Proposed Diversion Road to Improve Traffic Movement of Commercially Developed Areas in Bacoor Cavite City

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Abstract: Traffic congestion is one of the causes of many problems like being late in school and work; and delivery of supplies and materials that might be needed. This study generally aims to develop a diversion road to be located in Molino 3, Bacoor, Cavite. The traffic system in the area is already poor; and, undoubtedly, the start of construction and operation of commercial/residential projects would generate a denser population in Bacoor and lead to a higher volume of traffic utilizing the Molino Road. Considering the denser population and traffic that it will generate, it will be of great advantage to develop a diversion road that would divert traffic and improve traffic movement. Moreover, this would aid in the promotion of sustainable growth of the place by engaging into an environmentally compatible design of the proposed structure using recyclable materials specifically recycled concrete as additive in the sub-base.

Keywords: Diversion Road, Traffic Impact Assessment, Recycled Concrete, Pavement Design

1. INTRODUCTION

The government has been always giving great importance to the transportation sector due to the concept that is it one of the key elements towards national integration and economic improvement of our country. The transportation sector is a focus of the government also because this sector still has many problems that haven't been solved. In line with this, the Department of Transportation and Communications, as the transportation arm of the government, continues to take part in various transportation developmental projects which principally aim to systematize the different transportation systems in our country, particularly road transport. The municipality of Bacoor in Cavite recently becomes a city and in this event, the city of Bacoor is expected to have numerous projects in the future such as commercial and residential construction development. Road transport in Bacoor Cavite needs improvement due to the massive traffic and population that these anticipated projects will draw.

A Traffic Impact Assessment (TIA) will be conducted on a commercial establishment construction in order to provide statistics needed to forecast the traffic that the project will induce to the roads. Upon obtaining these forecasted figures from the TIA, these data will be used in the development particularly the road transport; this would imply a substantial number of populations that will emerge on the aforementioned location of the project. The proposed diversion road will provide a higher capacity, more reliable, efficient and accessible means of transport to the area in Bacoor Cavite.

The traffic system in the Molino Road is already poor and undoubtedly, the start of construction and operation of commercial or residential projects would generate a denser population in Bacoor and would lead to a higher volume of traffic utilizing the Molino Road.

A new road that will be accessible to the public will attract business establishments which can contribute to the growth of population and traffic in the area. The establishment of businesses will unavoidably enable various changes that will lead to either positively, to the progress and development of the area, or negatively, to the pollution and deterioration of the surroundings; in which the latter result can be revealed in Philippine setting.

To prevent and relieve such future negative impacts that will be induced by the sudden emerge of population and traffic produced by commercial or residential projects, a diversion road is proposed in order to control the traffic in the area. Moreover, this study would be applying usage of recyclable materials specifically recycled concrete as additive to the sub-base in order to sustain the environment for the future generations.

2. PROJECT LOCATION

This proposed project will be located at Barangay Molino 3, Bacoor, Cavite. This place is situated parallel to the Molino Road and almost at the edge of the mini-dam in the area. It is also near the Barangay Molino 3 hall.

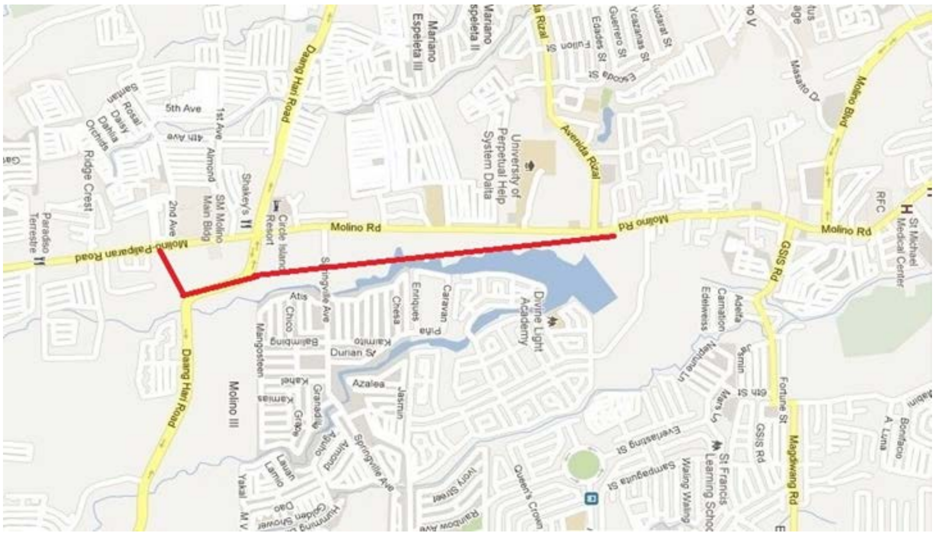

Figure 1. Red line delineation for the proposed road project

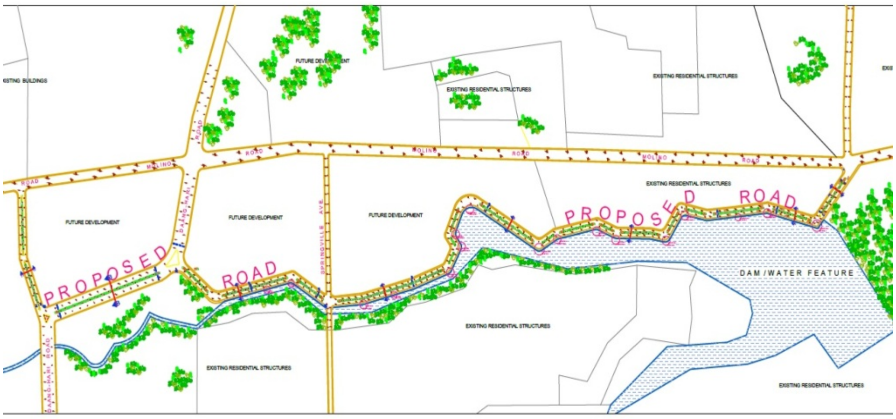

Figure 2. More detailed version of the proposed road

Figure 3. Perspective view of the proposed road

3. PROJECT IMPLEMENTATION

3.1 Pre-construction/Operational Phase

This stage gives emphasis to the preparation of necessary project documents, plans and specifications, and the awarding of contract documents before the construction takes place.

a. Planning and Designing
b. Preparation of Construction Documents
c. Site Surveying and Land Use Assessment
d. Project Cost Estimation
e. Bidding (Selection of Contractor)
f. Construction Planning and Management

3.2 Construction Phase

This stage deals with the actual procedures required for the implementation and completion of the project.

a. Site Preparation and Diversion of Existing Nearby Facilities
b. Excavation and Construction of Road Drainage System
c. Water, Sewer, Mechanical and Electrical Lines
d. Backfilling and Compaction of Soil Subgrade
e. Construction of Rigid Road Slab
f. Placement of Wearing course/Asphalt Road

3.3 Operational Phase

This phase takes place after the full construction of the road has already been completed. The road is continuously examined to identify any deficiencies which will be subjected to appropriate repairs.

a. Road's Continuous Monitoring
b. Maintenance and Repair

3.4 Abandonment Phase

This phase generally concerns on the elimination of the waste produced and the restoration of the areas that have been affected by the construction. In addition, all the equipment used must be pulled out.

a. General Clearing and Removal of Wastes
b. Pull out of Equipment Used

4. FACTORS IN PAVEMENT DESIGN

Traffic is the most important factor in the pavement design. The key factors include contact pressure, wheel load, moving loads, load, and load repetitions, temperature and precipitation. Contact pressure determines the contact area and the contact pressure between the wheel and the pavement surface. Wheel load determines the depth of the pavement required to ensure that the subgrade soil is not failed. Moving loads is the damage to the pavement is much higher if the vehicle is moving at creep speed. Repetition of Loads is the influences of traffic on pavement not only depend on the magnitude of the wheel load, but also on the frequency of the load applications. Each load application causes some deformation and the total deformation is the summation of all these. Temperature affects the resilient modulus of asphalt layers, while it induces curling of concrete slab. In rigid pavements, due to difference in temperatures of top and bottom of slab, temperature stresses or frictional stresses are developed. The precipitation from rain and snow affects the quantity of surface water infiltrating into the subgrade and the depth of ground water table. Poor drainage may bring lack of shear strength, pumping, loss of support, etc.

4.1 Pavement Construction

'Pavement' is a general term for any paved surface, and is also the term applied specifically to the whole construction of a road. Road pavements can be classified as flexible pavements that, for the purpose of design, are assumed to have no tensile strength and consist of a series of layers of materials to distribute the wheel loads to the subgrade.

Pavement systems generally consist of three layers: prepared sub-grade, sub-base, and pavement. This section will deal with the proper design and construction of sub-bases. The sub-base is the layer of aggregate material that lies immediately below the pavement and usually consists of crushed aggregate or gravel or recycled materials. Although the terms "base" and "sub-base" are sometimes used interchangeably to refer to the sub-surface layers of a pavement, base course is typically used in asphalt pavements, primarily as a structural load-distributing layer, whereas the sub-base layer used in concrete pavements primarily serves as a drainage layer. Aggregate sub-base is typically composed of crushed rock, comprised of material capable of passing through a 1 ½-inch screen, with component particles varying in size from 1 ½-inch down to dust. The material can be made of virgin (newly mined) rock or of recycled asphalt and concrete.

The function of the pavement sub-base is to provide drainage and stability to achieve longer service life of the pavement. Most pavement structures now incorporate sub-surface layers, part of whose function is to drain away excess water that can be deleterious to the life of the pavement. However, aggregate materials for permeable bases must be carefully selected and properly constructed to provide not only permeability, but uniform stability as well. Proper construction and QC/QA testing operations can help to ensure good performance of the sub-base layer. Excessive compaction can alter the gradation and create additional fines that may result in lower permeability than determined in laboratory tests and used in the pavement system design. However, the optimization of structural contributions from high stability, versus the need to provide adequate drainage for pavement materials is still a point of debate. The focus of this section is to provide guidance on selection of proper sub-base materials, best construction practices, and suitable QC/QA testing methods.

4.2 Flexible Pavements

The sub-base for a flexible pavement is laid directly onto the formation level and should consist of a well-compacted granular material such as a quarry overburden or crushed rocks.

4.3 Rigid Pavements

This is a form of road using a concrete slab laid over a base layer. The subgrade is prepared as described above for flexible pavements, and it should be adequately protected against water. The base layer is laid over the subgrade, and is required to form a working surface from which to case the concrete slab and enable work to proceed during wet and frosty weather without damage to the subgrade.

5. DETAILED ENGINEERING DESIGN

5.1 Loads and Codes

The design data used for this project should ordinarily equal or exceed the values given in the computations and specifications of this thesis paper. Should there be modifications on the design presented in this report proper considerations should be met so that the structural integrity of the roadway would be preserved. A requirement of consideration of and permits use of lesser values when such action to meet the needs of the project in the best interest of the public is whole should be presented beforehand.

The design presented in this thesis is limited to the roadway layout, which is the inclusion of superelevations, curves and elevation alignment, headwall, riprap, thickness of road layers, and cross section of road.

5.2 Design Load

The manual design of this thesis is based on the AASHTO method. AASHTO method is plainly mechanics-based in order to design the thickness of sub-base and base course. Assumption of the largest and heaviest vehicle is firstly performed. For the case of the proposed diversion road, dead load is governed by a ten-wheeler truck which is at most, 54 000 lbs or 250 kN. The percentage of trucks in the proposed diversion road is approximated to be 5%. The DESAL is computed with the aid of the ESAL Calculator with the following assumptions:

Design Period, Y = 40 years
Directional Distribution Factor, D = 0.5
Lane Distribution Factor, L = 1
Two-way Average Daily Traffic = 800

Growth Rate = 2%
Percent Truck = 5%
Truck Factor, Tf= 1.7

The assumptions are based on typical data from the traffic and population growth of Bacoor, Cavite. ESAL calculator would provide the projected total ESAL for the design period. It will also show the output of the ESAL Calculator which is 749, 589 total ESAL for the design period.

The DESAL is the cumulative traffic load summary statistics. The statistics represents a mixed stream of traffic of different axle loads and axle configurations predicted over the design or analysis period and then converted into an equivalent number of 18,000-lb single axle loads summed over that period. Such output could also be computed using:

$$DESAL = T_f \, TGDL(365)Y \quad (1)$$

where,

T_f : traffic factor

$$T_f = \left(\sum_{i=1}^{m} p_i F_i\right) A \quad (2)$$

where,

p_i : percentage of total repetitions for *i*th load group
F_i : equivalent axle load factor for the *i*th load group
A : average number of axles per truck
T : percentage of trucks in average daily traffic (ADT)
G : growth factor

$$G = \frac{(1+g)^n - 1}{g} \quad (3)$$

where,

g : annual growth rate
n : analysis period in years
D : directional distribution factor
L : lane distribution factor
Y : design period in years

6. DESIGN SPEED

The value of a roadway is judged by the convenience and economy that it affords in transporting people and goods, to which speed and safety of operation are directly related. The speed adopted by the driver depends, in addition to capabilities of himself and his vehicle, upon four general conditions: the physical characteristics of the highway and its roadsides; the weather; the presence of other vehicles; and the speed limitations; either legal or control devices. An approximately uniform speed is generally the aim of most drivers.

7. SUPERELEVATION AND ROAD WIDENING

Because, on curves, the rear wheels of motor vehicles do not ordinarily travel in the same radius as the front wheels, it is desirable to widen the roadbed especially along sharp curves. On simple curves, widening should be applied on the inside edge of pavement only. You can check the highway design guidelines for the recommended standards for superelevation and widening.

8. CONCRETE RECYCLING

Aging U.S. infrastructure, decreasing availability of landfill space, and environmental concerns work together to increase concrete recycling.

There are two approaches to recycling concrete. One alternative is to haul the concrete debris to a permanent recycling facility, usually close by to minimize transportation costs, for crushing and screening. The other approach is to do the crushing and screening at the demolition site where the aggregate is reused as soon as it is processed.

Recycling at the demolition site (see photo on back) reduces heavy materials hauling, thereby reducing transportation costs, energy use, and wear and tear on roads and equipment.

8.1 Economics of Recycling

Concrete recycling has proven to be profitable, but its use has limitations. Transportation costs need to be kept low, which forces the market to be urban-oriented. The market for recycled aggregates may be restricted by user specifications and prejudices. Finally, the availability of feedstock into recycling plants is fixed by the amount of demolition taking place, which generally places the activity within older, larger cities.

Depending on the size of the recycling facility, entry into the aggregates recycling business requires a capital investment between $4.40 and $8.80 per metric ton of annual capacity (Wilburn &Goonan, 1998).

Processing costs for the aggregates recycler range from $2.76 to $6.61 per metric ton, again depending on the size of the operation. The larger operations distribute costs over more units of output. The average production capacity for a fixed site recycling operation is about 150,000 tonne per year.

Prices for the various aggregate products made from recycled concrete range between $1 and $18 per metric ton and vary from region to region. The highest prices are in aggregate-poor areas of the southern United States.

Recyclers often have the opportunity to charge a fee for accepting concrete debris, especially along the Atlantic corridor where landfill space is running short and charges for depositing materials into landfills are high. In such cases, the added revenue can compensate for a lower market price for the recycled aggregate product. As natural aggregate producers dominate the market, they tend to set the terms that recyclers can obtain.

8.2 Summary of Recycling

The recycling of aggregates from recovered asphalt pavement and demolished concrete debris conserves resources and landfill space, while also generating healthy profits for recyclers. Recycling can take place either at a permanent facility or at the demolition site, using mobile equipment.

A sustainable recycling industry requires numerous factors, including sufficient concrete and asphalt decay and demolition to supply the recycler with raw materials, demand for new infrastructure, favorable transportation distances, product acceptance, and limited landfill space.

9. SUSTAINABLE CONCEPT

Aside from diversion road that will reduce the traffic congestion in Molino Road- DaangHari Road intersection, this project will also apply the conceptual design of the pavement. Moreover we are promoting the use of recycled/crushed concrete as additive to the sub-base that will lessen the used of gravel as filler material in the sub-base and promotes more economical designs.

10. CONCLUSION

The study made on the area is basically improving the current state of the traffic system of the region. A new road could be used as a variety of purposes such as the diversion of vehicles that does not necessarily need to use the existing Molino road. A diversion road serves as an alternate route for the vehicles and reduces the vehicular density on each of the two roads, the existing Molino road and the proposed diversion road.

Also, the new road gives opportunities for economic improvement of the place due to the possible commercial usage of the place. The new road provides a place that could be utilized as a commercial area that could accommodate primary functional establishments such as a market, schools, religious buildings, banks, and other business related places. Residential structures such as houses and apartments on the side of roads are normal in the province of Cavite, which means the new diversion road could also serve a residential purpose for some of the residents of Bacoor specifically the barangay of Molino. The increase in the number of commercial and residential establishments provides better economic stability of the newly established city since there will be additional taxes from the new buildings that could be accommodated by the road.

The proposed diversion road helps in the conservation and usage of the natural resources by the utilization of the recycled concrete. Usage of recycled concrete reduces the cost of the whole project and preserves natural resources that are needed in order to produce concrete.

The design of the road is based on the design standards of the AASHTO, DPWH manual. These standards are the basis of most of the roads in the country because it is the general guide of the roads. The concrete used for the road may it be recycled concrete or the typical concrete should undergo testing like compression test based on the design standards of the NSCP. The soil profile of the place is not yet available since there was no previous study performed on the area. The design of the road was based on ideal conditions of the soil also based from the NSCP.

The main problem of this paper is about the traffic situation in the Molino road and that is the focus of this problem. This paper has come up with a solution to the challenge that the problem is presenting and its solution is to design a diversion road to alleviate the traffic flow in the Molino road. This solution to the problem is only one of the possible solutions to the problem. The problem could be solved through various projects like road widening, traffic light management, possible flyover and well managed public transportation stops for loading and unloading but this paper has come up with the extreme solution of making a new road because it aims to provide a long term solution to the problem.

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