Eco Underpass Method

Solution for Traffic Congestion in Urban Area





Introduction

Inspiration of Public Structure Appearance

Current Concept of Public Structures

Structures that are constructed for use in public are generally considered as "Permanent Structures" where the main emphasis is to build a strong and durable structure with higher factor of safety. These structures are mainly reinforced concrete and expected to remain permanently, inflexible and bounded by three factors such as purpose, location and function of structure. Recently, such permanent structures have been demolished as the requirements have been changed. Vast energy and time have been spent to destroy such strong and durable structures and consequently, noise, vibration, exhaust gas and industrial waste are emitted. Considering the advancement of science and technology, the concept of public structures has to be reviewed to accommodate for the changing needs in accordance with cultural development

New Concept of Public Structures

If the concept of "Provision for Necessity" is fixed, satisfactory results cannot be achieved due to the fact that improvement in daily needs is a continuous process. Public facilities will be meaningless if they are not well suited to the new requirements, which change according to the progress of science, technology and cultural development. Therefore, the current phrase of "Permanent Structure" has to be redefined to a new phrase called "Functional Structure". Hence, "Functional Period" is the duration in which the structure is performing its function. With this new concept for public structures, the construction methods and requirement of intended structures will be totally different from before.

Design of Functional Structures

Functional Structures shall satisfy the current requirements and flexible enough to accommodate future adjustments once the purpose, location and function of the structure are changed. Hence, it is important to cater for this aspect during the design stage so that built structure can be easily removed once its functional needs have to be changed. This is the basic concept of "Design of Functional Structures". This concept also looks into the re-cycling aspect of removable materials after the demolition of a structure. Hence, structures built for public should be designed based on function and not only on the strength itself, allowing full flexibility in accordance to current and future requirements.

Construction Method for Functional Structures

Functional Structures shall satisfy the current and future requirements in accordance with changing social demands. Thus, the construction method for functional structures shall be flexible during both construction and removal stages. Most suitable construction materials shall be selected and installed by specialized machine so that the future demolition works for the functional structures can be done easily and systematically. Hence, it is important to establish specialized method for each sequence of works.

Life Cycle of Functional Structures



General Outline

Problems in Urban Traffic

In the modern society, automobiles has spread remarkably, and its benefit to our daily life is immeasurable. On the other hand, traffic congestions become chronic and one of major causes environmental problems such as traffic accidents, traffic noise and exhausted gas pollution. Despite of the high demand to immediately solve those problems, they haven't been solved, yet. Especially in big cities, traffic congestions are so serious that they affect to environment, economy and securities. The major cause of the problems arises at busy road junctions.

Why are the problems not solved? – 3 Major Negative Factors

Generally, the busy road junctions are situated in the city centre. The degree of difficulty for construction works in the area is high due to large passage of cars and pedestrians.

- ① Scarcity of Land Land acquisition is difficult for new structures. There is not enough space for construction activities.
- Construction Period
 Construction duration is usually too long to keep occupying existing traffics.
- ③ Construction Cost

Structure designs are complicated. Many work sequences are executed under restricted conditions. No specialised construction method is established.

Conventional Structure and Method – Large Negative Factors Involved

Conventional structures are built with massive temporary reinforced concrete retaining wall. Hence, constructing this type of structure will occupy large working spaces and necessitate many different sequences of works, and consequently higher costs and longer construction period are inevitable. Nevertheless, no appropriate construction machines and methods are available, yet. In urban area, construction of an underpass should not rely on conventional methods, because there are too many negative aspects on the both structures and construction methods.

New Type of Structure and Method – Three Major Negative Factors Solved

Structures and construction methods Giken proposes are "Functional Structure" and "Eco Underpass Method". "Functional Structure" can dramatically change the duties and sense of value on conventional structures. "Eco Underpass Method" is established for urban constructions based on the radically new idea. The basic concept of these ideas is derived from The Five Construction Principles; see p 13. It is capable of solving the 3 major problems by the new structure and method.

Features of Functional Structures (Implant Structure)

- ① The continuously pressed-in piles are employed as the both pile foundation and retaining walls for underground structure. Those piles are embedded below the base slab level and form a stable structure by integrating the retaining walls and slab. This rigid structure can prevent the effect of liquefaction by earthquake.
- ⁽²⁾ "Functional Structure" performs its function with full capability during the functional period. In case of any change in the purpose of this structure, it is easily demolished and removed.
- ③ The structure is so simple that it requires the minimum land acquisition and construction materials are saved efficiently. It requires less temporary works and less energy consumption, thus it is cost effective.
- ④ The employment of a pre-tensioned girder enables the reduction in the thickness of overburden soil and reduces the required land space. Hence, the construction period can be reduced to minimize the effect to surroundings.

Features of Eco Underpass Method

Eco Underpass Method applies the GRB System which has the superiorities of the Press-in principle. It is established as an urban rehabilitation construction method for constructing underpasses.

① Solution to Land Space

systemized machineries can be small and compact, allowing works to be carried out under restricted working space.

2 Solution to Construction Period

scheduled completion can be achieved because of the systematic sequence of works. Earlier completion can be achieved if multiple units are employed.

③ Solution to Construction Cost

structure can be constructed by simple press-in procedure at designated place, with emphasis on the "One-step Approach" to eliminate temporary works. Less construction material and energy is required, enabling a shorter construction period thus, reducing the construction cost.

4 Removal of Functional Structure

Structures that are for public use can be easily removed to accommodate the changes of purpose, location and function of structures, which will be considered during design stage. This method can be planned from the beginning to construct the underpass in urban areas without causing obstruction to the existing traffic and disruption to people and buildings.



This illustration is an example for a road junction. Other applications, such as crossing of railroads, approach part of tunnels and underground structures are also available.

Construction Method Comparison

Eco Underpass Method

The retaining wall is constructed using the GRB System where the whole piling operation walks along and clamps onto previous installed piles, enabling the wall to be constructed with minimum disturbance to the existing live traffic. Multiple units of machines can be mobilized on site to significantly reduce the construction duration and provide a total cost saving. Risk of collapse to the support system during temporary works is eliminated considering the fact that the top slab is constructed before the excavation work begins.





Conventional Method

Large working space is required using conventional piling equipments to construct the retaining wall system during the temporary stage. Bulky machine causes congestion on site, limiting the number of machines that could be mobilized at one time. Live traffic is disrupted, causing major inconvenient to road users during the construction stage. Temporary decks are required to construct the permanent structures.





After Construction



Features of Method

1 Piled Raft Foundation

Multi-Functions; Pile Foundation and Spread Foundation

Under this design, the retaining wall has the both functions of the temporary wall and bearing superstructure. After completion of the excavation work, the both sides of continuous pressed-in piles walls are connected with RC base slab. The extraction resistance force of the continuous piles will resist uplift forces due to high ground water table. The structure is also stable against liquefaction by earthquake.





[After Construction]

2 Propped Function Transfer Horizontal Force to Superstructure

The concept of this design is to transfer horizontal force to superstructures, the pre-tensioned girders. The cushioning materials are inserted between the parapets of abutments and the both ends of the girders in order to transfer not the bending moment but the horizontal force. In this design, the simple beam is applied, because the fulcrums are at pile tops. As the result, stresses and deformations are smaller than those in cantilever beam, and no massive substructure is necessary.



3 Press-in Piling Using GRB System with the Minimum Space

Piling can be feasibly executed using the GRB System without reduction to existing live lanes of road, resulting in less traffic congestion.



4 Safety Aspect

No Collapse of Road and Machine Stable

Construction of superstructure, such as pre-tensioned girders at level crossing extended part of slab structures, are completed prior to the commencement of excavation works. Road collapse, which is a common concern in conventional methods, is preventable. In addition, excavation work needs the only one layer temporary strutting.



5 Implant Structure -

Advantageous for Underground Lifelines

It is crucial to ensure that the construction is carried out without halting the life lines. To avoid the disruption of lifelines, space beside the road is necessary even during the construction works. The Giken wall system requires less excavation and shoring works, thus minimizing the working space and allowing existing life lines to carry on as per normal.



[Conventional Method]



Work Sequence

STEP 1 Press-in Piling Works at the Crossing Part -[Multi-Unit Execution]

- · Press-in piling at the crossing part
- Construction of abutments at the crossing part
- · Installation of cover plates at the crossing part







Pavement Work



Eco Underpass Method













Work Sequence







Ļ











Key Words

The Five Construction Principles

Even though construction industry has a tremendous influence to country, there is no definition for "Construction Work" in the industry. At least public woks must be described in a manner that people can understand. For the answer, "The Five Construction Principles" are the definitions, in accordance with public desire and the nature of construction. They consist of 5 aspects, Environmental Protection, Safety, Speed, Economy and Aesthetic with an equilateral pentagon shaped symbol. If any one of these aspects is missing in a construction work, this work will never be successful. If any one of them exceeds more than other aspects, this work will never be successful, either. From now all construction methods and contractors should be selected based on the Five Construction Principles rather than its size or history of the organisation and one's connections.



Implant Structure

In order to support and fix structure, a base part is constructed at the bottom of the structure. The base part is called "Footing" which unifies with the Earth and the structure. The Implant Structure is a structure unifies with the Earth without footing. This structure has advantages, which can eliminate negative aspects of conventional structures. It is a perfect model, which satisfies the Five Construction Principles. It can minimise working space and eliminate temporary works and some work procedures. Implant Structure can be removed easily after the end of its function or life cycle. It is substantial as ideal construction by the superiorities of Press-in method.



The GRB System

The GRB System is named from "Giken Reaction Base" and means a systematic method which is based on superiorities of Press-in principle. Under this system, the Press-in machine, the Clamp Crane and the Pile Runner are operated systematically on the top of installed sheet piles. There are 5 major characteristics, ① All machines hold those installed pile tops during operation so that it is safe from any collapse, ② No temporary work for operation stages, ③ No restriction or limitation on working condition such as slope, above water and urban area. ④ It is also applicable for removal work. ⑤ The minimum required working width is the same as the width of the machine, so that it is applicable in a narrow working space. Hence the GRB System contains all necessary functions of piling activities with Press-in principles. The GRB







Construction Solutions Company



CONTACT US

www.giken.com