

Best Practices

For

Site Supervision

Joint Accreditation Committee

	<p>c/o The Institution of Engineers, Singapore 70, Bukit Tinggi Road, Singapore 289758 Tel: 6469 5000 Fax: 6467 1108 Email: re.rto@iesnet.org.sg</p>	 <p>ASSOCIATION OF CONSULTING ENGINEERS SINGAPORE</p>
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Foreword & Acknowledgment

Since 15 February 2009, the Joint Accreditation Committee (JAC) of The Institution of Engineers Singapore (IES) and Association of Consulting Engineers Singapore (ACES) has been accrediting Site Supervisors (SS) for the site supervision of structural works. The accredited SS assists the Qualified Person (QP) in ensuring the high quality and safety of buildings on site is achieved. To effectively carry out site supervision of structural works, the SS must constantly keep abreast of the latest construction technology and adopt the best practices in site supervision.

A Technical Committee was thus formed to develop a guidebook on “Best Practices for Site Supervision” (BPSS) to not only ensure building safety, but also for the SS to work with the QP, builders and developers to enhance construction productivity. The BPSS provides simple and practical tips to assist the SS, QP, builders and developers in achieving high standards of workmanship in building. The BPSS serves to gather some good practices in carrying out quality supervision of structural works. It is not meant to be a complete handbook to showcase how site supervision is to be carried out at site.

Technical Committee For Best Practices For Site Supervision

Chairman	: Er. Chong Kee Sen	IES
Co-Chairman	: Er. Henry Lim Hung Tjung	ACES
Secretary	: Mr Brendon Ho	IES
Members	: Mr Alex Pang	SCAL
	: Ms Quek Chay Hoon	REDAS
	: Dr. Kannan V	Resident Engineer
	: Mr Tan Bee Loke	Resident Technical Officer
	: Er. Tan Chong Lin	BCA
	: Er. Shee Siu Ming	BCA

We trust that the industry will find this publication useful in its pursuit of quality excellence. We wish to express our gratitude to the members of the Technical Committee for their contribution in drafting the “Best Practices for Site Supervision”.

Er. Chong Kee Sen
Chairman
BPSS Technical Committee

Er. Henry Lim Hung Tjung
Co-Chairman
BPSS Technical Committee

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1. Introduction

The guidebook on Best Practices for Site Supervision (BPSS) serves to outline some good industry practices that the developer, builder, site supervisor (SS) and qualified persons have adopted in carrying out site supervision of structural works. However, it is not meant to be a complete handbook to showcase how the site supervision is to be carried out at site.

2. The Objectives

The objectives of the BPSS are to ensure that a high standard of site supervision in construction is systematically carried out by the project parties, namely, the developer, builder, site supervisor and qualified persons to safeguard the structural integrity of the building, and to enhance construction productivity of a development project. To meet the objectives, the project parties must play their roles diligently through the following broad frameworks of the BPSS.

- I. To set out good industry practices for construction to ensure safe buildings are built
- II. To motivate the site supervisor work closely with the builder, developer and qualified persons to enhance construction productivity
- III. To reward the site supervisor for achieving high quality and safety standard of building

3. Safe and Productive Construction Works

I Planning for Construction Works

Role of Builder

3.1 Early Involvement for Constructability of Building Design

The building design has a significant impact on the constructability of a development project. A buildable design will enhance construction productivity and may shorten construction period of a development project. The builder, specialist builder or their sub-contractors, should be involved in the early stage of building design to allow sufficient time for the builder to plan and adopt the most productive construction method to enhance constructability of the development project.

3.2 Conduct Pre-construction Survey of Adjacent Building Properties

The builder should carry out pre-construction survey with photographs and report on adjacent building properties. The carrying out of pre-construction survey should not be limited to building properties immediately adjacent to site construction. The survey will serve as a useful reference in determining suitable methods of construction to minimise any damage to nearby properties caused by the construction works. The builder should consult qualified person for supervision of structural works [QP(S)] on the extent of pre-construction survey to be carried out if the construction works are likely to have adverse effects on the nearby building properties.

3.3 Produce Shop Drawings for Ease of Construction

For ease of construction and to minimise construction error, correct and accurate construction details are to be reflected in the construction drawings.

The builder, specialist builder or their sub-contractors, should employ suitable qualified staff to constantly review and translate the structural details into construction shop drawings for construction. If there are discrepancies found in the approved structural details, these discrepancies should be resolved with the qualified person for structural works [QP(D)] early in order to avoid disruption to the progress of site construction works.

Role of Qualified Person

3.4 Carry Out Risk Assessment on Adjacent Building Properties

The QP(D) should carry out risk assessment on adjacent building properties. However, for carrying out demolition works to existing building, QP(S) should carry out the risk assessment on adjacent building properties. The QP(S) should direct the builder to implement safety measures, and to safeguard structural integrity of these building structures if site construction works are likely to cause damage to these building structures. In addition, monitoring instruments have to be installed to monitor the effect of the construction works on the buildings.

3.5 Prioritise the Alternative Building design for Plan Approval

The QP(D) should engage the builder, specialist builder or their sub-contractors, early to allow time for them to propose alternative building design that is more productive and easier to build. By engaging the builder, specialist builder or their sub-contractors, early, it also allows time for QP(D) to review and adopt the alternative building design, and to submit the design for plan approval by the building authority.

3.6 Briefing to Site Supervisor

The QP(S) should brief the SS that site supervision of structural works should follow strictly to the approved structural plans, and deviation from the approved structural details is not allowed unless consent has been obtained from him. The QP(S) should also regularly brief the SS on issues relating to site supervision of critical structural works, such as transfer structures, steel connections joints, etc., highlighting the critical areas for construction to ensure that a safe construction is carried out. The QP(S) should organise and delegate the different areas of supervisory duties to each site supervisor in a supervision team.

3.7 Briefing to Builder

The QP(S) should highlight the statutory role of the builder to carry out construction works in accordance to the approved structural details, and no deviation of approved structural details is allowed to be carried out unless his consent is obtained. The QP(S) should also similarly brief the builder, in the presence of the SS, on areas of concern for the construction of critical structural elements of the building structures to ensure that a safe construction is carried out.

3.8 Additional Site Staff for Night-shift Works

For development project that requires 24-hour working shift, the QP(S) is advised to appoint additional SS to supervise the construction during the night shift work. As a good industry practice, there should be a daily record of handing and taking over the statutory duties of SS between the SS for the day-shift works and night-shift works.

Role of Developer

3.9 Provide Adequate Number of Soil Boreholes for Foundation Design

It is important that adequate and accurate soil boreholes information is made available for QP(D) to design the foundation of the building. As a good industry practice, there should be at least one soil borehole underneath each proposed block of building. For project development of 10-storey or more, reference to BCA's advisory note on site investigation should be made. However, if the QP(D) assess that additional no. of soil boreholes are required to be carried out, the developer should support QP(D) for carrying out the additional no. of soil boreholes.

3.10 Engage More Site Supervisor for Complex Development Project

The minimum number of SS to be engaged to supervise the development project is stipulated in the building regulations. However, for a complex project that requires more supervisors to supervise, the developer and the QP(S) should work together to engage more SS.

II Execution for Construction Works

Role of Builder

3.11 Compliance with Approved Structural Plans

The builder is statutorily¹ required to carry out construction works in accordance with the structural plans approved by the building authority. The builder should not carry out any structural works without the supervision of a QP(S) or the SS. The builder needs to obtain the consent from QP(S) if he

¹ Section 11(1)(a)(iii) of Building Control Act – A builder undertaking any building works shall ensure that the building works are carried out in accordance with the relevant plans approved by the Commissioner of Building Control and supplied to him by a qualified person under section 9(1)(c);

intends to carry out structural works which are deviated from the approved structural plans.

3.12 Compliance with Workmanship Standard

The builder should carry out construction works to meet the design specification of the building structures. The builder is advised to follow the Workman Standard for Structural Works (See Annex I) or any other workmanship standard to achieve a safe and quality construction at site. The builder should consult QP(S) if he needs clarification from the Workman Standard for Structural Works.

3.13 Prepare Monthly Site Inspection Schedule

The builder should prepare a monthly schedule for site inspection by QP(S) or the SS. The builder should inform QP(S) or the SS at least 24 hours before the actual day of the site inspection. If the SS for the development project could not carry out site inspection on the scheduled date, a replacement SS should carry out the site inspection and the builder should be informed accordingly.

3.14 Engage Construction Supervisors

The builder is advised to engage qualified construction supervisors to progressively inspect the construction works to ensure that construction works are carried out right at the first time as re-working on the completed construction works will be time consuming and costly. As construction works are progressively inspected by the construction supervisors, it will be unlikely to have any major shortcoming detected during the final site inspection carried out by the SS to approve concreting of the structural elements of the building.

3.15 Engage a Professional Engineer for the Design of Falsework

A robust falsework is vital to support the construction of building structure, especially structures with high floor to floor headroom or supporting heavy loads, etc. Hence, it is important that the builder should engage a professional engineer (PE) to design the falsework. After the installation of the falsework but before concreting of the permanent structural elements, the builder should get the PE to inspect the falsework and to certify that they are safe. The builder should also obtain the consent from the PE before dismantling the falsework in accordance with the dismantling procedures as set out by the PE for the falsework.

3.16 Notification of Contravention of Building Regulations

The builder² should notify the building authority directly if he notices that there is contravention of building regulations carried out by other project parties, e.g. QP carries out material changes to the design of building works without first obtaining amendment plan approval, etc.

Role of Site Supervisor

3.17 Construction Works Deviated from Approved Structural Plans

It is the statutory role of the SS³ to ensure that the construction works carried out by the builder follow strictly to the approved structural plans. The SS should report to QP(S) immediately if the builder proposes to carry out construction works which are deviated from the approved structural plans.

² Section 11(1)(b) of the Building Control Act – A builder undertaking any building works shall notify the Commissioner of Building Control of any contravention of this Act or the building regulations relating to those building works of which the builder knows or ought reasonably to know;

³ Section 10(5) of the Building Control Act – Every site supervisor appointed under this section in respect of any building works shall take all reasonable steps and exercise due diligenceto ensure that the structural elements or critical structural elements....are carried out in accordance with the plans of building works in accordance with section 9(1)(c) by a qualified person...

3.18 Detection of Construction Irregularities

The SS should immediately notify QP and the builder if construction irregularities are detected at site so that corrective measures can be taken to rectify the construction irregularities before carrying out the next stage of construction works at site.

3.19 Minimise Abortive Construction Works

The SS should work closely with the builder and his sub-contractors in carrying out inspections at different stages of construction. The SS should regularly check the construction works, and if there are construction irregularities found during the construction, the SS should notify the builder and his sub-contractors to rectify them immediately. Frequent inspections carried out by the SS would minimise any major shortcomings detected during the final inspection prior to concreting of the structural elements.

3.20 Adhere to Site Inspection Schedule

The SS shall adhere to the site inspection schedule prepared by the builder. The SS shall notify QP(S) if he could not carry out site inspection on the scheduled date and time so that alternative arrangement could be made for a replacement SS e.g. an engineer from the QP's office to carry out the site inspection. The SS should work closely with the builder to adhere strictly to the site inspection schedule to avoid disruption to the overall progress of the construction works at site.

3.21 Ensuring Falsework is Safe for Use and Dismantling

The SS should allow the builder to cast concrete or laying of reinforcement bars only after the PE for falsework has inspected and certified that the

falsework is safe for use. The SS should also obtain the consent from the PE for falsework that the structural members have attained sufficient strength to support the design loads of the building before allowing the builder to dismantle the falsework in accordance with the dismantling procedures as set out by the PE for falsework.

Role of Qualified Person

3.22 Safeguard Construction Works to Meet Design Specification

The QP(S) should visit site frequently to ensure that site construction works are carried out in accordance with the design specification of the building structures, especially during construction of critical structural elements, such as transfer structures, critical joint connections in steel structures, etc.

3.23 Compliance with the Building Regulations

It is the statutory role of the QP⁴ to ensure that the building works are designed in accordance with the provision of the Building Control Act. The QP shall also ensure that those building works are being carried out in accordance with the relevant plans approved by the Commissioner of Building Control.

3.24 Checklist for Construction of Complex Structures

⁴ Section 9(1)(a)(i) of the Building Control Act – Every qualified person who is appointed under section 8 or 11 to prepare the plans of any building works shall take all reasonable steps and exercise due diligence to ensure that the building works are design in accordance with the provision of this Act

Section 9(1)(4)(a)(iii) of the Building Control Act - Every qualified person who is appointed under section 8 or 11 to supervise the carrying out of any building works, or any geotechnical aspects of any underground building works, shall take all reasonable steps and exercise due diligence in supervising and inspecting the building works or underground building works, as the case may be, to ensure that the building works are carried out in accordance with the relevant plans approved by the Commissioner of Building Control;

The QP(S) should prepare checklists, highlighting the areas of concern for the pile installation, construction of transfer beam and columns, long span steel trusses and cantilever structures, etc. The QP(S) should brief the SS or the builder on areas of concern, such as pile set criteria for pile installation, number and frequency of weld tests for critical steel structures, checking the audited mills with necessary Factory Production Control certificate and mill test certificate to ensure reliable quality assurance for the steel used for the critical steel structures, etc. The QP(S) should regularly check that the checklists are complied with by the SS and the builder.

3.25 Conduct Essential Tests on Building Materials

In Singapore, many building materials, such as steel bars, structural steel sections, prestressing wires, etc, are imported. The quality of these materials can vary significantly depending on the technology used and the quality control of the manufacturers. Poor quality materials, if not detected, can undermine the structural integrity of the building structures. It is therefore important for the QP(S) to require the builder to engage independent testing agency (ITA) to conduct tests to confirm the quality of these materials. The QP(S) should also stipulate the number and frequency of such tests to be carried out by the ITA.

3.26 Implement Instrumentation Monitoring Measures

The QP(S) should instruct the builder or specialist builder to install site monitoring instruments to measure the effect and performance of the construction works. The instrumentation monitoring results serve as an early alarm if the adjacent building properties are affected or the performance of the

construction works cannot meet the design specification. Based on the monitoring results, the QP(S) should immediately stop construction works, and take corrective measures to rectify the shortcomings.

3.27 Verification of Soil Parameters for Design of Piles

The QP(S) should brief the SS and the builder that piles must be installed in accordance to approved piling plans. As soil profile may vary significantly at site, the QP(S) should instruct the builder to install test piles to confirm the pile design before carrying out piling works. As a good industry practice, the QP(S) should inspect the soil samples extracted during test piling works, and instruct the builder to stop piling works if the extracted soil samples are different from the soil types used for the pile design. In such cases, the QP(D) should submit amendment piling plans based on the new soil parameters for approval by the building authority before carrying out the piling works.

3.28 Steel Frames/Precast Structures Fabricated Off Site

For steel frames or precast concrete structures that are fabricated off site in Singapore or overseas, the QP(S) should appoint another SS to supervise the construction of these structures off-site. The QP(S) should brief the SS and the builder to carry out the necessary verification tests on these structures when these structures are delivered to the site. If the tests fail to meet the design specification of the building, the QP(S) should insist that more tests to be carried out on these structures. If the tests still fail to meet the design specification, the QP(S) should reject the structures delivered at site.

Role of Developer

3.29 Avoid Amendment to Approved Building Design

Developer should refrain from changing the building design after the commencement of the construction as construction works may have to be temporarily suspended while the QP(D) amends the structural details for construction, and seek plan approval from building authority before the amendment can be implemented at site. In the circumstance that changing of the approved building design is necessary, the developer is strongly advised to allow time for QP(D) to effect the changes to the approved plans before construction.

III Completion of Construction Works

Role of Builder

3.30 Submission of Certification of Completion of Building

Upon completion of all construction works, it is a statutory requirement for the builder to submit promptly the as-built drawings of both permanent and temporary (left-in) structures (temporary shoring structures, kingposts, etc), and a certificate of completion of building works certifying that all construction works have been carried out in accordance with the approved structural plans. The builder should not withhold the submission of the certificate of completion because of disputes on payment by the developer. The submission of certificate by the builder is important for the application of Temporary Occupation Permit (TOP)/Certificate of Statutory Completion (CSC).

Role of Site Supervisor

3.31 Check the Completed Building Works

The SS shall check that the constructed structural elements comply with the technical design specification of the development project. If sub-standard structural works were noted at site, the SS shall report to QP(S) with attached photographs of those sub-standard structural works to seek instruction from QP(S) on the rectification of those sub-standard structural works.

Role of Qualified Person

3.32 Collaborate with Architect For TOP/CSC Application

The QP should promptly submit the relevant record plans and certificates of supervision upon completion of all building works to assist the architect for the TOP/CSC application. The QP should also work closely with the architect to obtain all necessary technical clearances leading to the application for the TOP/CSC.

4. Motivation and Reward for Site Supervisor

4.1 Performance Bonus for Outstanding Site Supervisor

The SS plays an important role in ensuring that a high standard of workmanship of the building works is achieved as the cost of rectification works is high if sub-standard building works are produced. To motivate the SS to play the role, the developer is encouraged to reward the SS with performance bonus through the QP if high standard of workmanship (See Annex I) and construction productivity of building works are achieved. Payment of performance bonus (See Annex II) may be made upon certificate

of the Structural Conquas Score from BCA in compliance with standard of workmanship as in Annex I

4.2 Exemplary Site Supervisor Award

To motivate the SS to work closely with the builder, developer, and the QP(S) to ensure safe construction of building works, the Joint Accreditation Committee (JAC) of the Institution of Engineers, Singapore (IES) and Association of Consulting Engineering, Singapore (ACES) has introduced the “Exemplary Site supervisor Award” for outstanding SS. Nomination of the SS for this award has to be made by the QP of the project. Both the builder and developer of the project should also give favourable appraisals to the SS before he can be qualified for this award. JAC shall reward the exemplary SS with training or cash vouchers. In addition, the names of the exemplary SS will also be published in IES website to enhance their employability. The developer or the QP(S) is encouraged to individually reward the SS if their performance is commendable.

WORKMAN STANDARD FOR STRUCTURAL WORK

Part I : REINFORCED CONCRETE STRUCTURE

	Item	*Acceptable Standard
1.0	Formworks	
1a	Formwork dimensions and openings for services	<ol style="list-style-type: none"> 1) Tolerance for cross-sectional dimensions of cast in-situ & precast elements: $\pm 10\text{mm}$ 2) Tolerance for penetration / opening for services: $\pm 10\text{mm}$ for size and $\pm 25\text{mm}$ for location 3) Tolerance for length of precast members (major dimension of unit): <ul style="list-style-type: none"> • Up to 3m: $\pm 6\text{mm}$ • 3m to 4,5m: $\pm 9\text{mm}$ • 4,5m to 6m: $\pm 12\text{mm}$ • Additional deviation for every subsequent 6m: $\pm 6\text{mm}$
1b	Alignment, plumb and level	<ol style="list-style-type: none"> 1) Tolerance for departure of any point from its position: $\pm 10\text{mm}$ 2) Tolerance for plumb: $\pm 3\text{mm} / \text{m}$, maximum $\pm 20\text{mm}$ 3) Maximum deviation of mean level of staircase

1c	Condition of formwork, props & bracing	<p>thread to temporary bench mark: $\pm 5\text{mm}$</p> <p>4) For cast in-situ elements, the deviation of <i>level</i> of any point from the intended level: $\pm 10\text{mm}$</p> <p>1) Formwork must be free from defects</p> <p>2) Before concreting, the interior must be free from debris</p> <p>3) All formwork joints must not have noticeable gaps to prevent grout leakage</p> <p>4) There must be adequate support, bracing and tie-back for the formwork to prevent bulging or displacement of structural elements</p>
2.0	Reinforcement (cast in-situ & precast)	
2a	Main & Secondary rebars	<p>1) According to structural drawings (numbers / sizes)</p> <p>2) Spacing of bars not more than that specified</p>
2b	Anchorage & lap lengths	<p>1) Required lap length not less than that specified</p>
2c	Cover provision	<p>1) According to specifications with tolerance of $\pm 5\text{mm}$</p>

2d	Links, stirrups and trimming bars	<ol style="list-style-type: none"> 1) According to structural drawings (numbers / sizes) 2) Spacing of links not more than specified
2e	Rebar Condition	<ol style="list-style-type: none"> 1) Rebars must be securely and properly tied In place 2) Rebars must be freed from concrete dropping, corrosion etc
3.0	Finished Concrete (cast in-situ & precast)	<ol style="list-style-type: none"> 1) Tolerance for cross-sectional dimension of cast in-'situ and precast elements: $\pm 10\text{mm}$ 2) Tolerance for opening: ± 10 for size and $\pm 25\text{mm}$ for location 3) Tolerance for length of precast members (major dimension of unit): <ul style="list-style-type: none"> • Up to 3m: $\pm 6\text{mm}$ • 3m to 4.5m: $\pm 9\text{mm}$ • 4.5m to 6m: $\pm 12\text{mm}$ • Additional deviation for every subsequent 6m: $\pm 6\text{mm}$ 4) Straightness or bow (deviation from Intended
3a	Dimension for elements/opening for services	

<p>3b</p>	<p>Alignment, plumb and level</p>	<p>line) of precast member:</p> <ul style="list-style-type: none"> • Up to 3m: $\pm 6\text{mm}$ • 3m to 6m: $\pm 9\text{mm}$ • 4.5m to 6m: $\pm 12\text{mm}$ • Additional for every subsequent 6m: $\pm 6\text{mm}$ <p>5) Squareness of precast member -Difference between the greatest and shortest dimensions should not exceed the following:</p> <p style="padding-left: 40px;">Length of shorter sides</p> <ul style="list-style-type: none"> • Up to and including 1.2m: $\pm 6\text{mm}$ • Over 1.2m but less than 1.8m: $\pm 9\text{mm}$ • 1.8m and over: $\pm 12\text{mm}$ <p>6) Twist of precast member -Any corner should not be more than the deviation stated from the plane containing the other 3 corners:</p> <ul style="list-style-type: none"> • Up to 600mm wide and 6m in length: $\pm 6\text{mm}$ • Over 600mm wide and for any length: $\pm 12\text{mm}$ <p>7) Flatness: 6mm per 1.5m</p> <p>1) Tolerance for departure of any point from its position: $\pm 10\text{mm}$</p> <p>2) Tolerance for plumb: $\pm 3\text{mm} / 1\text{m}$, maximum $\pm 20\text{mm}$ for floor to floor height and $\pm 40\text{mm}$ for the entire building height</p>
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3c	Exposed surface	<p>3) Maximum deviation of mean level: $\pm 10\text{mm}$</p> <p>4) For cast in-situ elements, the maximum deviation of levels within the element: $\pm 10\text{mm}$</p> <p>5) Camber at mid-span: according to specifications</p> <p>1) Should not have visual exposure of groups of coarse aggregates resulting from grout leakage</p> <p>2) Cold joint & formwork joint must be smooth</p> <p>3) No bulging of structural elements</p> <p>4) All formwork, nails, zinc strips, etc must be removed</p> <p>5) No cracks or damages</p>
4.0	Precast Specific Requirements	
4a	Lifting points/inserts	<p>1) Tolerance for position: $\pm 20\text{mm}$ from centre line location in drawing</p> <p>2) Lifting devices and inserts free from damages</p>
4b	Sleeve system/connections	<p>1) Tolerance for position: $\pm 6\text{mm}$ from centre line location in drawings</p>

<p>4c</p>	<p>Interface/joint requirements</p>	<p>2) Bar protrusion length according to requirements. No bending, cranking or damages to bars</p> <p>3) Bars free from concrete droppings or corrosion</p> <p>4) Sleeves, grout holes, grout tubes not congested with debris</p> <p>1) Joint taper:</p> <ul style="list-style-type: none"> • Over 3m length: $\pm 6\text{mm}$ • Maximum for entire length: $\pm 9\text{mm}$ <p>2) Alignment of horizontal and vertical joint $\pm 6\text{mm}$</p> <p>3) Jog in alignment of matching edges: $\pm 6\text{mm}$</p> <p>4) Sitting of element according to specifications</p> <p>5) Installation of sealant and waterproofing: according to specifications</p>
<p>4d</p>	<p>Cast-in steel items/welded & bolted connections</p>	<p>1) Tolerance for position of cast-in steel items: $\pm 6\text{mm}$ from centre line location in drawings</p> <p>2) Tolerance for position of openings for bolt connections: $\pm 3\text{mm}$ from centre line location in drawings</p> <p>3) Relevant requirements in CONQUAS</p>

		steelwork standards to be used where applicable
5.0	Structure Quality	
5a	Concrete Cube Test	1) According to specifications; for every pour of concrete, test cubes results at 28 days must satisfy the passing criteria as in SS289
5b	Reinforcement	<p>1) To pass the tensile strength test for all the reinforcement bars used as according to:</p> <ul style="list-style-type: none"> • -SS2:1999 for Grade 500 ribbed bars or • -SS2:1987 for Grade 460 ribbed bars <p>2) All the welded steel fabric used to comply with SS32 in their respective specified characteristic strength of not less than 250 N per mm², 460 N per mm² and 485 N per mm²</p> <p>3) No non-conforming reinforcement detected through test records has been installed in the structure</p>
6.0	Non-destructive testing	
6a	Ultra Pulse Velocity test for Concrete Uniformity	<p>1) To conduct NDT using ultrasonic pulse velocity (UPV) to check the degree of uniformity of hardened concrete</p> <p>2) 5 columns per set and 2 readings per column</p>

<p>6b</p>	<p>Electro-Cover meter test for concrete cover</p>	<p>3) Assessment is based on the difference between the 2 UPV readings within a column shall not exceed 0.05 <i>km/s</i></p> <p>4) Method as per SS 78 : Part B3 : 1992</p> <p>1) To check hardened concrete cover for reinforcement bars after casting: minimum 25mm or higher as according to specification</p> <p>2) 5 structural samples per set including:</p> <ul style="list-style-type: none"> • 3 for slab soffit @ 4 readings each • 1 for column @ 2 readings each on both axis of the column • 1 for beam @ 2 readings each on the soffit and one side of the beam <p>3) For each reading, full point for $\pm 5mm$ and half point for $>\pm 5mm$ to $\pm 8mm$. For each location, no point will be awarded if any of the 4 readings exceeds $\pm 12mm$.</p> <p>4) Method as per SS 78 : Part B4 : 1992</p>
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Part II : STRUCTURAL STEELWORKS

	Item	*Acceptable Standard
1.0	Main member/Partial assembled component	
1a	Physical dimensions	<ol style="list-style-type: none"> 1) Cross sectional tolerance should not be less than the structural steel specifications or approved plan 2) Tolerance for length of structural steel member: $\pm 3\text{mm}$ 3) Tolerance for bolt hole size: <ul style="list-style-type: none"> • $\leq 2\text{mm}$ for bolt diameter $< 24\text{mm}$ • $\leq 3\text{mm}$ for bolt diameter $\geq 24\text{mm}$ Tolerance for bolt hole position: $\pm 2\text{mm}$
1b	Type and condition	<ol style="list-style-type: none"> 1) According to the structural steel specifications 2) Surface preparation shall meet the surface roughness specifications 3) Material used must be traceable to its original mill certificates
1c	Welding	<ol style="list-style-type: none"> 1) Weld size, length and profile shall meet the structural steel specifications and drawings 2) Visual inspection shall meet the structural steel

<p>1d</p>	<p>Bolting</p>	<p>specifications</p> <ol style="list-style-type: none"> 3) All weld shall follow approved welding procedures 4) All welding must be done by qualified welders 1) Bolts and washers, type, size and number shall be according to the structural steel specifications 2) Drilled holes shall be free from burrs 3) The condition of bolted parts adjacent to the bolt heads, nuts, flat washers, connection gussets and splice plates shall be free from oil, paint, and loose mill scales or otherwise specified by the structural steel specifications 4) Gap between adjacent parts shall not exceed $\pm 2\text{mm}$ 5) Bolts shall be tightened to specified torque or as specified by the structural steel specifications 6) Threaded bolts protruding at least one thread length with washers
<p>2.0</p> <p>2a</p>	<p>Metal decking</p> <p>Type and condition</p>	<ol style="list-style-type: none"> 1) Correct type and thickness of metal decking used 2) All decking joints must not <i>have</i> gaps

<p>2b</p>	<p>Shear studs</p>	<ul style="list-style-type: none"> 3) All metal decking must be properly secured in place 4) Metal decking must be free from defects and visible damages 5) Before concreting, the decking must be free from grease, oil, paint, and all other foreign materials 6) All accessories such as pour stop, end closures and cover plates must be in place before concreting 1) Correct number and type of shear studs used 2) Spacing and position according to approved plan 3) Strength of shear stud welds not less than specified 4) All welds should show a full 360-degree weld fillet. All welds free from visible damages
<p>2c</p>	<p>Lapping and deck openings</p>	<ul style="list-style-type: none"> 1) According to structural steel specifications or approved plan
<p>3.0</p>	<p>Erection tolerances</p>	
<p>3a</p>	<p>Column verticality</p>	<ul style="list-style-type: none"> 1) Tolerance for verticality: $\pm H/600$ or 5mm, maximum ± 25mm; where H is the floor to floor height in mm.

<p>3b</p>	<p>Column position</p>	<p>1) The position in plan of a steel column at the base shall not <i>deviate</i> from the specified position by more than 10mm along either of the principal setting out axes</p>
<p>3c</p>	<p>Beam level</p>	<p>1) Maximum deviation of level at each end of the same beam: $\pm 5\text{mm}$</p> <p>2) The <i>level</i> of the top of the steelwork at any storey shall be within $\pm 10\text{mm}$ of the specified <i>level</i></p>
<p>3d</p>	<p>Beam position</p>	<p>1) Beams shall not <i>deviate</i> from their specified positions relative to the column to which they are connected by more than 5mm</p>
<p>4.0</p>	<p>Welding test reports</p>	<p>1) Reports for all critical welding joints from the approved structural plans must be submitted</p> <p>2) Test reports must comply with the acceptable criteria and to be endorsed by qualified person for structural works</p>

Part III : PRE-STRESSING OF CONCRETE

	item	*Acceptable Standard
1.0	Condition of tendons & anchorages	<p>1) All pre-stressing strands and wires should comply with the specified standards and requirements and be free from loose rust, oil, tar, paint and any foreign objects</p> <p>2) All tendon anchorage are to comply with the specified standards and protected from corrosion</p> <p>Thread parts to be greased wrapped and tapped holes protected until use</p>
2.0	Installation of sheathing	<p>1) Sheathing properly secured and protected and free from damage or puncture</p> <p>2) Sheathing profile according to drawings throughout the length with position tolerance: $\pm 5\text{mm}$</p> <p>3) Splice to sheathing shall be mortar tight</p> <p>4) Air vents or grout tubes provided according to the drawing</p>
3.0	Stressing & Grouting process	<p>1) Tendon ducts clean and free from foreign objects and tendon free moving in the duct</p> <p>2) Strands stressed to the final pressure / elongation within the specific % accuracy of the</p>

		<p>stipulated value</p> <p>3) All grouting operations of the tendons must be smooth and achieved without need to flush out in the first grouting.</p>
4.0	Debonding	<p>1) Open ends of debond tubes over the debond length of strands sealed</p> <p>2) Debond lengths according to the drawings</p> <p>3) Debonding materials not punctured or damaged</p>

Part IV : FOUNDATION WORKS

	Item	*Acceptable Standard
1.0	Shallow Foundation	
1a	Setting out	1) Sufficient lines and level pegs are provided to enable each footing and column to be accurately positioned.
1b	Safety of excavation	1) Temporary earth retaining structure is provided if for the purpose of pilecaps, footings, sump, lift pit or trench, the depth of excavation is more than 2m in depth and the area of excavation exceeds 10m ²
1c	Trial Pits	<p>1) Sufficient trial pits are required before works is carried out to</p> <p>a. inspect and confirm that the founding soil layer is suitable for the foundation design</p> <p>b. determine the location and extent of existing foundation and services</p> <p>2) No new foundation is constructed over existing foundation and services without the approval of the qualified person.</p>
1d	Excavated material	1) The excavated material shall not store in a manner likely to endanger the excavated or

1e	Backfilling material	surrounding areas. 1) All backfilled material shall be free of debris, and of good material soil
2.0 2a 2b 2c 2d 2e	Piling Works Setting out Piling method Piling performance criteria Install Instruments Testing piles	1) The setting out of all piling works are certified by registered surveyor. 1) Details of piling method are provided to qualified person for him to assess the suitability of the piling method before commencement of piling works 1) Piling works are carried out to meet the piling performance criteria that are stipulated in the approved piling plans 1) Appropriate instruments are installed to monitor the piling works to avoid damages to adjacent structures, underground services, etc. 1) All piling tests are carried out according to the stipulated piling tests on approved piling plans or are instructed by the qualified person

**Acceptable Standard is meant to be a guide for measuring the level of workmanship of construction. Ultimately, the qualified person for supervision works shall decide the acceptable standard to be used in meeting the technical design specification of the development project.*

Performance Bonus Upon Certification (example)

<u>Structural Conquas Score</u>	<u>Performance Bonus</u>
94.6% to less than 96%	1 month Salary
96% to less than 98.4%	1.5 months Salary
98.4% and above	2 months Salary