A REVIEW OF RECENT LARGE-SCALE COASTAL INFRASTRUCTURE DEVELOPMENT OF HONG KONG SINCE 1990s’

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Abstract

Since the 1990s’, Hong Kong has been very active in the development of a number of large-scale infrastructure projects, many of which were involved with significant amount of coastal or marine works. These projects can be roughly categorized into 3 main areas; that is, projects of port and airport related, railway and highway projects, as well as some of miscellaneous nature like works for logistic support, new town, urban improvement, environmental or even of leisure and recreational purposes.

Representing examples for the port and airport projects include the new airport at Chek Lap Kok, the airport core projects in particular the reclamation at Wanchai, Central and West Kowloon, and the development of container terminals (CT No. 8 and 9) at Kwai Chung and Tsing Yi. The West Kowloon and North Lantau Expressway, the Airport Railway, the Western Harbour Crossing, Route 3 (Ting Kau Bridge), as well as some recently completed projects like the Improvements to Island Eastern Corridor at Quarry Bay and the West Rail (Tsuen Wan Station), are examples belong to the railway and highway category.

Lasty, the Hung Hom Bay reclamation, Tsueng Kwan O New Town, Cyberport, or the Disney Land at Penny Bay, are examples belong to the last categories.

This paper tries to provide an overall review of all the major infrastructure developments in the last decade in which coastal or marine works were involved. Besides, a brief engineering and technological summary for individual projects will also be highlighted. And finally, a review of the overall development strategies on a territorial scale, as well as the aims and purposes that these infrastructure developments may achieve, will also be discussed.

Keywords
Classification of Coastal Infrastructures, Airport Core Projects, Urban Development, Development Strategies.

1. Introduction

Scarcity in the supply of land is an inherited problem in the urban development of Hong Kong. Whenever where there is an ultimate need to perform some essential and large-scale community developments, one of the immediate solutions is to obtain the required land from the sea. The situation was becoming more critical after the 1970s’ when Hong Kong had experienced a rapid growth both in population or other sectors of economy. As a result, large amount of coastal infrastructure or related developments were carried out to satisfy a variety of needs. Such infrastructure developments, in majority, involved a large extent of reclamation. In general, the developments can fulfill the following functions from a territorial prospective:

- To provide land to support major strategic developments such as the development of new towns (e.g. Tseung Kwan O, Tung Chung), government or community facilities (e.g. West Kowloon Cultural District), or other specific social, commercial or strategic projects (e.g. Hong Kong Convention and Exhibition Centre, Science Parks, Cyberport).
- To facilitate the restructuring or thinning out of densely populated districts by providing lands for housing and other related facilities (e.g. West Kowloon Reclamation).
- To accommodate or to provide new land for major transportation infrastructure especially for those congested districts where new provisions or local re-routing is not possible (Island Eastern Corridor, Hung Hom Bypass, West Rail Tsuen Wan section).
- To provide basic port or other related facilities such as typhoon shelters, public piers, cargo bays, trans-shipment areas or container terminals.
- To provide land for use as pedestrian facilities, recreational or tourism enhancement projects such as the waterfront promenades as proposed in the Hung Hom Bay, Central/Waichai Reclamation, or South-East Kowloon Development.
- As part of the environment upgrading projects such as for sewage discharge (the Harbour Area Treatment Scheme), decontamination treatment (Kowloon Bay, Tsing Yi and Penny Bay) or outlying islands environmental improvement projects (Tai O and Peng Chau).

It should be noted that coastal infrastructure developments are often not single-issue matter. They are in reality usually of hybrid nature satisfying carefully coordinated urban functions, or even on a larger scale forming part of the overall territorial development strategies in terms of population, land utilization, urban re-structuring, logistic or transportation needs.
2. Extent of Coastal Infrastructure Developments

Quite a number of large-scale coastal infrastructure developments have been carried out since the 1990s’. These works can be classified in a more systematic ways under the following categories.

2.1 Works as part of the Airport Core Projects

As a strategy to coordinate and implement the huge project to construct the new airport at Chek Lap Kok, the then Provisional Airport Authority had sub-divided the overall works into more convenient packages known as the Airport Core Projects (ACPs). Altogether there were 10 ACPs of which many had coastal work components within. These ACPs included the Airport Platform at the Island of Chek Lap Kok, forming of the Tung Chung New Town, North Lantau Expressway, West Kowloon Reclamation, Western Harbour Crossing and the Central & Wanchai Reclamation. All of these projects contained a significant amount of reclamation and marine works. As a result, a total of more than 1400 hectares of new land was formed for the purpose of providing a new airport and other related long-term strategic developments. The time line for these projects spanned from 1992 up till the end of 1997. Below is some of the projects’ highlight.

The Airport Platform – The total area of the airport island is about 1250 hectares, with about 310 hectares coming from the original Chek Lap Kok Island. The man-made island (Photo 1) was formed mainly by sand-filling, with some crushed rock dumped as fill under the runway or areas where future construction is unlikely. Total length of seawall is 13 km, majority of which are armoured sloping wall. About 195 Mm³ of fill were required to form the island, of which 70 Mm³ came from marine borrow areas within Hong Kong waters.

Tung Chung New Town – Initially 60 hectares of land was formed by reclamation (Photo 2) to support the development of a new town with population aiming at 100,000 in late 2000s’. The reclamation was so designed with temporary seawall to allow for onward reclamation in incremental stages to fit for various growth scenarios.

North Lantau Expressway – This is a 12.5 km dual 3-lane expressway constructed along the north shore of Lantau Island. Majority of land required was formed by reclamation. The project package also included the formation of a 30-hectare rail depot, and a corridor for the Airport Railway and other essential utilities in parallel with the expressway. A portion of the natural seashore (in Tai Ho Bay, Photo 3), about 2 km in length, was also preserved as a means of protecting the eco-environment of the island.

West Kowloon Reclamation – This project package produced 335 hectares of land along the western shore of the Kowloon Peninsula (Photo 4). The newly formed land is used to support the airport-related transportation corridor as well as to provide the required land for strategic development in future. During the reclamation process, a great number of existing facilities (e.g. dockyards, whole-sale markets) and services (mainly sewage and storm discharge system coming from the nearby districts in West Kowloon) were required to be relocated, reprovisioned or redverted in order to integrate into the new planning.
Western Harbour Crossing – This is a 2 km dual 3-lane tunnel linking between Hong Kong Island and the West Kowloon Reclamation. The tunnel was formed by the using of 12 precast immersed tubes (Photo 5), each about 15000 tons in weight, and placed to pre-prepared seafloor by carefully controlled sinking process by the help of tag boats and barges. Both ends of the tunnel were joined to the approach section by stages of filling and re-excavation in order to make the joining structure land-borne for connection to be carried out (Photo 6).

Central Reclamation – This project package provided 20 hectares of land on the north shore of Hong Kong Island adjacent the Central business district (Photo 7). The newly formed land accommodated the Airport Railway’s Hong Kong Station and its approach tunnel heading to the railway harbour crossing tunnel. Besides, it also provided the land to support commercial developments, the profits so generated from which formed part of the funding sources for the Airport Railway.

2.2 Port Works

Hong Kong has developed his status as an international container terminal port back into the mid 1970s’ by the time when Container Terminal 1 to 4 (5 berths) were put into operation. There were 5 more berths (Container Terminal 5 to 7) put into operation during the 1980s’, followed by the 4-berth Container Terminal 8 in 1994 (Photo 8). By the end of 2000, the civil works for the construction of the Container Terminal 9 (Photo 9) commenced. Terminal 9 situated on a 150-hectare reclaimed site at the south bank of Tsing Yi Island facing Kwai Chung Basin with 6 berths when fully completed for handing over in mid 2004.
Besides container handling facilities, there is also port facilities for the handling of cargos coming from other smaller ports within the Pearl River Delta region. This facility is known as the River Trade Terminal which is located in a 65-hectare site at Tuen Mun West. This facility is multi-function in design serving general container and bulk cargo operation and storage, trans-shipment, marine shuttle, warehouse services, as well as container maintenance and repair. The River Trade Terminal was put into operation in 1999.

2.3 Transportation Infrastructure (other than the ACPs)

Majority of the transportation infrastructure where coastal works are involved belongs to roadwork. Listing from a chronological order, the following roadwork have been carried out since early 1990 in which significant amount of marine works were involved.

Kwun Tong Bypass – Part of the 3.7 km long viaducts were constructed and supported on marine piles outside the seawall of the Kwun Tong ferry piers. The viaduct was formed by box-section precast segment girder and erected to form the deck using truss-gantry type launching machine. Besides saving a lot of working space on the ground or water surface, this method can also eliminate the use of great amount of falsework. The project was completed in mid 1991 to signify the final completion of the Highways’ Route 6 system (previous trunk road numbering system, currently it is called Route 2)

Ting Kau Bridge, Route 3 (1996 - 1998) – The bridge consisted of 3 towers located on the Tsing Yi, mid-channel of the Rambler Strait, and on the Ting Kau side respectively (Photo 10). About 0.6 hectare of land was formed by reclamation on the beach of Ting Kau for use as the work depot as well as to situate the bridge tower on Ting Kau side. The centre tower was constructed on a man-made island (Photo 11) formed by rock and sand filling. Bored-pile foundation and the foundation raft for the tower was constructed afterward on the island. A semi-circular double-skin cofferdam (Photo 12) using grouted H-pile was formed on the Tsing Yi side as the footing for the Tsing Yi Tower.

Improvement to Island Eastern Corridor (2000 - 2003) – The project involved the construction of an 800m elevated carriageway on harbour with the structure supported on marine piles on seabed (Photo 13). The deck of the carriageway was formed by precast beams placed onto the pier portals by a crane mounted on barge. Besides, the new pier supports of the carriageway had caused obstruction or blockage to the existing unloading facilities along the nearby seawall. Some of these facilities have to be partially demolished or reprovisioned to give way for the positioning of the piers.
Forming the bored-piles to support the pier portals with drilling rigs stationed on temporary work platform along the existing slip road of the Island Eastern Corridor at North Point Interchange.

Improvement to Castle Peak Road (2002 - 2005) – In order to provide the required land for the widening or re-alignment of the existing 9 km roadway, about 2.5 hectares of land at various locations are formed by reclamation (Photo 14). Besides, a 800m section of viaduct will be constructed on sea at Tai Lam Kok to replace a number of awkward bends in the existing road alignment.

Narrow strips of reclaimed land are formed to provide extra space for the widening of the existing roadway in the Castle Peak Road Extension project.

Besides roadwork, some of the recent railway projects, such as the Airport Railway (in Central Reclamation, Photo 15, and in North Lantau), MTR Tseung Kwan O Extension (in Tseung Kwan O Reclamation, Photo 16) and the KCR West Rail Tsuen Wan West Station (reclamation being carried out to locate the new station and the approach tunnels, Photo 17), have contained certain amount of works located in close proximity to the coast or actually involved with marine work operation. Out of these projects, the largest involvement was the Airport Railway harbour-crossing tunnel and the West Rail Tsuen Wan West Station. For the former project, 12 precast immersed tubes were submersed into the seabed forming the dual-track tunnel linked between Central and the West Kowloon Reclamation. While for the latter, about 12 hectares of land was formed by reclamation to accommodate a new underground railway station as well as provided space to support other related developments at a later stage. The reclamation also required to demolish a ferry pier and redvert 3 main storm water discharge.
2.4 Formation of Lands for various purposes

As mentioned in section 1, new lands are often formed, usually by reclamation, for a number of urban development purposes. The followings are some of these major projects.

Hung Hom Bay reclamation – The project was completed in late 1994. The 36-hectare newly formed land (Photo 18) was designed for use as general residential and commercial developments as well as government, institutional and community facilities. In addition, the land was also used to construct a freight-yard extension for KCRC with development above the podium, as well as the Hung Hom Bypass and Princess Margaret Road Link as an improvement arrangement to the overall traffic condition of the nearby districts.

Aldrich Bay Reclamation – The project was completed in 1997 and 19 hectares of land was formed by public dumping in particular making use of the excavated spoil from the site formation of the Yiu Tung Estate in East Shaukiwan. The new land is used mainly for residential development and other institutional and community purposes.

Tseung Kwan O Reclamation – The new town of Tseung Kwan O was basically formed by reclamation from the Tseung Kwan O Bay since 1982. The current reclamation, commenced in 1995, is an extension to the town centre, in which about 60 hectares of new land was being formed (Photo 19). The use of the land is mainly for residential development and community purposes, as well as for the accommodation of the MTR Tseung Kwan O Extension Line. Besides, on the further east from the town centre, another 90 hectares of land was also formed for the Industrial Estate development.

Developments for specific strategic functions – The Cyberport (24-hectare land at Telegraph Bay, Photo 20), Science and Technology Parks (22-hectare land at Pak Sek Kok) and the Hong Kong Disney Land (280-hectare land at Penny Bay, Photo 21) are representing examples. These lands are formed by reclamation between 1999 to 2003 to achieve various strategic functions such as for the promotion and development of information technology, hi-tech research and development nurturing, or as large-scale enhancement project for tourism industries.

Photo 18  Aerial view of the 36-hectare Hung Hom Bay reclamation as seen in 1998 with the Hung Hom Bypass in place.

Photo 19  Tseung Kwan O Reclamation Phase 3 as seen in late 2000. The construction of the MTR Tseung Kwan O Station can be seen in the centre of the photo.

Photo 20  Final stage of reclamation at Telegraph Bay to provide the required land for the Cyberport Development.

Photo 21  Penny Bay Stage I Reclamation (sand filling by rainbowing process).
3. Common Features in the Carrying out of Infrastructure Coastal Projects in Hong Kong

As observed from the past experience, in particular for the carrying out of coastal infrastructure works within the built-in areas, a number of common features or problems can be observed. The below are some of the examples.

3.1 Relocation of existing facilities

A number of existing facilities can often be found in the coastline or seawall which are required to be decommissioned, relocated or re-provisioned before they are permanently sealed-off by the new works. Such facilities include, for example, shipyards, cargo unloading areas, servicing piers, private or government owned premises, pedestrian facilities or salt water intake points etc. The relocation of these facilities sometimes involves large amount of planning and arrangement in advance especially for those essential public services, or for properties owned by private organizations where compensation in the form of re-providing new facility to replace the disrupted one is called for.

Representing cases were the relocation of the public ferry piers (serving Central to Jordon Road) and the salt water intake plant for the cooling systems for a number of commercial buildings being disrupted by the Central Reclamation project in 1993 (Photo 22). Similarly, the relocation of a number of government/private owned shipyards and the whole-sale market at Chueng Sha Wan during the West Kowloon Reclamation (Photo 23), were another typical examples. In both cases, marine piles for the new ferry piers, reclamation for forming the land for the new facilities, or the construction of the new pump and piping systems for the salt water intakes, followed by the provision of new road to the new areas, were carried out in advanced phases. The old facilities would then be decommissioned and demolished after the completion of these advanced works. In some situations, a one-night change-over may be arranged in order to avoid any disruption to the essential services.

3.2 Extension or Re-diversion of Essential Services

Besides existing facilities, large amount of underground services such as sewage drains, storm water discharge, power cable or gas pipes may also be interrupted which require to be extended to the new seawall or be re-diverted to avoid cutting-across by other new underground facilities. Out of such services, the most significant work is the provision of new culvert for storm water discharge. This culvert system sometimes can be more than a kilometre in length and with a width of 20m to 30m in section (6 to 8 cells box). This kind of culvert can be constructed in a number of ways to fit various situations, such as in the form of large-sized semi-immersed sections, modulated sections, or cast-in-situ cells using tunnel formwork. The systems being employed in the KCR West Rail Tsuen Wan West Reclamation (1999) and the Tseung Kwan O Reclamation (2001) were very outstanding examples. In the former project, 3 existing storm discharge outlets were being cut-across by the approach tunnels of the new railway line. The construction of the new culvert systems had to be worked in tightly coordinated manner with the new Tsuen Wan Station (Photo 24). While for the Tseung Kwan O case, a 1.2 km long, 5m x 20m section (5-cell unit) culvert system was constructed using precast units that seated on pile-support ground beams (Photo 25).
3.3 Meeting with Extremely Fast-Track Schedule

Almost all infrastructure works in Hong Kong were carried out under an extremely fast-track schedule due to understandable reasons. When compare to the scale and complexity of these projects, the requirement to have the works completed in such a short time should be of no doubt creating enormous difficulties especially in terms of contract arrangement, resource allocation, construction planning and quality considerations. Take for an example in the construction of the Container Terminal 8. The first civil work started in December 1991 with the driving of the first marine pile for the berth of the container terminal. While 18 months later, the first container berth was put into actual operation with the remaining 3 berths followed within another 6 months. Situation was equally very tight for the construction of the Hong Kong Convention and Exhibition Centre. Reclamation commenced in August 1993. Exactly a year later, the first portion of land was required to hand over to the foundation contractor for the carrying out of the piling work for the upper structure of the Centre. While the outstanding works such as the provision of two vehicular link bridges, sea wall, ferry pier and other drainage works were scheduled to be completed at later phases. Needless to mention, the 340-hectare West Kowloon Reclamation projects, with the first contract commenced in October 1991 and all the major civil works substantially completed before mid-1994, probably made one of the world’s civil engineering record in works of similar nature and scale.

3.4 Environmental Protection Requirements

Being active as a busy harbour for more than a century, almost all seabed adjacent to the built-up areas in Hong Kong are to a great extent highly contaminated. Out of which, the area in the previous Hung Hom Bay, Tseung Kwan O, Quarry Bay (Tai Koo Shing), West Kowloon, Kowloon Bay, Yau Tong and Tsing Yi, may for sure exceed the mildest environmental standard according to current requirements. These areas have been used for decades as docks, ship repair yards, industrial unloading areas, temporary ship parking; as well as used for storage of fuels, recycled substances, or dangerous goods. The common pollutants exist in the harbour include large amount of heavy metals and toxic organic substances, in which trace of dioxins is often found. The current case in Penny Bay (Disney Land Theme Park) for the decommissioning of the former Cheoy Lee Shipyard should be one of the most eye-catching examples.

Due to the insufficiency in the statutory control in the past years, very limited de-contamination or environmental protection measures have been carried out effectively during the construction process of coastal works. The situation has been much improved after the mid 1990’s. By the time more stringent planning standards or monitoring and implementation procedures have been set to control all major works with environmental concerns. As a result, quite a significant amount of inputs are introduced in the pre and post contract stages to ensure projects can be enforced accordingly to meet the prescribed standards. These include the preparation of Environment Impact Assessment Report, appointing of environmental consultants, independent checkers; or in the providing of all necessary measures and facilities to minimize damages to the environment in the construction stage. And of course, effective measures to control the water quality such as by the providing of silt screen (Photo 26) or to closely monitor the approved dumping and marine borrow areas during dredging or sand-filling process; or other provisions to ensure air, land and ecological quality, or to control the production of noise and waste during the entire construction processes, are part of the routines in any large-scale project nowadays.
portion of works in respect of providing the necessary traffic links which at the end formed also part of the overall development. Take for an instance in the case of West Kowloon Reclamation, the Route 3 which provides a direct link between Hong Kong Island and the new airport, bypasses the newly formed land (Photo 27). There are 3 major interchanges with kilometers of slip roads bringing traffic into the nearby districts. In some cases, like in the Tsuen Kwan O new town or the new Theme Park at Penny Bay (Photo 28), rail services are also provided forming part of the strategic development of the area.

Photo 27 The Lai Wan Interchange of the West Kowloon Expressway (Route 3) provides outlets for high-speed traffic to enter into the West Kowloon districts at Lai Chi Kok.

Photo 28 The new MTR Yam O Station provides public transportation/railway interchange for visitors to get into the Disney Land Theme Park at Penny Bay.

4. Means of Procurement

In general, most of the coastal infrastructure developments are constructed, managed, owned and operated by the government. However, as a consideration to simplify administration and to avoid overloading the government structure, as well as to make the financial arrangement and operation of these developments easier in a long run, some of these infrastructure projects are delivered using other means of procuring methods. The usual government bodies responsible for the procuring of projects of the said nature are the Civil Engineering Department, Territorial Development Department, Highways Department and the Drainage Services Department.

While for some other types of projects, with examples as listed below, are delivered and operated under other form of arrangement.

The Airport – The Provisional Airport Authority (PPA) was set up to administer the construction of all the related projects (ACPs) leading to the final delivery of the new airport at Chek Lap Kok. After its completion in 1998, the PPA was converted into the Airport Authority, which is a statutory body and responsible for the running of the Airport under the entrusted conditions.

Railway projects – All railway projects are planned, administered and operation by either the Kowloon Canton Railway Corporation (KCRC) or the Mass Transit Railway Corporation (MTRC). They are having their own design standards, supervision and commissioning procedures when handling the projects entrusted to them by the government.

Projects of Build, Operate and Transfer nature – in terms of coastal infrastructure, only the three existing harbour crossing tunnels are delivered for operation under this form of arrangement.

Projects of other nature – as mentioned in previous sections, some developments of special strategic functions can be dealt with as individual negotiable case and arranged under specific commercial contract package between the investor or the entrusted body and the government. Examples of these projects are the Hong Kong Convention and Exhibition Centre, the Cyberport, Science Park and the Hong Kong Disney Land. In these cases, the government is still involved in the overall planning and coordination process, as well as in the early stage of civil works.

5. Current and Forthcoming Projects

One major project currently in progress involving significant amount of marine work is the construction of the Stonecutters Bridge of Route 8. The west tower of the bridge and its related approaches will be located on newly reclaimed land next to Container Terminal 9. The 1018m-span Stonecutters Bridges is a cable stayed bridge with its deck constructed in prefabricated steel girders, which will be hoisted directly from barges to the deck level for erection.

Another project recently commenced is the 24-hectaces Central Wanchai Reclamation Stage 3. The project when completed in 2006 will support the Central-Wanchai Bypass, two public piers, and other community facilities in particular for pedestrian and landscaping purposes. It also provides the required
land for the station and approach tunnel for the future Shatin-Central Link.

The other large-scale projects in the forthcoming years are mainly of cross-boundary nature, such as the Hong Kong-Shenzhen Western Corridor (HK-SWC) and the Hong Kong-Zhuhai-Macau Bridge Hong Kong Section (HZMB). The advanced portion of project (the Deep Bay Link) for the HK-SWC has been commenced in June 2003. While the detail studies and final stage of coordination with Mainland has been carried out since 2003. Finalization of the required details for commencing the actual construction is expected not later than mid-2005.

The Shatin-Central Line entrusted to the KCRC, will also include a harbour-crossing tunnel. One or two railway stations on the Hong Kong side will be built in reclaimed land. The detail planning is subjected to onward technical studies before the proposal is forwarded to the government for final approval. It is expected that the related civil works can be started not later than 2006.

There are also some more uncommitted projects that have been proposed in the recent transport studies by the government. However, due to a number of factors in particular in the shrinking in demand resulted from changes in economical or population structure, some of these proposals have been deferred subject to further justification or public consultation. Examples of these projects include the South-East Kowloon Development, Wanchai Reclamation Stage 2, or some highway trunk roads leading to Tseung Kwan O or Aberdeen with the use of viaduct constructed along existing coast line.

6. Conclusion

It was quite a prospectus picture when the government publicized the Territorial Development Strategy Review in 1996, by the time Hong Kong’s economy has climbed to its climax. Pro-active plans were stipulated in port, highway, railway and urban developments to cater for the expected growth of Hong Kong. However, after a few years, conditions varied and the growth scenario is even worse than the poorest situation expected. As a result of this, many projects supposing to be launched were being deferred or cancelled. Examples of these may be the Green Island Reclamation, Route 10 from Kennedy Town via Lantau Island to Yuen Long (including the Tsing Lung Bridge), or Container Terminal 10 to 12 at south-east Lantau.

On the other hand, public consciousness and concerns on the environment increased in particular for works that are carried out within the harbour or other environmental-sensitive marine regions. Before the carrying out of this kind of projects, tremendous time is used in consultation or legislation, and in the preparation of the environment impact assessment report. For some worse cases, the planning, consultation and legislation process even become a political issue that beyond the control of planners and engineers. This often makes the time line of development lengthened and cost for work increased. The role of the government as a strategic planner for the territory sometimes becomes blurred. It seems that the downfall of economy may not be the only cause of the situation. The Central-Wanchai Reclamation or the development of South-East Kowloon may be typical examples.

Fortunately, the overall contact between Hong Kong and the Mainland is growing very much tighter than any time before. Backing up by the manufacturing industries in the neighbouring regions, the role of Hong Kong as a logistic centre cannot be easily replaceable in the coming future. Building up of closer coordination between the governments to create better climate for more cross-boundary infrastructure developments should be a natural trend. In this respect, engineers should get themselves ready for the future challenges to come.

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