The portion of National Highway Map of Bangladesh was digitized from existing data available in Roads and Highways Department. The Dhaka Sylhet National Highway (N2) was separated from National Highway Map of Bangladesh by Adobe Photoshop 6 and it was in JPGE format. The N2 map was used as a base map. Now the ARCVIEW 3.1 was used to create a digital map. Survey data was put in the Digital map Table. Then some important bridges were added in the digital map using" New Theme Function", of ARCVIEW-3.1. The digital map has been analyzed using ARCVIEW-3.1 software. ARCVIEW-3.1, a powerful desktop GIS to visualize, update, analyze geographic information was used to create quality presentations that brings the power of Digital mapping. The Dhaka Sylhet National Highway (N2) was rated by Roughness Based road condition rating system. Query Function of ARCVIEW-3.1 software was used to rated the N2, based on International Roughness Index (IRI). Then Query Function of ARCVIEW-3.1 also determined Pavement, Shoulder and Annual Average Daily Traffic (motorized and non-motorized) condition. The Digital map clearly identifies the rating and pavement and shoulder conditions in the N2 map. Computers digitally processed the data and the road conditions were identified.

RESULTS & DISCUSSION

The road condition survey observes and records the physical condition of the surface of the road pavement and associated features such as shoulders, embankments, and number of culverts and bridges in a specific road. This is done by visual inspection, which measures the present condition of the road features. Surveys were based on Manual Inspection Method. It was done for every 100m intervals. These surveys were done by the Rating Team consists of one graduate engineer, two surveyors and one work assistant. The road under the study is Dhaka Sylhet National Highway (N2). RHD rated the National Highways in four sections based on International roughness index (IRI). IRI based road condition rating system given by RHD for National Highways are given in (Table 1).In this study, Dhaka Sylhet National Highway (N2) has been classified as good, fair, poor, and bad section based on IRI with

the help of Digital Map using ARCVIEW 3.1 Software. For performing this task we used Query function of ARCVIEW 3.1 and put some equations. Those were given in Table 2.

Table 1. Roughness based road condition rating system for National Highways

Road type	Good	Fair	Poor	Bad
National Highways	2-4 IRI	4-6 IRI	6-8 IRI	>8 IRI

Table 2. Equations for Digital Map to Rate N2 based on IRI

Road type	Good	Fair	Poor	Bad
Eqs.	IRI<=4 (New set)	IRI>4 (New set) IRI<=6 (Select from set)	IRI>6 (New set) IRI<=8 (Select from set)	IRI>8 (New set

The road sections, which have an IRI value of 2 to 4, is rated as good section. Now good section of N2 is presented in (Fig. 2) gray color shows good section and blue colour shows other sections. So, the total length of Good section in N2 is 257.98 kilometer.
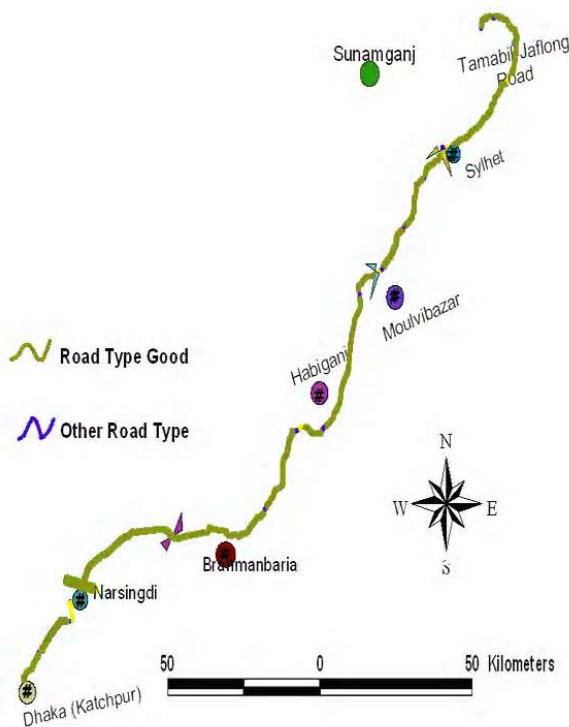
Dhaka Sulhet National Highway (N2)

Fig. 2. Showing Good section of N2 based on IRI

The road sections, which have an IRI value of 4 to 6, is rated as fair section. Now fair section of N2 is presented in (Fig. 3) gray color shows fair section and blue colour shows other sections. So, the total length of fair section in N2 is 21.8 km.

Dhaka Sulhet National Highway(N2)

Fig. 3. Showing Fair section of N2 based on IRI

The road sections, which have an IRI value of 6 to 8, is rated as poor section. Now poor section of N2 is shown in (Fig. 4) gray color shows poor section and black colour shows other sections. So, the total length of poor section in N2 is 3.52 kilometer. The road sections, which have an IRI value of more than 8, is rated as bad section. Now bad section of N2 is presented in (Fig. 5) gray color shows bad section and blue colour shows other sections. So, the total length of bad section in N2 is 1.6 kilometer. It will give an idea about decision-making regarding maintenance of highway. For determining the present condition of pavement width of N2, prepared digital map of N2 is used. In the (Fig . 6) gray and black color shows different pavement width of N2 (Fig.7). Table 3 shows the equation used for evaluation of present width.

Dhaka Sulhet National Highway(N2)

Fig. 4. Showing Poor section of N2
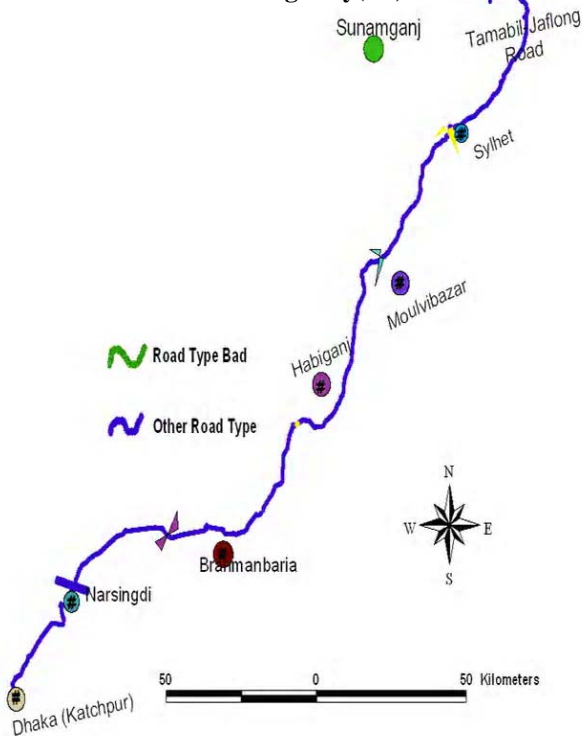
Dhaka Sulhet National Highway(N2)

Fig. 5. Showing Bad section of N2

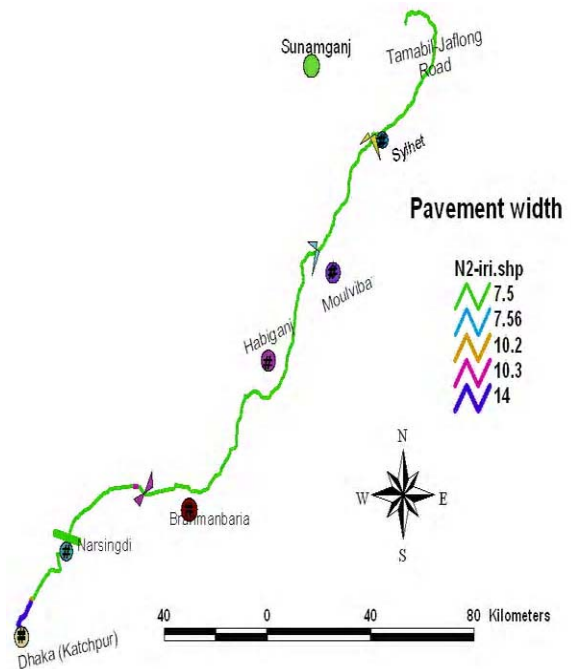**Dhaka Sulhet National Highway(N2)**
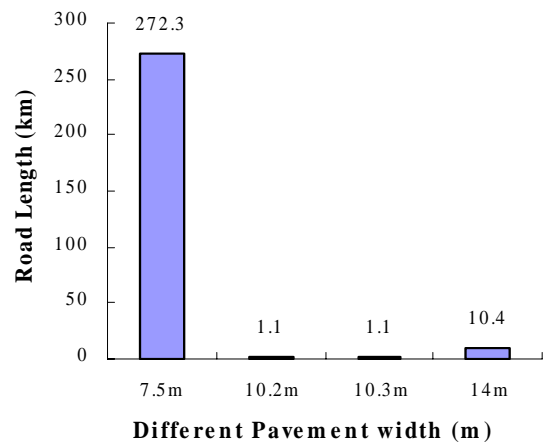

Fig. 6. Showing different Pavement width of N2

Fig. 7. Pavement width of N2 in the year 2005

Shoulders are strips provided on both the sides of the carriageway. Shoulders serve as parking place for vehicles. Shoulders should be wide enough to permit and encourage vehicles to leave the pavement when stopping. Now with the help of prepared digital (Fig. 8) a clear idea of the present shoulder width of N2 using ARCVIEW 3.1 Software was evaluated. In the map, different colour shows different shoulder width of N2. The following equations are used to evaluate the shoulder condition. It is clear from the figure that 266.6 km length having a shoulder 3m. Those were as follows:

Table 3. Equations to determining the Condition of Pavement width of N2

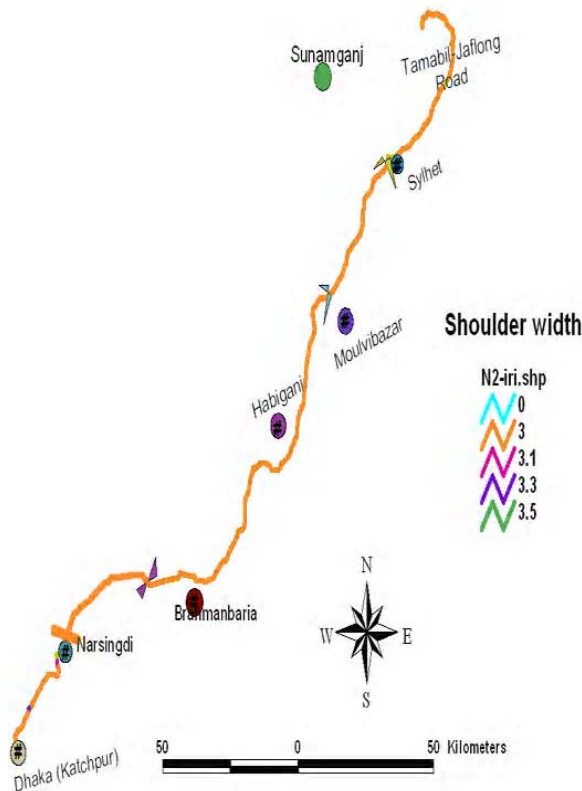| Pavement Width(m)	14	10.20	10.30	7.5
Equations	Pav.Width=14 (New set)	Pav.Width=10.20 (New set)	Pav.Width=10.30 (New set)	Pav.Width=7.5 (New set)

Dhaka Sulhet National Highway (N2)

Fig. 8. Showing different Shoulder width of N2

From RHD ROAD NETWORK data base, National Highways, Joydebpur-Tangail-Jamalpur Road (N4) was taken to compare with Dhaka-Sylhet National Highway (N2). N4 has a total length of 140 km and in case of N2 it is 284.9 km. Based on International Roughness Index (IRI), N4 has good section of 43%, fair 19%, poor 26.4%, and bad of 11.4%. The condition of N2 is good section of 90.8%, fair 7.4%, poor 1.2%, and bad of 0.56%. Again the highest motorized traffic in N4 is 15056 and in case of N2 it is 11434. The highest non motorized traffic in N4 is 1938, but in case of N2 it is 1596. So from the above comparison, it is clear that N2 is in better condition than N4. The reasons behind it are (i) N2 is relatively newly built highway than N4 (ii) N4 has much greater motorized traffic than N2 (iii)

Rainfall is another effective factor that may damage Highway and (iv) as Dhaka-Sylhet National Highway (N2) is situated in hilly region of Bangladesh, it is not affected by flood water. But the case is not same for N4.

CONCLUSION

The objective for the development of digital map of Dhaka Sylhet National Highway (N2) is to facilitate the highway transportation organizations, which have the notion of improvement of quality of life of the people. To evaluate the current condition of N2 we have to consider some parameters such as International Roughness Index (IRI), Pavement width, Shoulder width, motorized vehicle (MT), Non-motorize vehicle (NMT) and bridges. This study proved that the Geographic Information Systems is very useful tool for determining the condition of highways. The major findings of our study are as follows:

1. The Dhaka Sylhet National Highway (N2) is 284.9 km. On the basis of International Roughness Index (IRI), it's 90.8% is good, 7.4% is Fair. The percent of poor section is 1.2 and has a bad section of 0.56%.

2. The Dhaka Sylhet National Highway (N2) has four different pavement widths. Road-length of 272.3 km has a pavement width of 7.5 m. Pavement width 14 m has a road length of 10.4 km. Pavement width 10.2 m and Pavement width 10.3 m each has a road length of 1.1 km.

3. N2 has four different shoulder widths. The shoulder width 3 m has a road-length of 266.6 km, 3.1m has 1.4 km, 3.3 m has 1.1 km and 3.5 m shoulder width has 15.8 km road length.

4. From our study, we found that N2 has highest motorized traffic of 11434 and it exists between the chains of 0 km to 11.5 km. The lowest motorized traffic of 928 exists between the chains of 145.892 km to 184.875 km.

5. N2 has highest non-motorized traffic of 1596 and it exists between the chains of 44.60 km to

73.192 km. The lowest non-motorized traffic of 97 exists between the chains of 185.874 km to 204.775 km.

6. In our study, three major bridges of N2 were suggested to easy traffic movement and safe handling of future traffic. Among them, Bhairab Bridge and New Bridge has structure type o f PC Girder and length of 1700 m and 550 m respectively. Calender Hamilton is the structure type of Shearpur Bridge and length of 750m.

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