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Investigation on Bridges Connection to Network Carrefour in Existing Roads in Africa Big Cities: The Case of Cotonou in Benin Republic

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ABSTRACT
The rapid and continuous growth of populations and vehicles has caused very big traffic volume in most of African big cities. In order to ensure a better distribution of traffic and enables quick access to vehicles, reasonable interchange can be designed to allow greater connection and realizes rapid dividing of vehicles at existing road network carrefour. This paper uses Cotonou, which is the largest urban and economic city of Benin Republic as a case study. Firstly, the paper reviews literatures on history and development of interchanges bridge systems. Based on the case study, the paper then mainly introduces a typical interchange at Godomey carrefour, explains difficulties encountered in engineering design and realizes rapid dividing of vehicles by designing reasonable interchange at Godomey carrefour, so as to accumulate certain experience in the construction of interchange at existing road network carrefour. By studying this case, the research seeks to identify and expand on lessons learned under the first interchange bridge design in Benin. Using the lessons learned government agencies, engineering and construction communities could adopt reasonable structure and construction method according to local conditions based on current situations.
Keywords **-** Bridges connection, existing roads, interchange at network carrefour, rapid traffic, Benin Republic.

I. INTRODUCTION

With the rapid and continuous growth of populations and vehicles in most of African big cities, imbalance between supply and demand of traffic infrastructures in the existing road network carrefour becomes more and more acute, and traffic block becomes even more serious although breakthrough has been made in the road construction. Nowadays, an interchange bridge, a crucial component in roadway system exists and continues to play an important role in road network system. It has the ability to reduce or eliminate traffic conflicts and improves the efficiency at the junction of two or more roadways cross at different levels. An interchange is defined by AASHTO as a system of interconnecting roadways in conjunction with one or more grade separations that provides for the movement of traffic between two or more highways on different levels. Many countries in the world attach great importance to highway interchange.

In the beginning man created the interchange with the United States (US) patent in 1912 of a cloverleaf. After 16 years later that the first interchange was constructed in Woodbridge, New Jersey in 1928. Other interchanges opened to traffic over the next several years. Engineers have developed and used numerous designs to effectively and safely manage traffic movements at interchanges. These included three-leg interchanges, diamond, partial cloverleaf, cloverleaf, directional, and multi-leg interchanges. However, none of the existing interchanges bridges satisfied all the requirements and restrictions at all places. As a result, designers and transportation experts have tried to provide and test new kinds of interchanges, such as single point interchanges, diverging diamond interchanges, and continuous flow interchanges. Experience gained with the cloverleaf showed relatively low capacity due to the four weaving sections between loop ramps and high collision rates. Besides capacity and safety issues, it has many disadvantages: long paths for loop users, weaving issues, signing, safety issues due to multiple exit points, and large right-of-way requirements. The early interchanges (1928-1955) in the US and Canada will provide the base from which the multitude of interchanges have evolved. By the late 1960s nearly 72,000 km of the US Interstate Highway System had been constructed. Canada had

constructed several thousand miles of freeways with hundreds of interchanges mostly in metropolitan areas, particularly the first three-seat leg flared traffic interchange in Ontario, and Vancouver, Edmonton, Calgary, and Montreal were not far behind. In order to solve traffic problems, Sweden and Stockholm interchange was built using three small part cloverleaf interchange ring road (in 1931 and 1935 respectively). By the mid-1950s every basic interchange form had been designed and constructed.

After World War II ushered in a period of great interchange development, especially from the mid-1950s onwards, the US, Britain, France, Germany, Japan and other countries set off a boom in the construction and development of the highway interchange bridge. The first four-level stack interchange was built in Los Angeles, around 1952. In china, the first cloverleaf interchanges in Wuhan Riverside road has been built in until 1955. After 1960s, many others countries such as Australia, Spain and some developing countries have joined the ranks of a large number of construction overpass. The experience gained over the decade gave planners and engineers the opportunity to observe and experience their accomplishments. What they learned by experience and observation along with research gave direction to improvements in future interchange design criteria, design and signing to better meet driver characteristics and expectations, and even more efficient and safer Interchange forms. AASHO produced a new design policy and the second generation of the Highway Capacity Manual was published providing engineers the new tools for designing interchanges.

By the late 1960s, through the 1970s and into the 1980s more efficient and safer interchanges bridge was being constructed. Interchange bridge design is more complex and costly. In the reform and opening up 20 years, many interchanges bridges construction have been development in China. From 2006, China has built more than a dozen full-featured, more complex and costly. After 80 years of use, interchange still has good effect in road network and plays its role.

Adoption of reasonable structure and construction method according to local conditions based on current situations and development in the near future has become more important in Benin Republic, where the inefficient road system and rising incomes have stimulated the rising demand for personal mobility with increased uncheck growth of vehicles and automobile ownership and use.

At present, the developed countries due to the almost complete road network, slowing down the pace of construction of interchange bridge, and many developing countries by means of sustained and rapid economic growth, the construction of the interchange is ascendant. In summary, based on the literature review, there has been a good deal of research on interchange bridge abroad, but little or no research work had been done in this aspect of interchange studies in Benin Republic specifically on the design of interchange. With the development of the interstate road network system, the use of interchanges bridge became more prevalent as engineers sought to improve flow on the nation's new highways.

In order to realize rapid traffic of vehicles, reasonable interchange ramp can be designed to realize rapid dividing of vehicles at bridgehead. This paper mainly introduces a typical interchange at Godomey carrefour, located in the heart of Cotonou, which is the largest urban with over 1 million inhabitants and economic city of Benin Republic. The paper explains difficulties encountered in engineering design and realize rapid dividing of vehicles by designing reasonable interchange at Godomey carrefour, so as to accumulate certain experience in the construction of interchange at existing road network carrefour, puts forward the existing problems and improvement scheme.

This paper is organized as follows. Section 2 presents some types of Interchange Bridge. The design and construction features of Interchange Bridge are shown in Section 3. Section 4 contains a description of the case study. Finally, some recommendations for Interchanges Bridge are provided along with the main conclusions of the study in Section 5.

II. TYPES OF INTERCHANGE BRIDGE

Over the years, several grade-separated interchanges bridge has been developed in order to facilitate vehicular traffic flow. Each interchange has specific advantages and disadvantages inherent in its design. An interchange type selection and its design are influenced by many factors including the following: highway classification of intersecting facilities, volume and pattern of existing and future traffic, environmental requirements, local access and circulation considerations, physical constraints and right-of-way considerations, local planning construction and maintenance costs, and road-user costs. The first two factors provide direction on the basic interchange forms. Right-of-way, construction cost, safety, and operations are likely to dictate interchange bridge type selection for any specific location. Even though interchanges are, of necessity, designed to fit specific conditions and controls, it is desirable that the pattern of interchange ramps along a freeway follow some degree of consistency. It is frequently desirable to rearrange portions of the local street system in connection with freeway construction in order to affect the most desirable overall plan of traffic service and community

development. Several researchers (Garber, G.J., and M.D. Fontaine, 1994; Bonneson, J.A., and S. Lee, 2002) have developed useful characterizations about the operational performance of several commonly used service interchanges. The characterizations based on the use of models tend to quantify the performance of alternative interchange types over a range of traffic volumes. Interchange bridge types are characterized by the basic shapes of ramps layouts for the conditions encountered: namely, diamond, directional, hook, loop, or variations of these types. Many interchanges designs are combinations of these basic types. Schematic interchange patterns are illustrated in Figure 1.

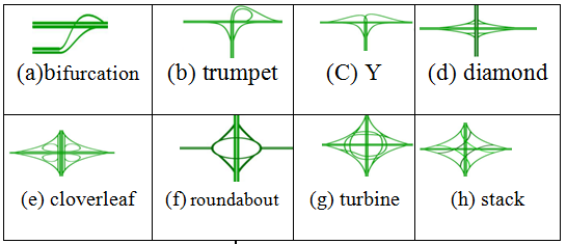

Figure1: Schematic Interchange Types commonly used

These interchange geometric shapes considerably vary due to different design requirements and terrain environments. These are classified as two main types: Local Street interchanges and freeway-to-freeway interchanges. At interchanges between freeways, or other full-access control facilities, a directional interchange offers the highest level of service by directly serving all movements with minimal or no reductions in speed. The attributes of interchange type varies: Traffic operations, Safety, Physical impacts, Construction cost, and Constructability. In all cases, the proposal to provide an interchange bridge must be justified and documented and may require an interchange type study and selection. Since interchange selection is often based on experience and engineering judgment, it can be a time-consuming and expensive process. Each interchange must be designed to fit individual project site conditions. The final design may be a combination of the above basic types and forms.

III. DESIGN AND CONSTRUCTION FEATURES OF INTERCHANGE BRIDGE

Interchanges bridges are important parts of highway design due to their significant impact on safety performance and operational efficiency. Interchanges bridges are grade-separated intersections of roadways that use structures to separate conflicting streams of traffic. Connections between the roadways are made potential with the use of ramps or loops. Interchange bridge eliminates the need for at-grade intersections on freeways, which improves safety performance and increases capacity.

Although bridge interchange offers significant advantages, they are also complicated, expensive and can degrade overall system performance if not designed and implemented properly because they are the source and destination of traffic. The proper design of an interchange depends upon many factors, the prime factor being the selection of the suitable type of interchange (Nicholas J. Garber, 1999). A variety of sources provide recommendations for proper ranges of design elements, including federal, state, and local guidance (AASHTO, 2011a and b). The principal reference is the American Association of State Highway and Transportation Officials Green Book (AASHTO, 2011a). However, design controls do not include attributes that are not critical for efficiency and safety, and are better suited to local decisions made within the context of the area; these include considerations of cost, right of way, adjacent land uses.

Recently, Both, Hong and Leisch have echoed this view; the major problem of interchange design is the selection of the proper type of interchange at a given location. Under the present day methodology of highways design, the selection of a particular type of interchange bridge at a particular location is one of the last decisions made in the preliminary design process. Clearly, the first step is to select a corridor through which the highway should be located. Then an analysis is made of several alternate roads resulting in the selection of a preferred road. In many cases, the final center line of the new facility is located without determination of the types of interchanges bridge that will adequately serve the traffic demands. As a result, sometimes it is impossible to build the most adequate interchange at a particular location. This work is referred to as pre-preliminary functional design (Leisch, 2005). Many agencies which have the responsibility for selecting the particular type of interchanges bridge to be used at a specific location seem to have their own preference of interchange type. Some state highway departments favor exclusive use of the diamond interchange bridge; others favor some variation of the cloverleaf; and still others seem to arbitrarily select the type of interchange to use at a particular location. On the other hand in some highway design agencies, interchanges are justified primarily on the basis of specific geometric design criteria, traffic service requirements, total construction costs, and potential road user benefits. Little consideration is given to the factors such as physical and cultural controls, esthetics, existing and future arterial street systems,

uniformity of interchange patterns, feasibility of stage construction, flexibility to accommodate unforeseen demands, signing and other safety considerations, present and anticipated land use adjacent to the interchange bridge.

Although engineering judgment should be applied to every design, the design controls sets the framework within which a designer must complete a design to sufficiently meet the needs of any interchange project. It is frequently desirable to rearrange portions of the local roadway in connection with freeway construction in order to affect the most desirable overall plan of traffic service and community development. Specifically, the following information should be available:

- Location and standards of existing and proposed local highways including types of traffic control.
- Existing and proposed land use including such developments as barroom, shopping centers, schools, recreational facilities, housing developments, and other institutions.
- A traffic flow diagram showing average daily traffic and design hourly volumes, as well as time of day, anticipated on the freeway ramps and affected local streets or roads.
- Relationship with adjacent interchanges.
- Location of major utilities, railroads, or airports.

Due to the interchanges sinuous architectural qualities, they tend to be the main focus of landscape and aesthetics design properties concerns. Safety, shade, drainage, gores and planting considerations can also affect interchange landscape and aesthetics design decisions. An interchange bridge type selection and design are influenced by many factors including the following: the community service, composition of traffic to be served, and topography, local planning, physical and economic factors and potential area development. All these factors mentioned should be obtained prior to interchange bridge design. In many cases, major interchanges bridges will be larger and more complex than the original junction. The choice of location will often be gravely restricted, compared with entirely new construction project. The traffic management on existing road section will often play a significant part in the assessment of options and the planning of construction.

The main feature of an interchange bridge is vertical grade separation of the intersecting routes to increase safety and efficiency as well. The grade separation is accomplished using a series of ramps and bridges to accommodate the various directional movements of the desirable interchange bridge. Within each interchange bridge type there are numerous variations in the ramp placement and configuration related to availability of right-of-way and traffic volumes.

IV. CASE STUDY OF GODOMEY INTERCHANGE

The Godomey Carrefour interchange is heavily traveled and represented the first major component of Benin gateway program for vehicles connecting to the outside world (Fig 2). The goal of this project is to relieve the rapid and seriously growing regional transportation congestion and promote economic growth through efficient movement of goods. The Godomey interchange bridge is a key project connecting segments of the original existing major National Highways, general traffic road and the newly planned west-east corridor. This project is located in the heart of Cotonou downtown, and will be a vital transportation link for city of Cotonou providing a gateway to the city for over 250,000 people a day. It consists of T-junction road with 2-lanes roads and 4-lanes roads. The traffic demand at this point, which links the town to job centers has also increased, 119,396 passengers per day in 2004. In addition, the interchange currently has the highest daily demand as it provides a crucial connection for the metropolitan vehicles services, local regional circulation, serves the country and other landlocked countries (Niger, Burkina Faso, and Mali) as pictured below.

Alternative designs were developed for the site characteristics. A "Trumpet A" type was recommended based on cost, feasibility, expected impacts on safety and efficiency, and ability to meet future capacity demands. The suggested design identifies and addresses safety and efficiency concerns by improving the geometry and pavement design of the interchange.

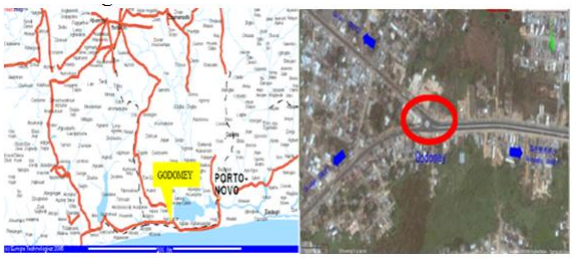

Figure 2: Project location map and existing roads network at Godomey Carrefour

Complexity Of Godomey Interchange

The construction area is surrounded by densely populated areas, shopping centers and oil stations which make the traffic quite busy at this point and therefore make also difficult the horizontal and vertical interchange design. The difficulties encountered are as follows:

1. For many years, the construction area has been blighted by heavy traffic passing through its narrow main roads. There are many buildings

around and it is also limited by the original existing roads network. The land area that can be effectively used for the interchange is quite small, creating a narrow geographical space.

2. Cotonou area is a transportation hub section due to high rate of urbanization and migration of people to the city and also the unchecked growth in vehicles which make its traffic volume extremely large. During the bridge design scheme, the traffic volume of existing roads and future social, environmental, economical and sustainability should be considered.
3. By considering the different attraction points in the construction area and the impact of the interchange to the local traffic, analysis of the traffic flows have been made, which enabled to identify possible and desirable connections.
4. Godomey interchange is located in developed area in the heart of Cotonou main urban zone along with the improvements in the oil station, barroom, shopping center and others. The current carrefour is the only one and unique important collection and distribution carrefour for people and good throughout Akosombo-Godomey, Godomey-Ouidah national highway No.1 (RNIE1) and Godomey-Calavi national highway No.2 (RNIE2). The construction area is the intersection of two sections of road (RNIE1 and RNIE2), for instance, Cotonou-Godomey (850m), Godomey-Ouidah (600m), and Godomey-Calavi road (600m) which makes the traffic center connecting east to west by RNIE1 and northern by RNIE2. This transport hub of Cotonou city serves as the gateway for vehicles connecting to the outside world. In addition, Godomey-Abomey-Calavi road is the only passage linking the northwest exit from Cotonou to RNIE2. Attracting local regional circulation, Cotonou is the financial and business hub of Benin and serves the country and other landlocked countries. Therefore, there are a great number of people and vehicles gathered and distributed, what makes design profile and beam column quite complicated. According to field survey, the construction site presented geotechnical engineering challenges which can cause great impact onto the ramp setting.
5. Underground pipe network at this place is quite complex. Regular communication, rain, drainpipe, electricity, postal channels and sewage pipes among other things of main urban zone with the diameters of several meters.
6. Since the construction area become developed along with the improvements of all the aforementioned, span and beam of ramp bridge are restricted in height such that they ensure comfort and safety to the street user and make the most effective use of all available resources.
7. Godomey interchange should be arranged and built, taking into account the everyday needs of the growing city whilst protecting existing environmental assets.

Difficulties In The Design Of Godomey Interchange

During the interchange design, numerous challenges as listed below can be encountered due to the particularity of construction area itself. Therefore, during the plan proposal, the following difficulties must be overcome:

1. The construction site presented geotechnical engineering challenges which can cause great impact onto the ramp setting.
2. Existing intersecting sections of road at the site are intricate and complex. There are two sections of road (Cotonou-Abomey-Calavi and Cotonou-Ouidah), three levels and two crossings, which makes it difficult to set the interchange ramp as overpass type. Simultaneously, because of an elevation difference between the bridges and the existing roads, it's necessary to increase the layers of the interchange, what was considered important apart from the convenience of motor traffic.
3. Construction site has become developed along with the improvements in the buildings, oil station and future development is also expected, and hence has much historical context. However, complex mega city engineering projects such as shopping and others in the construction area would make the interchange difficult in both plan and elevation meets current design standards and ensures that the highway meets the various demands placed on it. In order word, these engineering projects greatly limit the plan design, span layout of the ramp and produce higher requirements on ramp alignment design.
4. Shopping center can be seen at the middle of the construction area and need to be reserved due to certain causes and thus would affect to some extent the interchange design scheme and make difficult to set the ramp.
5. Cotonou-Ouidah section of bridge ramp has to pass through the main line at third positions upward and by-pass around the shopping center. Then, its alignment design will be limited by arrangement and elevation of bridge approach. Therefore, the bridge ramp will be greatly limited in alignment design.

Key Schematic Design Of Godomey Interchange

Considering the different characteristics of the site, the design that satisfies the following

overall goals would be accepted to operate safely and efficiently for the design life of Godomey project interchange. A systematic design process should be followed to assure that all design elements are in harmony and provide a high level of positive guidance. The recommended principals of Godomey interchange design objectives are as follows:

1. Sizing the bridge interchange to provide adequate capacity to satisfy expected vehicular traffic demand in an efficient and safety manner.
2. Selecting the most appropriate grade separation type, underpass and overpass for existing site conditions.
3. Providing a bridge interchange design that can be efficiently constructed, given Godomey construction area specific conditions in a minimum amount of time and traffic interruption.
4. Providing a fully integrated schematic design and build upon the scope a new landscape that would be welcomed by Cotonou local people.
5. Providing facilities appropriate to serve the expected bikes and pedestrians traffic pass under the bridge with 3.5m long.

It is significant to note that the foregoing list is certainly not exhaustive of all the important overall design goals and decision that need to be addressed and satisfied; however, it is provided to help focus the attention of Godomey bridge interchange design team on these items believed to be the most critical based on the results of the field survey conducted within this investigation.

In order to achieve the above design objectives, many difficulties need to be overcome during the schematic design stage. Four proposals were made during the preliminary design stage. The project program has been reviewed in detail and alternative design solutions were discussed. Then, two representative of the four proposals, were picked out for analysis, comparison and selection. At long last, based on a mutually agreed-upon project quality, budget, and schedule "Type Trumpet A" [Fig1: (b)] interchange proposal was determined. Like a cloverleaf, this type of interchange doesn't require many bridges, and designing for higher speed will take up more land. The T-type trumpet interchange involves the intersection of two roads that meet in a “T” shape. The through traffic should be placed on a direct alignment, while the left-turning movement with the lower volume should travel on the loop ramp. Trumpets are generally used exclusively when three intersecting legs are present. The proposed interchange type optimally suits the site constraints and it is significantly lighter than other bridge types, reducing the number of deep foundations and overall cost of the structure. Figure 3 depicted the most suitable structural style for the new landscape. The interchange reconfiguration has dramatically reduced the extent of interchange structure without compromising performance.

Godomey interchange proposal gives full consideration to the existing sections of road network RNIE1 and RNIE2, buildings, oil station, lake and influences of other factors. It's also reasonably makes full use of its complex topographic conditions.

Here, mains characteristics from among the construction area plans are described as follows:

1. Small in land occupation, demolition and relocation quantity without affecting the shopping center, oil station, barroom and hotel.
2. Clear traffic direction, favorable linear indicators, and 120 m for the minimum radius with relatively higher service level for Cotonou-Ouidah section road.
3. Shopping center, building, oil station, barroom and hotel are retained completed, which would not only benefit urban landscape and image, but also political conflict of interest.
4. Godomey and Abomey-Calavi sections of road are directly connected together and Ouidah and Cotonou road as well, and solve the problems of congestion left over by history since 1990s.

According to field survey of the interchange proposal, there are four ramps connected to the bridges for dividing vehicles driving on or off the bridges. They are:

1. A ramp starting from Cotonou to Abomey-Calavi, passing by Stadium of Kouhounou to the main Godomey Bridge going in a northerly direction.
2. A ramp starting from Ouidah to Cotonou, passing by Godomey School to the main Godomey bridge going in a southerly direction.
3. A ramp starting from Cotonou to Ouidah, passing by Stadium of Kouhounou to the main Godomey bridge going in a northerly direction.
4. A ramp starting from Abomey-Calavi road to the main Godomey bridge going in a southerly direction, passing by Cocotomey to Ouidah.

Figure 3: Godomey Type Trumpet an Interchange (Photo: D. D. BOKO-HAYA)

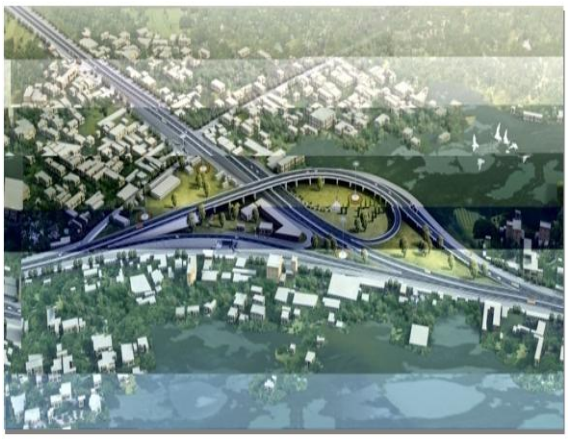

Figure 4: Plan of Godomey Type Trumpet A Interchange

Structural Design Of Godomey Interchange

Godomey interchange is set with four ramp bridges to connect to the bridge and the total length of ramps is 1,491.00 m. It also provides alternative walking and cycling opportunities to adjacent communities, 2 tunnels/undergrounds passage of 3.5 m each. Since the span of ramp bridge is limited by geographical challenges, bridge pier shall be arranged to try to avoid underground pipeline and others structure. The bridge design of the overall interchange falls between 20-22 m approach spans. According to survey current situation, the substructure of ramp is divided into two zones, i.e., original Godomey carrefour zone and newly built interchange zone.

To support the use of higher design pile capacities and minimize costs, static pile load test was carried out. At the original carrefour zone, in order to coordinate the substructure with original carrefour interchange pier, cylinder pier comprised a 1.5 m diameter (Fig.5) is adopted at outside zone of the shopping center, to approximately 80 m depth. Meanwhile, pier is of vase type pier to ensure its consistency with main four bridges approach in type.

Structural Features Of Godomey Interchange

Godomey interchange site is located in developed area in the heart of Cotonou main urban zone between Lake Nokoue and the Gulf of Benin. Around Godomey interchange, there are the lake, barroom locate in the northern part, building in the southern part, Cotonou in the eastern, Ouidah in the western, shopping center and others. Therefore, the surrounding topography is quite complicated. Complex construction environments bring more and more challenges to interchange construction. Problems such as: large difference between the surrounding existing roads network and bridges in elevation were considered important.

Because of the control of building, shopping center, underground structure, pipeline and clearance, bridge structure of interchange is quite limited. The span of the main beam of the interchange reaches up to 22 m. Godomey interchange superstructure is structured with prestressed concrete box girder and constructed with span-by-span cast-in-place.

Godomey interchange is the combination of existing road network and new bridges. At the Stadium of Kouhounou, vehicles coming from Cotonou can drive along connection ramp of the artery, then Godomey bridge and reach Ouidah, while original existing road network ramp can keep vehicles driving along Abomey-Calavi road. Vehicles driving on Ouidah road can drive along interchange ramp, then Godomey Bridge to reach Abomey-Calavi rapidly. These newly built interchange ramps are designed reasonably to reserve original carrefour and effectively develop the traffic functions of interchanges, thus dividing vehicles here.

1. Godomey interchange is closely integrated with urban environment in form and keeps harmonious with surrounding environment and landscape. As to interchange pier where ramp is lower and buildings are higher, existing interchange adopts cylinder piers. As a result, interchange where ramp is higher adopts cylinder piers as well.

Figure 5: Vase Piers of Godomey Interchange (Photo: D. D. BOKO-HAYA)

Figure 5: Vase Piers of Godomey Interchange (Photo: D. D. BOKO-HAYA)

Figure 6: Original Godomey Carrefour (Source: Google Earth)

Figure 7: New Godomey Interchange (Photo: D. D. BOKO-HAYA)

However, Cotonou Ouidah road by-pass around a shopping center, the ramp bridge adopts vase type high pier with a diameter of 1.20 m, 1.30 m to 1.50 m, which do not only meets the demands for basic traffic capacity of the interchange, but also coordinates with urban landscape.

2. Diversity of traffic function at the current point, also pedestrians can reach other places through exits. Proper setting of Godomey interchange ramp guarantees that traffic of any road will not affect vehicles of other ramps.

V. CONCLUSIONS AND RECOMMENDATIONS

In this paper, consideration is given to the development of bridges connection to network carrefour in Africa big cities through a review of literature, and through the investigation of Godomey interchanges using case study of Cotonou in Benin.

A first conclusion we can draw from this research is that ample guidance exists on development of interchange bridge design and construction features in general, mainly in international standards. Also a broad range of interchange bridge types existed. However, limited and scanty works have been done in this area of transportation studies in African big cities in general and Benin Republic in particular.

Secondly, a simplified method developed for Godomey interchange bridge planning and design practice in Benin Republic show that interchange planning and design are not fully adopted. Adoption of reasonable structure and construction method according to local conditions based on current situations and development is more important in the near future. This can serve as a means to identify further nontraditional interchange designs that might have been include as viable alternatives, and which could be refined in subsequent research effort.

Thirdly, it can be conclude that reasonable interchange bridge planning and design in continuity with the network carrefour in African big cities while allowing greater connection and realize rapid dividing of vehicles at existing roads is a complicated task that requires an integrated approach. Technical, planning and environmental consideration guidance need updating to be better addressed in guideline design (process).

It is expected that the finding of this paper will not only helps empower the transportation professional to promote creative and innovative thinking, but also will provide valuable reference for relevant design in Benin Republic for the coming years.

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