



**CONSTRUCTION
INDUSTRY COUNCIL**
建造業議會

Construction Industry Council

Task Force on Construction Industry Site Supervision Practice

REVIEW REPORT

ON

QUALITY SITE SUPERVISION PRACTICES

OF THE

HONG KONG CONSTRUCTION INDUSTRY

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List of Abbreviations

AACSB	Architectural & Associated Consultants Selection Board
AP	Authorized Person
AP's Rep	Authorized Person's Representative
AS	Authorized Signatory
AS's Rep	Authorized Signatory's Representative
BD	Buildings Department
BIM	Building Information Modelling
BO	Cap. 123 Buildings Ordinance
CIC	Construction Industry Council
CITF	Construction Innovation and Technology Fund
COI	Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project
CRE	Chief Resident Engineer
DfMA	Design for Manufacturing and Assembly
EACSB	Engineering & Associated Consultants Selection Board
HC	Higher Certificate
HD	Higher Diploma
IoT	Internet of Things
ISO	International Organization for Standardization
KPI	Key Performance Indicator
MiC	Modular Integrated Construction

NC	Non Conformance
NEC	New Engineering Contract
PAH	Project Administration Handbook for Civil Engineering Works (published by Civil Engineering and Development Department); and Project Administration Handbook for Building Engineering Works (administered by Architectural Services Department)
PNAP	Practice Notes for AP, RSE and RGE
PNRC	Practice Note for Registered Contractor
RC	Registered Contractor
RE	Resident Engineer
RGBC	Registered General Building Contractor
RGE	Registered Geotechnical Engineer
RGE's Rep	Registered Geotechnical Engineer's Representative
RPE	Registered Professional Engineer
RSC	Registered Specialist Contractor
RSE	Registered Structural Engineer
RSE's Rep	Registered Structural Engineer's Representative
RSS	Resident Site Staff (Note: refers to Resident Site Staff directly employed by consultants promulgated under Development Bureau Technical Circular (Works) No. 7/2018)
RSTCS	Registered Specialist Trade Contractors Scheme
SRE	Senior Resident Engineer

Supervision Code	Code of Practice for Site Supervision 2009
T1 ~ T5	Grade of TCP
TCP	Technically Competent Person
Technical Committee on Supervision Code	Technical Committee on the Code of Practice for Site Supervision
Technical Memorandum	Technical Memorandum for Supervision Plans 2009
UK	United Kingdom
WBTC	Works Bureau Technical Circular ■

Summary

A number of high-profile incidents involving alleged improper supervision processes and documentation in construction projects had occurred in recent years. In view of the increased public awareness of construction quality supervision practices and growing concerns, CIC commissioned a study to review the current site supervision practices of the Hong Kong construction industry, with particular attention to those related to major structural elements construction in building, civil and infrastructure projects. The review study covered three main areas of site supervision practices: 1) division of responsibilities, 2) documentation, and 3) application of innovation and technology, in both private sector and quasi-government projects regulated by the BD and Government public works projects¹.

The study included extensive literature review, benchmarking with overseas practices, structural interviews, focus group meetings, and project case studies. Views and suggestions were collected from a wide spectrum of stakeholders in the construction industry. It was evident from the study that there are well-established regulatory systems in place to ensure that construction works in Hong Kong are properly supervised. Also, there has been a culture and tradition that exists within the construction industry for works to be properly supervised and inspected, especially for structural elements. Nonetheless, a number of observations were made from the study, and the following areas for improvement are proposed:

- The level of quality supervision is loose and inconsistent among subcontractors, demanding more resource allocation for quality-related tasks and staff development investment.
- Current business environment is not conducive to main contractors to achieve quality construction through self-supervision.
- Site supervision personnel of consultants may sometimes take up minor design or detailing modifications (such as to cater for

¹ Hong Kong Housing Authority adopts a different site supervision practice for public housing development projects from other Government departments, and some observations and recommendations in the Review Report for Government public works projects may not directly be applicable.

unexpected site conditions) and a fair amount of administrative duties when projects become more complex.

- Checking of TCP site attendance and inspection records primarily relies on manual processes.
- Advanced digital technologies are yet fully applied in site supervision.

The following eight recommendations are made to address the above identified challenges and to improve the current site supervision standards by advancing professionalism of key parties and maximizing the use of digital technologies:

- 1) Advance subcontractor professionalism through phased registration on the RSTCS.
- 2) Introduce incentives for main contractors, with performance assessment by leading quality KPI, to incentivize diligent quality management and self-supervision.
- 3) Rationalize the duties of professional site supervision teams.
- 4) Implement e-reporting for TCP records and electronic submission for reports and other relevant documents.
- 5) Accelerate the use of digital technologies with the ultimate goal of creating an integrated supervision management and recording platform for all construction project stakeholders.
- 6) Attract and retain talents for quality supervision with certification for non-professional staff.
- 7) Drive collaborative culture from top-down by the Government and employers. Expand the use of NEC and other contractual partnering methods.
- 8) Adopt off-site construction.

Participants of construction activities are subject to a myriad of legal responsibilities. When dealing with statutory obligations, this study only focuses on the obligations under the BO. ■

Division of responsibilities

Overview of the Construction Quality Supervision System

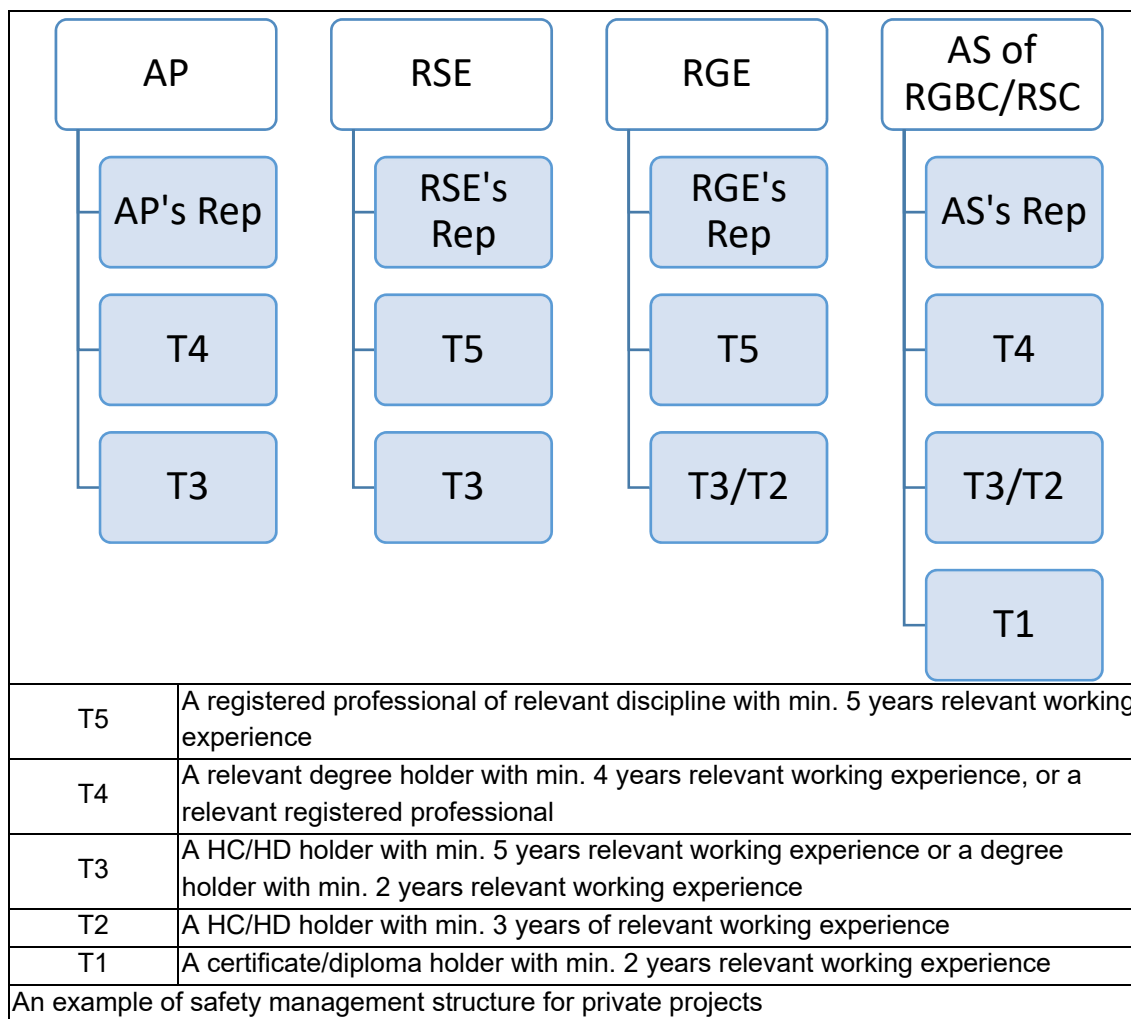
The construction quality supervision regime in Hong Kong focuses on design and process compliance with multiple layers of control and checking by various parties. Quality is ensured through compliance with the prescribed supervision requirements and related processes.

There are two quality site supervision systems in operation: one for private and quasi-government projects and one for public works projects. In the former system, the minimum site supervision requirements and related processes are governed by the BO² under the administration of the BD. As the design of buildings and their construction can be complex, it is necessary to provide closer supervision during certain stages of the construction process. Qualified supervision for certain stages of construction or for some particular operations may be imposed under the BO when granting approval of plans and consent for the commencement of the building works³. Failing to observe these site supervision duties, the parties involved may be subject to prosecution under the BO while AP, RSE, RGE as well as RGBC, RSC and their AS may additionally be subject to disciplinary action.

An example of the safety management structure for private projects pursuant to the Technical Memorandum is shown below. TCPs under the streams of AP, RSE, RGE, RGBC and RSC are engaged. Details of the minimum requirements for the relevant disciplines of diplomas, HC/HD, degrees and registered professionals are given in the Supervision Code.

² Reference can be made to Technical Memorandum, Supervision Code, PNAP ADM-13, PNAP APP-157, PNAP APP-158, PNRC 31, PNRC 76 and PNRC 77.

³ A new PNAP on conditions and requirements commonly imposed under the BO upon granting approval and consent will be shortly issued by BD.



Public works are exempted under the BO. The quality site supervision requirements of public works are given in the AACSB Handbook⁴, EACSB Handbook⁵, RSS Handbook⁶, PAH, WBTC and other relevant circulars or guidelines. Generally, contractual requirements on par with the statutory requirements for quality site supervision are imposed on consultants and contractors. Reference on the normal duties and minimum qualification and years of working experience required for the common ranks of RSS,

⁴ Handbook on Selection, Appointment and Administration of Architectural and Associated Consultants published by the AACSB.

⁵ Handbook on Selection, Appointment and Administration of Engineering and Associated Consultants published by the EACSB.

⁶ Management Handbook for Direct Employment of Resident Site Staff by Consultants for Public Works Project published by the Development Bureau.

including CRE, SRE, RE, etc. are given in Appendix 7.4 of the RSS Handbook.

For public works, the AACSB and EASCB maintain their Lists of consultants while the Development Bureau maintains the List of Approved Contractors for Public Works and the List of Approved Suppliers of Materials and Specialist Contractors for Public Works. These approved consultants and contractors are normally engaged in public works projects. Except otherwise specified, major consultants and contractors are required to satisfy the ISO requirements on quality assurance practices as part of the entry requirements of the abovementioned Approved Lists⁷. For some special public works projects, open tendering instead of selective tendering would be adopted⁸.

Similar to the site supervision practices of Hong Kong, public works projects in Singapore are exempted from the Building Control Act which is comparable to Hong Kong's BO.

In the UK where most of the public built assets have been privatized, there is little distinction between public and private construction projects and thus they are essentially under the same site supervision system. Compared to Hong Kong, the UK adopts a fundamentally different system which relies on independent checking and certification. The UK authorities have relatively little control over the construction process, and building professionals are expected to deliver quality works by whatever supervision necessary as part of their professional duties. Great responsibility is placed on independent certifiers to ensure the overall quality of the completed works.

⁷ WBTC 13/2001 states "*all consultants that are administered by the Works Departments and approved by the AACSB and EASCB are required to have obtained ISO quality certification. However, the certification requirements under this Circular are not applicable to sub-consultants*". Appendix C of WBTC 13/2001 also lists out those selected categories of approved contractors requiring ISO quality certification.

⁸ Stores and Procurement Regulation of the Government defines that in open tendering, all interested contractors are free to submit their tenders; in selective tendering, only contractors on the relevant approved lists of contractors are invited to submit tenders.

A comparison of Hong Kong’s construction quality site supervision systems on major structural elements with that of Singapore and the UK is given below.

	Continuous supervision	Periodic inspection	Spot check
Hong Kong Government Projects	Main Contractor (Site engineer/foreman)	Consultant (RSS) or in-house staff ⁹	Project Office (e.g. technical audit by independent team)
Hong Kong Private Sector and Quasi-Government Projects	RGBC, RSC and their TCPs (T1~T4) ¹⁰	AP, RSE, RGE and their TCPs (T2~T5) ¹⁰	BD (Site audit ¹¹) Employer (in-house staff ¹²)
Singapore	Main Contractor	Site Supervisor (independent from the design consultant)	Qualified Person (independent from the employer and contractor)
	Supervision & inspection as deemed appropriate		Ensure overall quality
UK	Main Contractor		Independent Certifier

Comparison of site supervision systems among Hong Kong, Singapore and the UK.

In Hong Kong, the roles and responsibilities of key stakeholders and their responsible personnel are well covered with sufficient layers of safeguards. For private and quasi-government projects, the minimum site supervision requirements and related processes are governed by the BO which is administered by the BD. The current stringent statutory control on site supervision was first formulated in response to a serious fatal incident in the 1990s and has been kept under regular review (including legislative amendments to the Technical Memorandum and amendments to the Site Supervision Code) by the BD, with the assistance of the Technical Committee on Supervision Code, after consultation with the industry through the established consultative committees and legislative amendments. The Technical Committee on Supervision Code and the consultative committees comprise representatives from professional institutions, stakeholder organizations (including contractors’ associations)

⁹ Full-time on site.

¹⁰ Subject to statutory responsibilities under the BO. PNAP APP-158 and PNRC 78 are relevant.

¹¹ Details are given in the PNAP ADM-18.

¹² Some employers deploy its in-house staff full-time on site and conduct periodic inspections.

and academia. This contrasts with the UK where the performance of site supervision duties is not governed by statute but relies on professional duty of care.

It is also worth noting that, while the Technical Memorandum, the Supervision Code and additional conditions imposed under the BO specify the minimum site supervision requirements, more frequent inspections or greater manpower would often be deployed as per the requirements of the employer in practice. For example, a T3 under RSE stream is required to conduct weekly regular and task-specific inspections, but in reality the RE acting as T3 would be on site full time, carrying out daily inspections under the employer's contractual requirements.

The Technical Memorandum and Supervision Code have clearly defined the responsibilities and duties of the AP, RSE, RGE and AS of the RGBC/RSC as well as their site supervisory personnel (i.e. their Representatives and TCP). The AP, RSE, RGE and AS of the RGBC/RSC shall have full responsibility and accountability for their respective functional stream. They are responsible for devising checklists by reference to the typical items, and inclusion of any other particular items considered essential for their projects, including those for specific tasks for quality supervision and any other conditions imposed under the BO for compliance by their TCPs. In general, the industry has sufficient knowledge of their duties and responsibilities under the BO.

While BD maintains its independent role as regulator, it has been playing a proactive facilitation role in the building development process as promulgated in PNAP ADM-19 and communicating with industry stakeholders through various established communication channels. BD maintains close dialogue with the industry to formulate more facilitation measures that will benefit the industry as well as to achieve the larger goal of creating better quality construction and buildings. To properly assign duties and responsibilities, BD continues to enhance the building control system so as to provide more guidance to practitioners, and give clearer and more precise description of the requirements and responsibilities of various parties under the BO.

Since promulgation of the Supervision Code in 2009, amendments have been made in 2015, 2016 and 2019 in view of feedback from the industry. BD has recently reviewed the Supervision Code and proposed amendments with a view to promoting an administrative TCP list and providing further details on the definition of supervision, record keeping requirements and non-conformance reporting, thus strengthening the requirements regarding obligations of site supervisory personnel and communication among site supervisory personnel to ensure delivery of design intentions in construction projects. The proposed amendments, include highlighting the manner of continuous supervision by full time TCP, completing and keeping inspection records and site supervision reports contemporaneously, keeping these records and reports by responsible functional streams, enhancing non-conformities reporting procedures, maintaining communication among TCP of different function streams, emphasizing the responsibility of the heads of each functional stream in ensuring their representatives and TCP are fully aware of supervision requirements, etc. Having consulted the industry via the established consultative committee in the second quarter of 2020, BD will promulgate the amendments to the Supervision Code in the third quarter of 2020.

With a view to providing a concise document on the requirements and responsibilities under the BO to the AP, RSE, RGE, RGBCC and RSC as well as their respective site supervisory personnel, BD has drafted a new PNAP which consolidates various requirements relating to specific tasks and testing of materials (e.g. quality supervision plan for specifying the installation requirements of ductility coupler splicing assemblies, on-site sampling for testing, etc.) imposed under the BO when approving plan submissions, so as to provide more precise descriptions of the requirements and responsibilities. BD has completed consultation with the industry via the established consultative committees in the second quarter of 2020 and will promulgate the new PNAP in the third quarter of 2020.

Supervision duties are discharged by various project parties. Required qualification, years of relevant working experience and duties of supervision personnel are generally well documented either in the RSS establishment approval for Government projects or the Technical Memorandum, the Supervision Code and various PNAP and PNRG for private sector or quasi-government projects. Depending on the types of

construction, building methods involved and the use of certain construction materials (e.g. in-situ reinforced concrete, structural steelwork, structural glass elements, etc.), task specific supervision requirements would be imposed as conditional to approval or consent to commencement of works. Additional requirements beyond the statutory minimum as deemed necessary by the employer, such as compliance with a recognized quality management system, are imposed as contractual requirements for the main contractor or the consultant. There are sufficient deterrents to ensure those involved in the supervision process duly discharge their duties. For Government projects, performance of RSS is assessed by the RSS performance appraisal system which keeps records of RSS's standard of work and conduct during their services, and provides the basis of any recommendation for the grant of annual increment and/or end-of-contract gratuity or extension or renewal of their employment contract. For private sector or quasi-government projects, one may even face prosecution and disciplinary action for contravention of the BO.

Subcontractors

Under Hong Kong's subletting practice, the majority of construction works are carried out by subcontractors, but it is observed that their quality site supervision performance may be inconsistent. Subcontractors have the same responsibilities as main contractors (i.e. RC/RSC) for quality site supervision under the BO because all personnel involved in the construction works, viz. AP, RSE, RGE, RGBC, RSC, AS of RGBC/RSC and their site supervisory personnel, subcontractors, site staff and individual workers are liable under the BO and may be prosecuted if there is sufficient evidence that they have contravened the BO. No matter private or public works projects, subcontractors are controlled under contractual provisions between the main contractor and the subcontractors, or may be dictated by the employer in the case of named or nominated subcontractors. Fundamentally, inadequate performance of the main contractor and subcontractors in supervision directly affects the quality of the built asset.

Under their contractual responsibilities, subcontractors are duty-bound to ensure the quality of their own trade of works. In addition, under the BO, TCPs are required to be nominated by the AP, RSE, RGE, RC and RSC for different types of works. Taking steel fixing for foundation as an example, the RSC for the foundation work should have a T1 while the RGBC should have a T1 for the superstructure works. In this connection, the RGBC can nominate a staff member for its steel fixing subcontractor as T1 for the superstructure works provided that the person being nominated meets the qualification and experience requirements of the Technical Memorandum and Supervision Code for superstructure works. In addition to the inspection by the T1 of the RSC regarding the number and size of the starter bars, the TCP of the RSE should also have counter-checked them while the T1 of the RGBC would also check the number and size of the starter bars. In general, the AP, RSE, RSC or RGE, where appropriate, must certify completion of the foundation works to their satisfaction before consent for commencement and carrying out of the superstructure works would be granted under the BO.

In main contracts, employers in general appreciate the value of engaging a competent main contractor. Two-envelop tenders (technical and price) are usually adopted to ensure the competency and resourcefulness of the

main contractor being engaged. However, in the subcontract tier it is still prevalent for subcontracts to be awarded to the lowest bidder. The capability, resources and experience of some subcontractors may be questionable and difficult to ascertain, the problem may further be exacerbated by the relatively high labour mobility as construction workers continue to be predominately employed on a daily wage or piecework basis. There is little incentive, and hence often only marginal resource is allocated for quality works and invested in staff development, especially at the subcontract tier.

At present, CIC administers the RSTCS for selected trades¹³. The RSTCS aims to elevate the performance standard of subcontractors through progressively more rigorous registration requirements. Regulation of subcontractors to ensure quality supervision and assurance is generally supported by the construction industry.

Reference is also made to Achilles¹⁴ in the UK, an independent validator and auditor of supply chains from different industries, which offers impartial reports on different aspects of a vendor or supplier, and employers could base their procurement decisions on such data. Some benefits quoted by Achilles include “employees at Achilles audited companies are 40% less likely to have an accident at work” and “an estimated £22,000,000 per year was saved on supplier qualification in the UK utilities industry”.

¹³ Demolition; Reinforcement bar fixing; Erection of concrete precast component; Concreting formwork; Concreting; Scaffolding; Curtain wall

¹⁴ <https://www.achilles.com>

Main Contractors

Main contractors play an indispensable role in the construction quality of the built asset. Under typical construction contracts, main contractors are ultimately responsible for discharging the supervision duties stipulated in the project quality supervision plan. Those duties normally include deploying the required staff (both in qualification and number) to supervise site construction works, irrespective of whether the works are performed by their direct-employed staff or subcontractors. Main contractors should also be responsible for the coordination and management of interfacing between the subcontractor trades. However, under a fiercely competitive business environment, main contractors lack real incentives for disciplined self-supervision. It would be the case for some main contractors to deploy less resources towards self-supervision and relying on others' checking. Sometimes, defects and other quality issues might not be discovered promptly and could only be dealt with when they are discovered by other parties (e.g. AP/RSE/RGE's TCP, employer's in-house staff, RSSs and REs).

In private sector projects, main contractors are registered as RGBC or RSC and they have statutory responsibility of supervision duties under the BO in addition to their contractual duties. Provided that the nominated TCPs fulfil relevant qualifications and working experience for the respective type/category of works required under the Technical Memorandum and Supervision Code, main contractors can assign supervision duties under the BO, notably the provision of TCPs, through subcontract arrangements, especially when nominated subcontractors are engaged.

For example, a subcontractor for the installation of a curtain wall being nominated as T1 of the RGBC for the curtain wall works is acceptable provided that the T1 meets the relevant qualification and experience requirements as laid down in the Technical Memorandum and Supervision Code. Regarding the installation of the cast-in anchorage, there should be another T1 of the RGBC supervising the installation works. The T3 of the RSE should also have counter-checked the installations. Moreover, irregularities of the cast-in anchorage revealed during the course of the curtain wall works would be reported to the RGBC for rectification as a normal and proper practice.

Site supervisory personnel, as required under the Technical Memorandum and Supervision Code irrespective of whether they are the employees of the main contractor or subcontractor, should meet specific requirements on qualification and experience. Only suitable grade of TCPs having the relevant qualifications and working experience for the respective type/category of works should be nominated. In addition to checking by AP/RSE/RGE/RGBR/RSC on the suitability of TCPs to be included in supervision plans, BD will conduct audit checks on the suitability of TCPs nominated in the submitted supervision plans to ensure adequate numbers of various required grades of TCPs have been provided for construction works according to the Technical Memorandum and Supervision Code.

The practices on control mechanism in Singapore and the UK, where personnel involved in supervision activities are certified by their respective certifying bodies, can be further explored to see if such facilitation measures/approach could be made reference to in enhancing the site supervision regime in Hong Kong.

Consultants and their Site Supervision Personnel for Public Works Projects

Consultants are responsible for the design and subsequent supervision of the concerned construction works. Consultants' supervision duties involve vetting of materials, construction methodology and programme submitted by the main contractor, hold point inspections, checking of materials on site, monitoring of critical construction activities and settlement records, etc. Apart from supervision duties, the site supervision personnel of consultants may sometimes take up minor design or detailing modification work (such as to cater for unexpected site conditions) and a fair amount of administrative duties when projects become more complex. Therefore, diligent management of tasks and staff deployment by the consultants is important to ensure their supervision duties are discharged properly.

Consultant's site supervision personnel who are professionally registered or qualified members of professional institutions have undergone structured training and vigorous testing. They should possess sufficient knowledge on their supervision duties. Strong professional ethics are also demanded from individuals to act impartially under challenging situations.

Employers and Regulators

Under the current regime, the BD exercises statutory control on site supervision under the BO for private and quasi-government projects, while different employers may have different degrees of involvement in the supervision process depending on the type and scale of their organization, but there is no doubt that it is ultimately the responsibility of those directly involved with construction, such as AP, RSE, RGE, consultants and contractors, to duly discharge their site supervision duties and ensure the quality of the works.

As it stands, the employers should understand that adequate resources provision is of paramount importance to the engagement of a pool of competent personnel to exercise site supervision duties, whom in turn would be responsible for the quality of the works. BD will conduct audit checks to ensure that the AP, RSE, RGE, RGBC, RSC, AS and TCPs are discharging their duties as required under the Technical Memorandum and Supervision Code. ■

Documentation

Construction quality supervision relies on effective site supervision and process control, and proper documentation records on how site supervision duties are discharged and processes complied with. The current documentation requirements in both the private and public sectors are considered comprehensive. Inspection records capture the site situation of critical stages or hold points of construction activities, including the structural elements inspected by respective site supervision personnel at critical stages and hold points. They provide good traceability of factual information for future review when necessary.

Many supervision workflows currently rely on paper records, where multiple parties are required to sign on the same physical form as supervision by different parties progress. Paper records are prone to damage and loss at working areas and, therefore, generally less efficient. Whilst many organizations follow a formal quality management system (e.g. ISO 9001), where document control, including record of inspection and defect rectification, is well maintained, missing records sometimes still occur due to mishandling, carelessness and/or poor site housekeeping.

Due to tight construction programme and/or inadequate site management, it has been noticed that timely completion (i.e. duly signed by all responsible parties at hold points) and filing of paper-based site inspection records is a challenge for some projects. Backdating of inspection records has been reported, which in turn places doubt over the authenticity of such records. Clearance of these backlog of verbal endorsements by memory not only undermines the credibility of the whole inspection/supervision system, but also affects the accuracy and consistency of the inspection records. The situation becomes more complicated if the responsible individual leaves the project team subsequently. This undesirable situation can be mitigated by completion of inspection records and filing via electronic means contemporaneously. This simple and straight forward approach has been adopted by some effective site supervision teams. Definitely the application of digital tools for recording will ease daily workload.

Use of instant messaging applications (e.g. WhatsApp and WeChat) has become a common means for documentation due to their accessibility. On the one hand, this has raised the awareness of subcontractors on the importance and need of records and documentation. On the other hand, this form of documentation is becoming increasingly difficult to trace unless dedicated resources are deployed to organize the records in a timely manner.

In the overseas practices reviewed, utilization of digital solutions for documentation is much more prevalent, which has led to relatively more foolproof and streamlined documentation handling. ■

Application of innovation and technology

Digitalization of supervision workflow and documentation in the construction industry in Hong Kong is not common in general. Many practitioners perceive the technical complexity and strict requirements of digital solutions as major deterrents to their adoption. Furthermore, the adoption of digital solutions is often an employer-driven decision, thus it could be difficult for contractors to initiate and implement, even with proven benefits. Cost is also a prohibiting factor for smaller organizations. Nonetheless, there is clear support from industry stakeholders on the adoption of technologies. A number of local organizations and construction companies have already extensively embraced digital construction.

There is noticeable progress by some recent projects in the digitalization of their supervision and workflow. The Development Bureau has spearheaded the implementation of digital solutions for its future projects. The CITF was set up by the Development Bureau and is being managed by the CIC to encourage wider adoption of innovative construction methods and new technologies. A number of digital supervision solutions are supported by the CITF and are gaining popularity in the local industry.

At present, checking of TCP records and associated inspection records still relies on hard copies during site audit inspections by the BD and submission to the BD. Documentation checking would become more efficient and timely through digitalization and centralized storage.

The adoption of digital supervision workflow can streamline many of the repetitive paperwork associated with current practices. It allows real-time monitoring of inspection status so management can much more easily spot any potential problems before they are manifested. Other project management tasks such as progress monitoring and payment certification can be integrated for even more efficiency.

All solutions offer cloud-based storage for remote accessibility. Site Supervision personnel could easily complete inspection records on the spot without needing to worry about the physical perils of paper forms. And since all data is uploaded in real time with full audit trail, the risk of tampering is minimized and the personnel would have a strong impetus to complete the records in a timely manner.

The fifth generation (5G) cellular network could offer much higher bandwidth and almost zero latency when compared to the fourth generation. With the launching of the 5G services, the application of technologies such as video analytics and real-time monitoring through IoT devices in construction sites would become much more practical.

The Government has pledged HK\$100 million in the 2020-21 budget to develop an integrated digital platform for data integration and information exchange to strengthen project supervision in Government projects. Starting from the second quarter of 2020, all Government projects will adopt the digital works supervision system in phases. The Development Bureau further issued Technical Circular (Works) No. 3/2020¹⁵ setting out the policy and requirements on the adoption of the Digital Works Supervision System in capital works contracts, with pre-tender estimate exceeding HK\$300 million, under the Capital Works Programme tendered on or after 1 April 2020. ■

¹⁵ <https://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/374/1/C-2020-03.pdf>

Recommendations

Having identified the challenges and opportunities faced by the construction industry, five recommendations (Recommendation 1 to 5) are proposed to address these challenges. Further three recommendations (Recommendation 6 to 8) are proposed in recognition of the development trends in both the local and international construction communities with an aim to generally elevate the construction quality supervision standard.

The eight recommendations given represent directions that the construction industry would be heading. Further studies would be warranted to develop implementation details of these recommendations. It is envisaged that by embracing these recommendations, the entire industry could improve on the current site supervision practices.

Recommendation 1 – Advance subcontractor professionalism through phased registration on the RSTCS

The RSTCS¹⁶ currently operates on a voluntary basis. Employers and main contractors can choose to engage Registered Specialist Trade Contractors and Registered Subcontractors on their own accord. Since the implementation of RSTCS in April 2019, major construction stakeholders have supported the RSTCS and have been incorporated into public works.

Requirements on quality performance of subcontractors should be tightened progressively, particularly the qualifications and experience of subcontractor staff and a demonstration of effective quality management system and processes. RSTCS should provide support to registered subcontractors for building up their in-house expertise and staff competency.

It is the vision of the RSTCS to have all subcontractor trades under the previous Subcontractor Registration Scheme to be regulated under the RSTCS. Priority should be given to migrating structural works trades not already under RSTCS, such as structural steelwork, with other trades to follow progressively.

When a pool of competent registered subcontractors has been built up, strengthening the requirements on the engagement of registered subcontractors could be further explored. Reference could be made to the roadmap of workers registration.

Employers could accelerate the journey towards professionalism and reap the benefits of a competent supply chain by offering financial incentives in the form of more weighting given to technical scores associated with quality performance of key subcontractors in tender evaluation. The employer

¹⁶ RSTCS aims to build up a pool of professional and responsible trade contractors with specialized skills through enhanced registration requirements. It comprises Registered Specialist Trade Contractors of seven designated trades and Registered Subcontractors of other common trades.

would benefit from an enhanced supply chain with more efficient deployment of resources towards quality.

As an added benefit, by adopting a recognized registration system, the scope of tender prequalification exercises and screening for basic competency could be reduced. Tender assessment efforts could then be focused on project specific requirements, thus achieving efficiencies for all parties involved.

Recommendation 2 – Introduce incentives for main contractors, with performance assessment by leading quality KPI, to incentivize diligent quality management and self-supervision

Main contractors hold the primary responsibility in construction quality. It is important to formulate tender evaluation and contract management schemes that are more conducive for the main contractors to put in place vigilant site supervision to deliver quality construction, with or without other layers of site supervision. It is recommended that consideration should be given to:

1. Introducing incentives for diligent quality management
2. Incorporating leading KPIs (in addition to traditional lagging KPIs) in regular quality performance evaluation

It should be noted that these measures to enhance construction quality are over and above the statutory requirements. They should not be taken as measures to achieve statutory compliance in view that even without these additional incentives and KPIs, main contractors are required to comply with statutory requirements.

Incentives could be provided by employers when payments are tied to performance of quality supervision and management activities. Leading KPIs would encourage self-supervision, and an example of which would be the percentage of first-time satisfactory inspections. This would encourage proactive self-checking and rectification by the main contractor before inviting RSS, RE, AP/RSE/RGE (including their TCP) or employer's in-house staff (as the case maybe) to inspect the works. Another example of KPI would be the level of senior management's participation in quality site walks. Mechanisms that allow a portion of payments to be directed to the responsible subcontractors should also be in place.

When sufficient past performance data has been collected, quality performance should be a key factor in contractor selection with sufficient weighting to signify its importance.

The ultimate goal is to instill a culture where main contractors are dependable, self-disciplined professionals comparable to architects, engineers and surveyors.

Recommendation 3 – Rationalize the duties of professional site supervision teams

Site supervision personnel hold an important role in quality supervision. In some construction projects, they may be under huge pressure to maintain progress, particularly for those projects under intense scrutiny by the client and the public. Appropriate level of workload should be assigned to site supervision personnel for them to perform their supervision duties properly.

Site supervision personnel should focus more on results-orientated inspections for assuring that quality and design intent are being delivered rather than mechanistic checking and administrative procedures. Consultants should look into investing in highly competent staff with the right mindset who can help mitigate and prevent site problems. This should be supported by the consultants' head office through expertise and structured training. Hence, appropriate site organization structure and size of the site supervision team should be devised to enable the entire quality supervision chain to function more efficiently and effectively while observing the statutory requirements under the BO.

A clear line of reporting and escalation should be established within the project organization. These should be transparent so that the employer has a clear oversight of the processes and may intervene if necessary. Site supervision personnel with professional qualifications are required to make prompt decisions based on their professional judgement and without undue influence. Senior management and the employer are advised to delegate appropriate authority to handle quality issues on site, enabling site supervision personnel to strictly enforce the quality requirement applicable to the project and where required by law. At the same time, site supervision personnel should be accountable for their performance towards construction quality and should comply with the requirements under the BO.

For public works projects, there are already published documents (e.g. PAH, RSS Management Handbook, etc.) providing relevant guidelines for reference by the government departments and their consultants. Other project clients, in particular those of non-construction background, may not be conversant with the roles, duties and resources required for site supervision teams. It is worth exploring the need for preparing a relevant

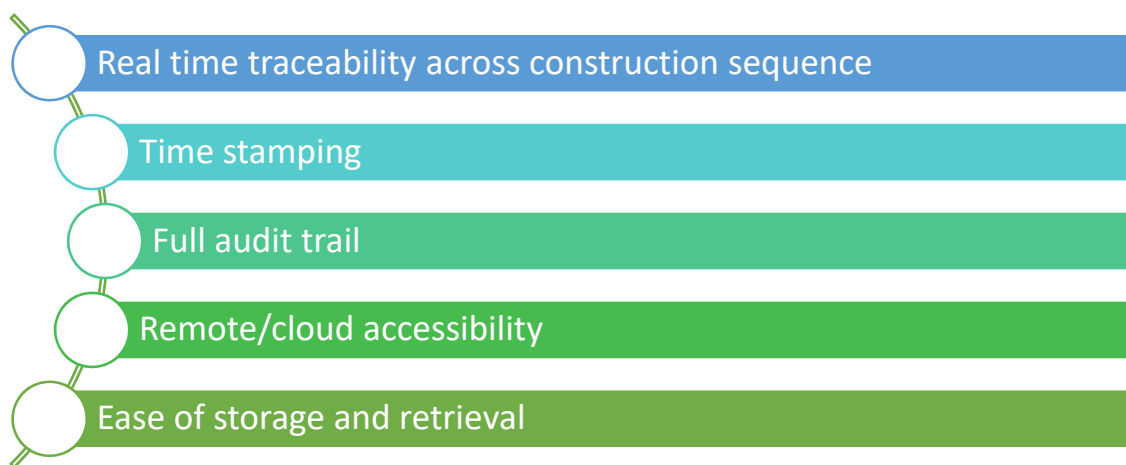
document spelling out the good practices and guidelines for rationalizing the relevant requirements for the industry's general reference.

Recommendation 4 – E-reporting for TCP records and electronic submission for reports and other relevant documents

E-reporting for TCP site attendance and inspection records could enhance the efficiency of BD and supplement the site audit checking approach currently adopted. Any non-compliance of TCP records could be alerted almost instantaneously rather than during site audit checking. This could also free up BD's manpower to focus on actual site works during site inspections. As the BD is developing an Electronic Submission Hub, relevant reports, inspection and other site supervision records could be integrated for comprehensive site and as-built records. Reference should be made to the Technical Circular (Works) No. 3/2020 issued by the Development Bureau for the adoption of Digital Works Supervision System in capital works contracts.

Recommendation 5 – Accelerate the use of digital technologies with the ultimate goal of creating an integrated supervision management and recording platform for all construction project stakeholders

For quality supervision, the need for moving the current predominantly paper-based workflow into the digital realm is the most pressing. Digital workflow would improve many of the observed challenges discussed above. While there are emerging solutions that would suit different project needs, the following features are conducive to ensure site supervision duties are discharged and recorded properly:



The Government and large corporations should take the lead in adopting digital supervision. They are well positioned to tackle the initial technical challenges, legal implications and compliance issues, paving the way for wider adoption by the rest of the industry. One of the key features of BIM and the accompanying Common Data Environment is the emphasis on a single source of truth. It allows for more efficient coordination and collaboration among various disciplines and contract parties, while the accuracy of construction information is greatly enhanced. Its benefits also extend to post-construction asset management. Timely maintenance schedules could be devised based on BIM to avoid catastrophic failure that disrupt the operation of the asset. Asset owners should consider the life cycle cost of the asset and should drive the adoption of such technology where appropriate.

Industry stakeholders are strongly recommended to make use of the CITF to equip themselves, in terms of hardware, software and staff development, to embrace the move towards digital supervision workflow.

The industry should move towards a construction quality supervision process that is controllable, verifiable and traceable through a streamlined supervision management and recording system among stakeholders, including suppliers, testing laboratories, contractors, subcontractors, consultants and employers.

For instance, in typical construction of reinforced concrete elements, digital solutions could be adopted to create a streamlined quality management and recording system, as appropriate, from concrete batching in plants, delivery of fresh concrete, site and laboratory sampling and testing, in-situ pouring into reinforced concrete elements after checking of steel reinforcement –the full process might affect the quality of the structural elements. During every key step of the above construction process, respective parties should complete their prescribed inspection duties, keep proper photographic, video and digitally-signed records, and signify the satisfactory completion of the relevant part of the workflow under the streamlined system. When a step is cleared can the construction process proceed (hold-and-go).

The system should be transparent throughout the supply chain as far as possible and every party involved could be alerted of any issue or problem that has occurred in any step, with corrective or intervening actions taken in a timely manner. This could cover the entire working process, responsible personnel and documentation (site testing and inspection records, product certificates, test reports, photos, and videos). Also, any site modifications and defect rectifications, could be properly maintained in the system, for easy traceability and retrieval during construction and after completion of the works. Reference should be made to the Technical Circular (Works) No. 3/2020 issued by the Development Bureau for the adoption of Digital Works Supervision System in capital works contracts.

Recommendation 6 – Attract and retain talents for quality supervision with certification for non-professional staff

Except for qualified professional architects, engineers and surveyors with membership from recognized professional institutions, there is currently no standard assessment of the competency of personnel involved in construction quality supervision.

For public works projects, there is an established system with relevant guidelines for the management of RSS. This encompasses setting of the minimum qualification and experience requirements for site supervision personnel including non-professional staff, requirements on declaration of conviction records, checking of proposed site supervision team before employment, reporting of termination and poor performance records, and mechanism for retaining a pool of experienced site supervision personnel.

To upgrade the standards of site supervision, an industry certification system for supervision personnel should be explored. Individuals without recognized professional qualification would be assessed based on their education, experience, practical knowledge and understanding of the BO, commensurate with the role and duties to be undertaken. Periodic re-certification and continuous training and development should be part of the certification system. Implementation details of the certification system, including certification body, entry threshold, standard requirements and complementary training could be developed in consultation with industry stakeholders in further studies.

Employers and consultants could play a more active role in scrutinizing the proposed supervision staff and TCPs and conduct interviews with the proposed personnel, where appropriate, to ensure the individuals possess the necessary competency and quality mindset to perform their intended duties. Also, employers are advised to specify certified supervisors as part of the consultant's and main contractor's management team, and retention of certified supervisors could form part of the registration requirement under RSTCS.

Recommendation 7 – Drive collaborative culture from top-down by the Government and employers. Expand the use of NEC and other contractual partnering methods

There is considerable scope for creating a more collaborative culture among all related parties with the objective of achieving more successful project outcomes, as Hong Kong supervision system is primarily based on multiple levels of checking. Progress is made across the world in changing the culture of the construction industry from segmental to more collaborative.

For such a change to take place expeditiously, all parties have a role to play and the major employers in Hong Kong (e.g. the Government and large public organisations/private corporations) should take a leading role in advocating a collaborative culture in a sustained manner by a wider use of NEC and/or other suitable means.

At the project level, senior leadership forums among the client, consultants, contractors and major subcontractors can be established (for major public infrastructure projects, key Government departments should be included) to promote collaborative working relationships and service delivery. More integrated and possibly co-located working between the parties could also be considered to achieve greater transparency of issues, better forward-planning and joint risk management.

There should be wider application of partnering with a collaborative form of contract. In a contractual partnering relationship, project parties are required to manage the project proactively, such as handling of issues as and when they appear. There are less confrontations and project parties are more focused on delivering the project on time, within budget and to the required quality. The Government has successfully adopted NEC in public works projects for the past 10 years. The private sector would have a lot to gain from taking on a more collaborative approach in construction projects.

Recommendation 8 – Adopt off-site construction

The construction site is dynamic in nature with most construction works carried out by workers on site. Under such highly-variable environment, there are inherent limitations to the quality that could be achieved. Supervision is just a means to achieve quality, and the industry should look beyond just supervision to ensure quality construction.

Off-site production allows building components, or even the entire finished modules, to be manufactured under a controlled factory environment. Naturally, the finished quality would be superior to their in-situ constructed counterparts. When off-site production that feeds into the latest construction technologies such as MiC and DfMA becomes more popular, the cost of construction would be comparable to that of traditional in-situ construction, with the added benefits of better quality, shorter overall construction period and lower life-cycle cost, more efficient quality control, improved site safety and less disturbance and nuisance to the neighbourhood. Government has led the wider adoption of MiC, and promulgated Technical Circular (Works) No. 2/2020 setting out the policy on the adoption of MiC for building works.

Quality supervision is still required for off-site manufacturing. A stable factory environment would no doubt be conducive to quality assurance and supervision activities. Upon completion of more projects with extensive adoption of off-site construction, building up of sufficient knowledge and experience by various stakeholders, and the availability of applicable technologies and various innovative solutions, the Government would consider exploring the suitability of the level and mode of the prevailing supervision requirements for off-site construction. ■