4

Managing Precast Concrete Components

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Concrete Components

Proper planning for the building design and construction processes plays a crucial role in ensuring successful implementation of any project. To fully capitalise on the benefits of using precast method, the project team must work together through the design and construction process to deliver solutions that equitably address each discipline's concerns.

The nature of precast concrete construction entails thorough preconstruction planning. As the various aspects and phases of the project are interrelated, its success will depend largely on how effective is the linkage between each construction phase during implementation. Construction sequences, production scheduling and resources are therefore important and need to be closely monitored to obviate costly delays in site progress

Each building system has its own set of design and construction issues. For precast concrete construction, one needs to consider and plan for temporary site facilities, precast production and erection among other construction activities.

4.1 PLAN FOR TEMPORARY SITE FACILITIES

CRANE LAYOUT AND CAPACITY: The speed of precast construction depends very much on the planning and execution of installation sequence. The crane plays a vital role in ensuring that the components are erected rapidly. Selection and positioning of numbers of crane depend on the size of project, site access (or constraints), block layout, cycle time, the numbers and tonnage of precast components. In general the crane capacity should be based on the combined weight of the heaviest panel and the rigging gear. The position of the crane in relative to the final panel location should also be considered. For example:

- How far must the crane reach to lift the panels?
- How far must the crane travel with the panels?
- How far must the crane reach to position the panels?

The crane's load chart and manufacturer's recommendations should be used before determining the correct crane size.

SITE ACCESSIBILITY: Good accessibility and sufficient space for manoeuvring crane and trailer within the site are important considerations for erection. Pre-planning of construction processes is required to allow for such access, particularly when two or more of the other construction activities are occurring at the same time.

Fig. 4.1 – Site access is important for the delivery and erection of precast components

DELIVERY: Efficiency in delivery is not just about maximizing payloads; it is important to consider the following pointers, particularly for precast concrete components:

- Arrival on time
- Correct components delivered according to schedule
- Components delivered without damage
- Panels loaded in a way that minimises handling on site

Fig. 4.2 – Wall panels transported by a low trailer

Consideration must be given to the height, width, length and weight limitations of the precast components in relation to transportation. For panels or components mounted on trailers, the overall height is limited to about 4200 mm in local context.

For panels that are delivered flat, careful consideration must be given to the method and equipment used on site to turn the panels to the final position. The panels must be designed for lifting stresses; otherwise the panels may be distorted and damaged during lifting.

JOBSITE STORAGE: Precast components that are cast off-site, generally do not require much site space for storage purpose. Whilst components that are cast on-site will require more site space for casting beds as well as storage space. Regardless of whether they are cast on-site or off-site, it is important to make provisions to store the precast components for subsequent installation. Storage area provided should be relatively level, firm and well drained to avoid differential ground settlement, which may damage the stored components.

Fig. 4.3 – Ground level of storage area should be relatively level and firm

Precast components should be stored based on the designed stacking method to pre-empt any damage and undue stresses. For horizontal precast elements such as precast slab, planks and beams, they can be stacked and supported separately using strips of woods or battens across the full width of designated bearing points. As for precast façade and wall panels, they are usually stored in vertical position supporting their own self-weight using rack with stabilising sleeper wall. In any case, precast components should be stored with careful consideration of the erection sequence so as to minimise double handling.

Fig. 4.4 – Secure vertical panels on racks at appropriate spacing

4.2 PLAN FOR PRECAST PRODUCTION

Owing to the more intricate architectural design in private residential development, precast elements, in particular building facades are adopted in a make-to-order fashion. Unlike the catalogued precast elements, which have been well designed, produced and stocked, the tailor-made precast elements produced are varied in shape, reinforcement and dimensions to meet specific project requirements. Generally, more time will be required for such production planning which involves development of precast element design and shop drawings as well as production processes.

PRECAST ELEMENT DESIGN AND DRAWINGS: Based on the project design, precast elements can be designed and developed with reasonable level of standardization and repetition. For economical design, the precast elements should be made as large as practicable and identical, to minimize the number of purpose-built moulds and to increase repetitive works.

For production purpose, shop drawings of individual precast components are prepared to detail all construction requirements. Changes to original design are not uncommon to improve buildability and to accommodate the production processes. Good co-ordination among project team members during this stage is therefore important. Any discrepancies should be resolved before confirming these drawings for production and construction. Essentially, shop drawings are the result of the integrated design process incorporating all design requirements for production and installation.

Good shop drawings should consist of the following information:

- Project location, reference number of components, and its location in the building plan, as well as references to the layout and elevation drawings
- Dimensions of components, centre of gravity, weight and concrete volume
- Locations of all reinforcing steel, cast-in inserts for connection, lifting and bracing.
- Locations of embedded items such as service conduits, blockouts and recesses as well as openings
- Edge details and architectural treatment where applicable

PRODUCTION PROCESSES: One of the foremost items in production processes is mould fabrication. To minimise cost, similar components can be grouped together to reduce the number of moulds required. Slight modifications using inserts or appropriate adjustments can be carried out to reduce the mould size for smaller pieces of the same general form to enable the reuse of moulds for several units. The other processes mainly involved procurement of raw materials for production of components, placement of reinforcements and accessories before casting. Resource management and scheduling are important and form part of these processes in ensuring precast components are produced on time for site erection.

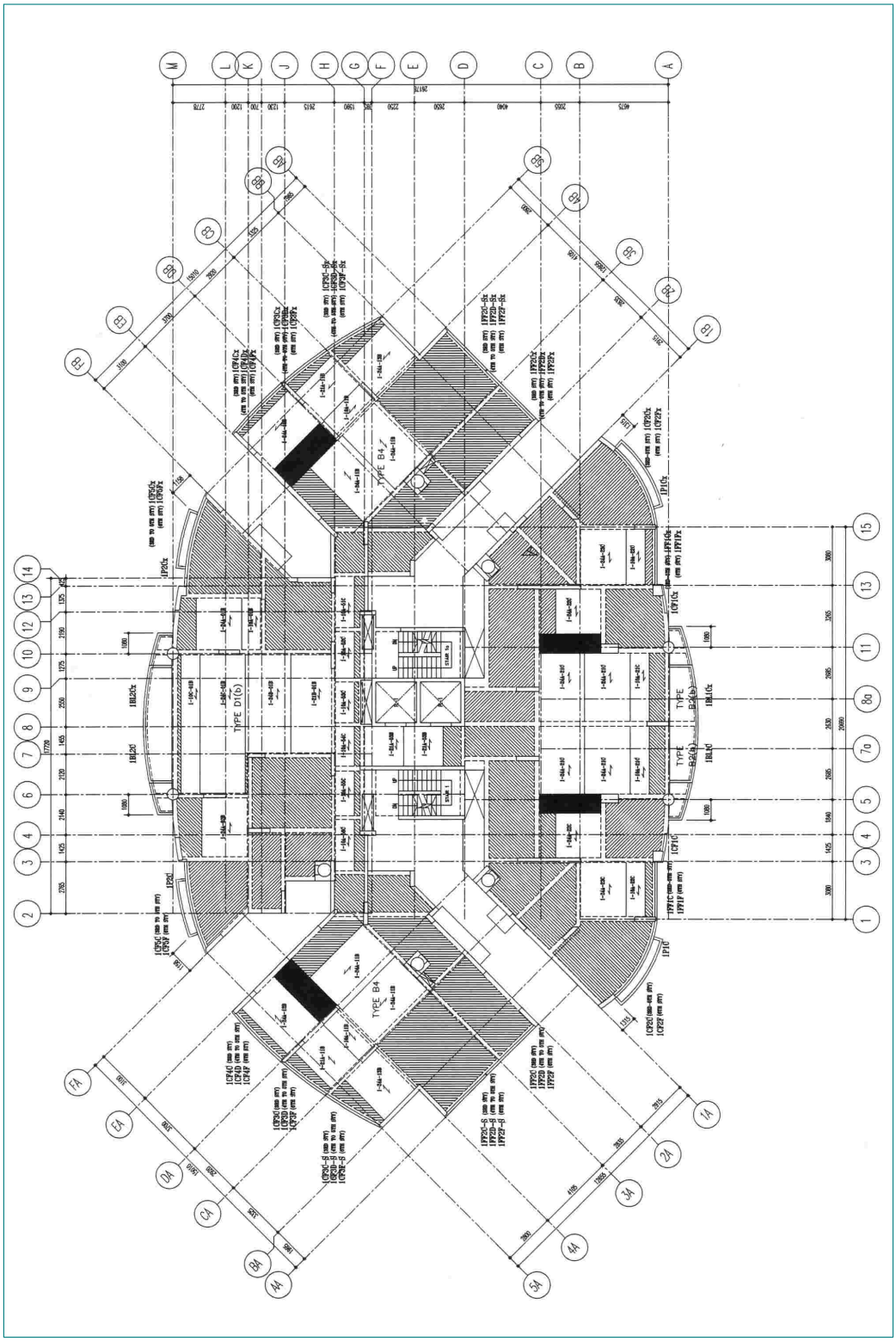


Fig. 4.5 – Typical floor layout showing floor & façade details and references

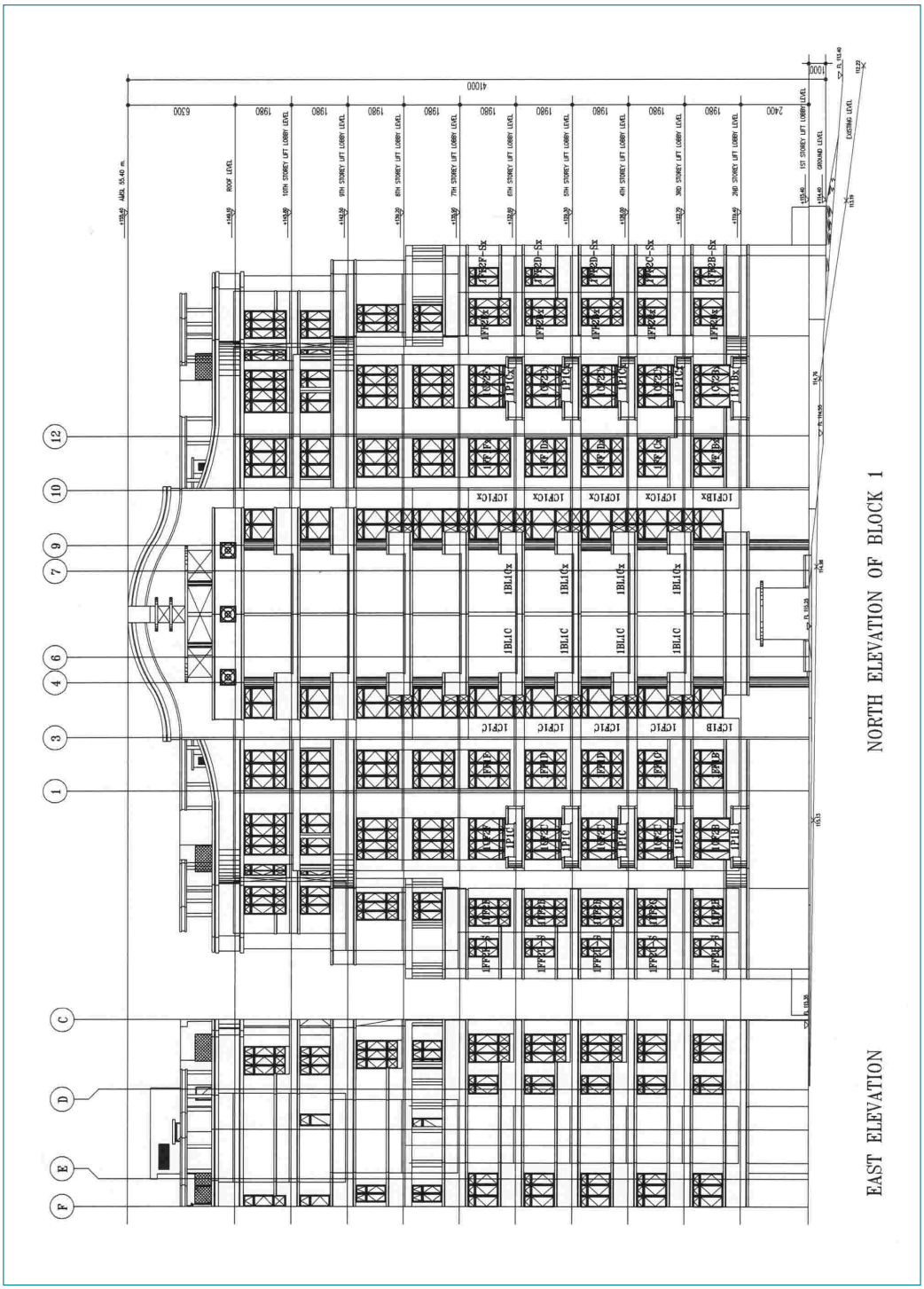


Fig. 4.6 – Elevation details showing façade location

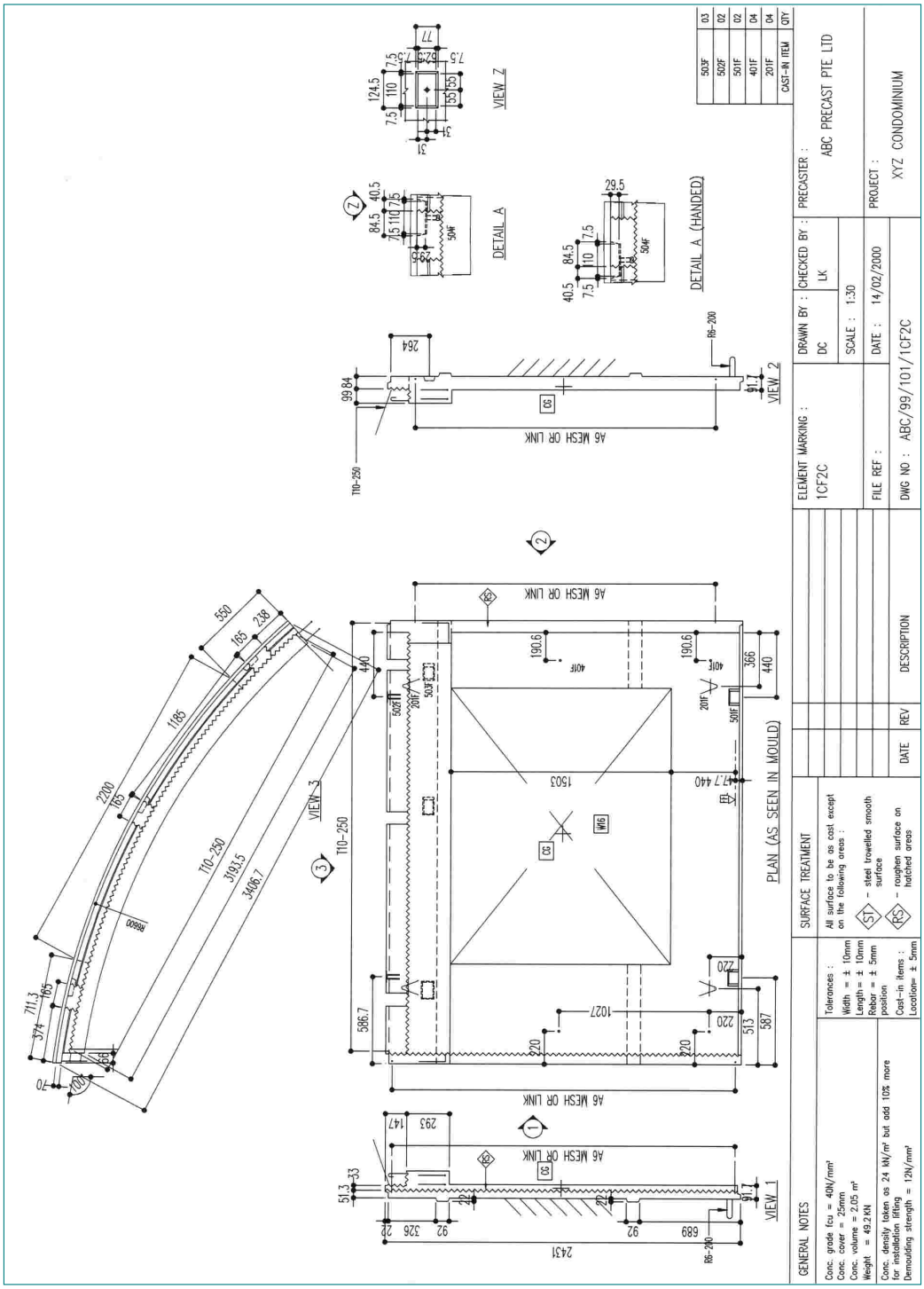


Fig. 4.7 – Example of mould details of precast façade element

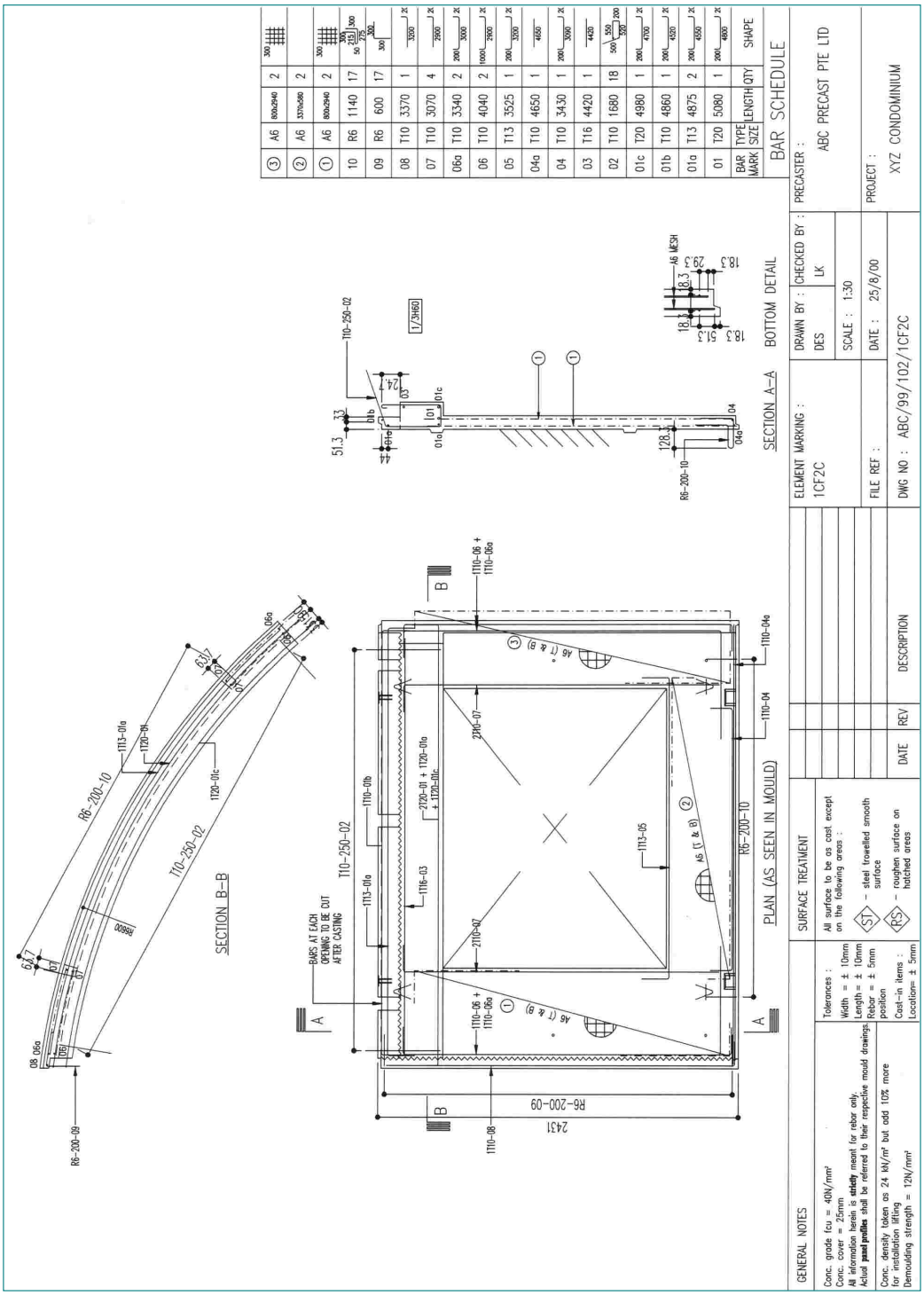


Fig. 4.8 – Example of reinforcement details of precast façade element

4.3 PRECAST PANEL INSTALLATION

In handling the precast panel installation, it is important to have the precaster, erector and builder working together to achieve the best performance and working method. Requirements for temporary propping, bracing and special lifting procedures have to be worked out in preparation for the actual installation.

Computer models can be used to simulate the erection sequence. During the actual installation, this should be checked against the computer modelling. If possible, a trial erection should be done at the site or precast plant to iron out any teething problems. Temporary supports required should be planned for and provided after installation to position the panels or components before jointing.

Generally, the preparation work and sequences of precast installation involved are as follows:

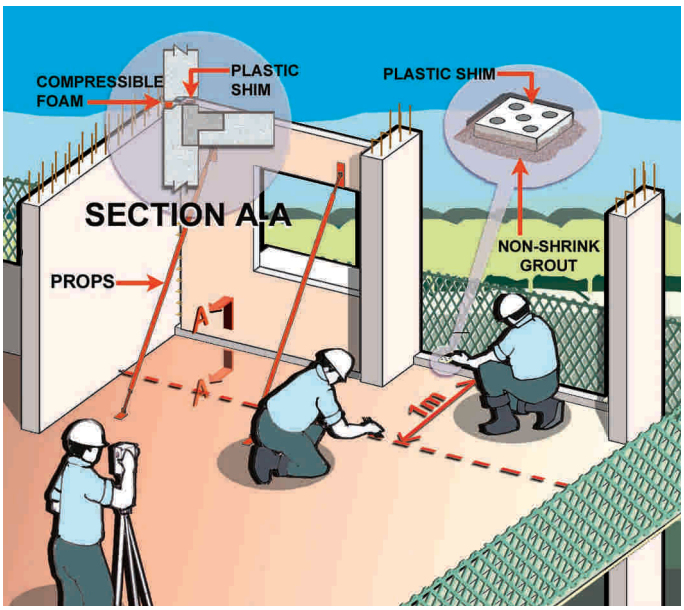
Table 4.1 – General Preparation Works

- Prepare storage area for precast concrete panels.
- Arrange tools, equipment and all necessary accessories for erection use.
- Prepare erection and delivery schedule.
- For vertical load bearing components, check all starter bars location in cast-in-situ joint.
- Set up all reference lines on the slab surface.
- Take level height of the starter bars which are embedded in floor.
- For vertical components, check the top re-bar level and alignment. For horizontal components, check the protruding bars dimension and alignment.

Table 4.2 – General Sequence of Installation Works

- Vertical structural components such as all load bearing walls including load bearing facades, columns, household shelter panels will be installed first.
- Other vertical components such refuse chutes, non load-bearing partition walls, facades walls, service ducts also need to be installed together with load-bearing vertical components
- Horizontal components will then be installed next. These include beams, slabs and staircase flights, parapets, ledges, balconies, planter boxes, and down hang panels.

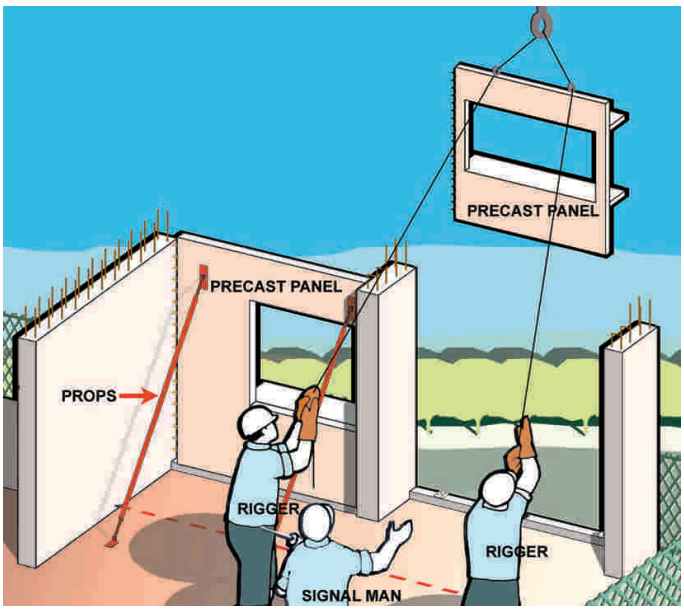
VERTICAL COMPONENT INSTALLATION: The method and sequence of installing the precast façade (which is also applicable to other vertical components) are outlined graphically as follows:



Operation Flow 1

SETTING OUT

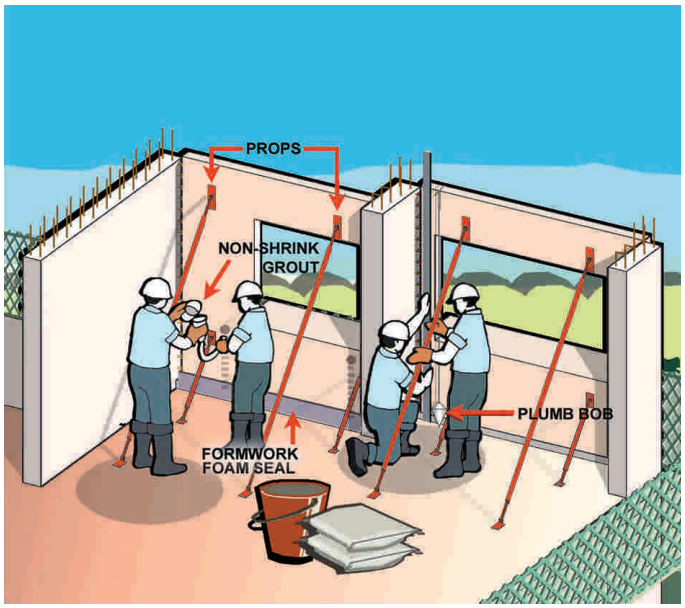
- Set reference line and offset say 1m
- Provide level pad (plastic shim) for panel setting and set level pad with non-shrink mortar
- For external wall/column, set compressible form on outer perimeter of wall



Operation Flow 2

LIFTING AND INSTALLING

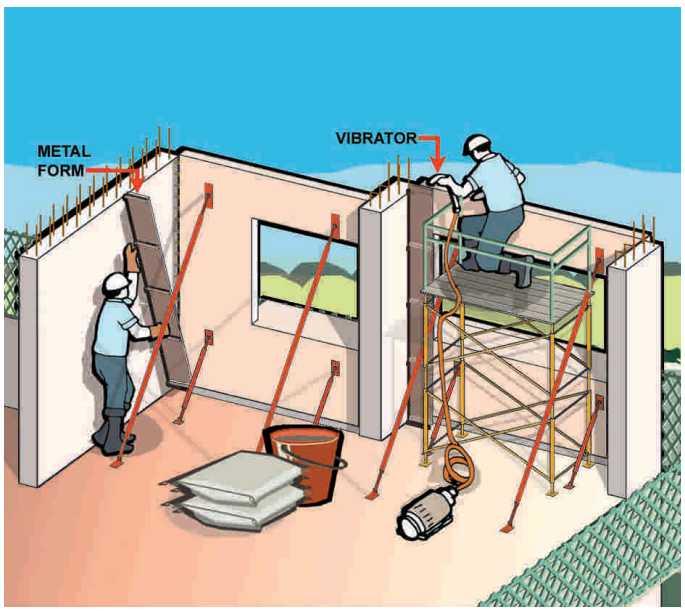
- One signal man and two riggers will be at the erection level
- Rigger will guide the panel into position and secure the panel by diagonal props
- For precast wall, props are provided on one side of the wall. For precast column or vertical shafts, props should be provided in two perpendicular directions
- After panel are being supported and aligned into corrected position, signal man will inform crane operator to release the panel



Operation Flow 3

GROUTING – NON-SHRINK MORTAR (for corrugated pipe where required in design)

- Seal along bottom length of inner side of wall using formwork and foam
- Apply non-shrink mortar to specification
- Take test cubes where necessary
- Pour non-shrink mortar into corrugated pipe
- Keep component undisturbed for at least 24 hours



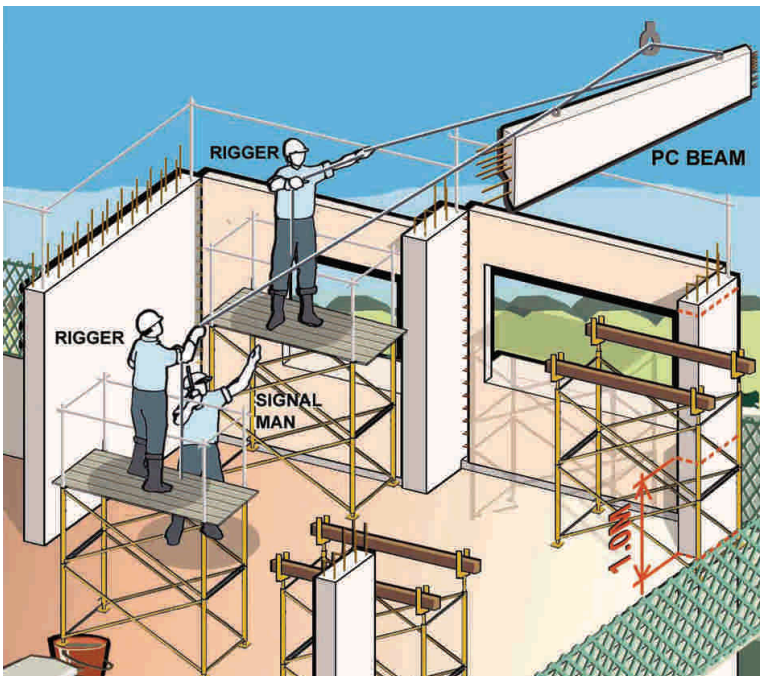
Operation Flow 4

VERTICAL JOINT CASTING AND SEALING (where required between vertical panels)

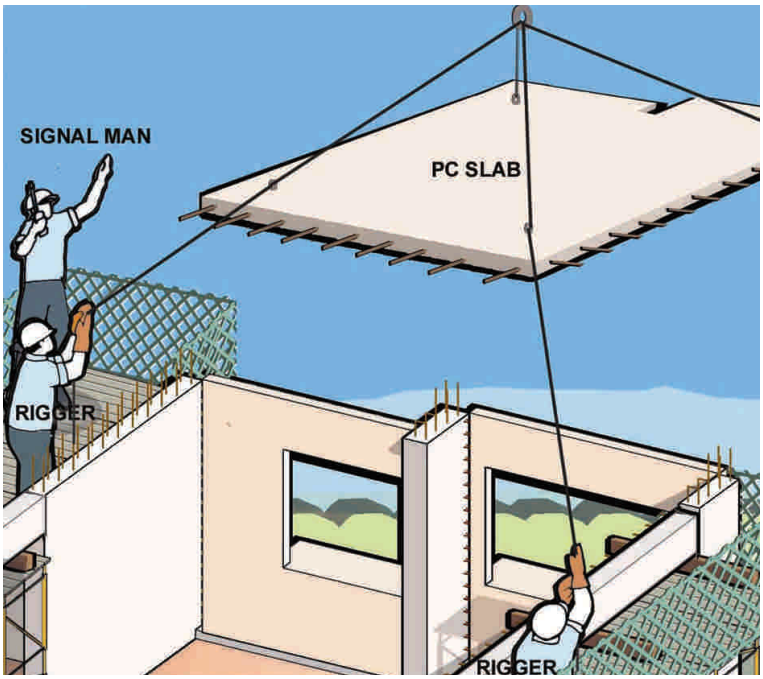
- For panel with wet connection, fix joint rebars
- Set up metal forms for the casting of the vertical joint
- Carry out concrete casting
- Remove metal forms after sufficient concrete strength achieved
- For panel with welded dry connection, place connecting plate between panels and weld as per design requirement

HORIZONTAL COMPONENT INSTALLATION: The following illustrations are pointers on the details and sequences of installing horizontal component such as precast beam, balcony, planter, ledge and slab.

Installation of Precast Beam



Installation of Precast Slab



Casting of In-situ Joint between Precast Beam and Slab

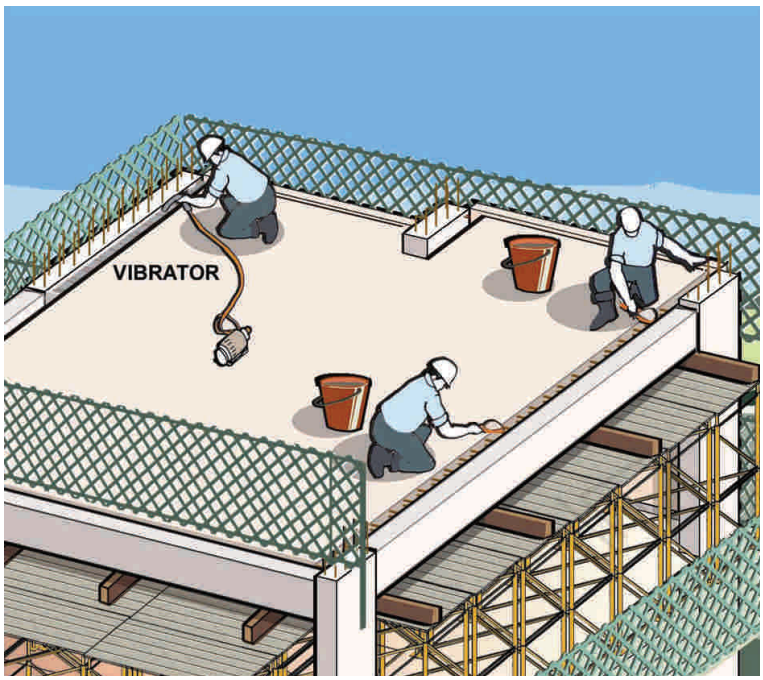
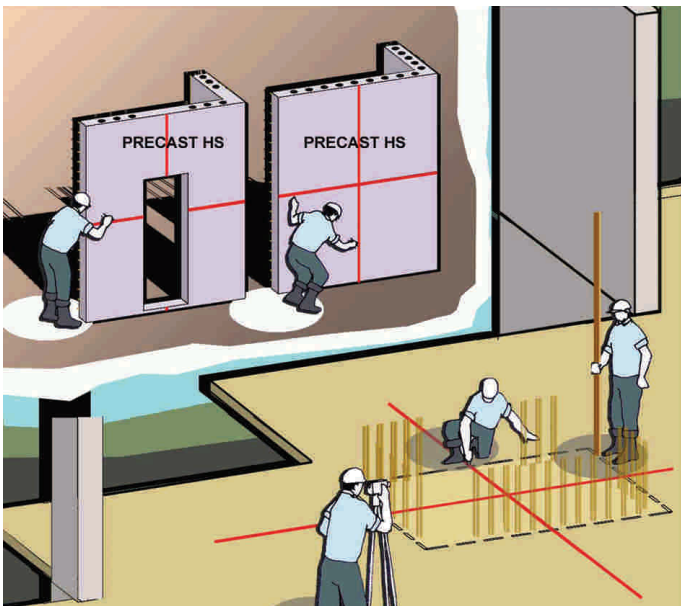


Table 4.3 – Details for Horizontal Component Installation

Setting Out • Setting out lines and reference levels to determine the alignment and level of installation	Points to note: • There should have sufficient tolerance for the placement of the rebars from horizontal components in connection with the rebars from supporting column/wall
Temporary Support & Bracing • Put up temporary vertical props (where required in design) for the horizontal panel. • For beam, down hang panel, each panel is supported at minimum two locations. For balcony, planter, ledge and slab, propping points will be more than two locations, depending on the width, length of panel and design consideration.	• Check that the vertical props are braced laterally • Bearing area at support should be sufficient. Panels should not be in tilted position especially for beam and down hang panel)
Panel Lifting & Placing • For typical precast beam & down hang panel, two numbers of lifting points at the top of panel are required for hoisting. For others, three or more lifting points are required. • Align and check level to suit the required setting out before placement of precast members to final position.	• Secure the precast elements against lateral tilt or movement during casting of joints

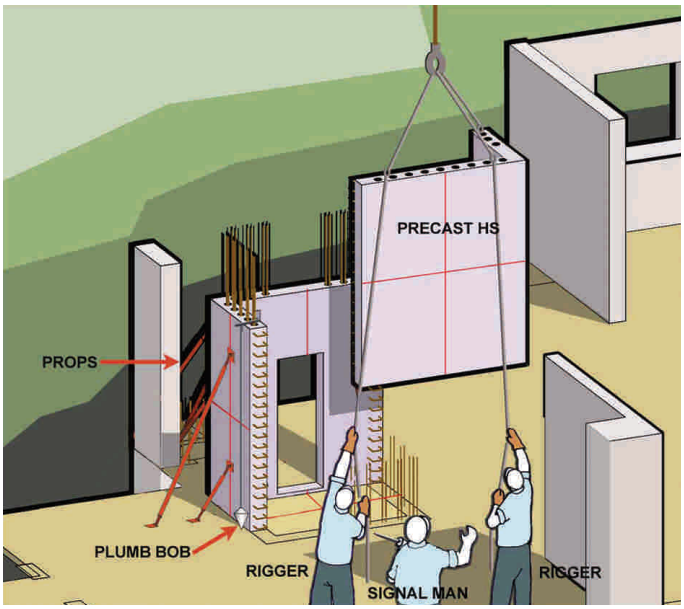
PRECAST HOUSEHOLD SHELTER INSTALLATION: The sequences of installing the precast household shelter with L shaped panel are as follows:



Operation Flow 1

PREPARATION WORK BEFORE INSTALLATION

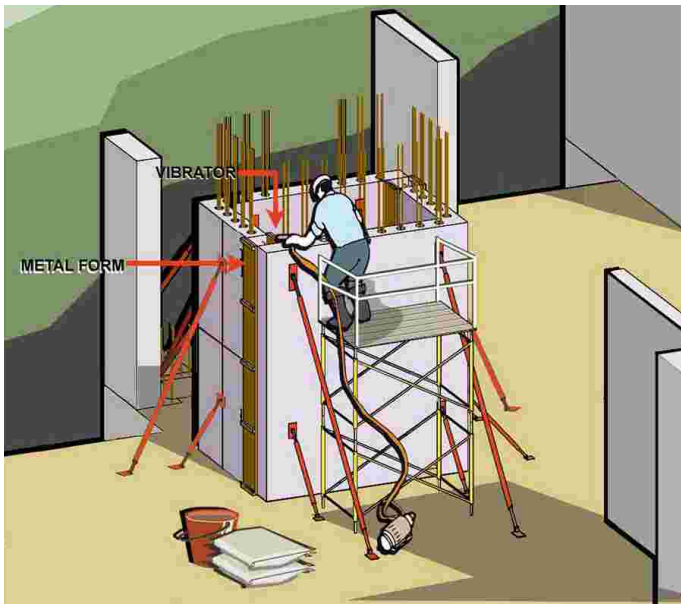
- Panel to be marked with two perpendicular lines on the rear surface
- Check that setting out lines and reference levels are correct
- Mark the wall location on the concrete floor and determine the level of the in-situ concrete



Operation Flow 2

PANEL LIFTING AND FIXING

- Panel is lifted to vertical position by using 3 numbers of lifting loops at the top of panel
- At final panel location, props are used to secure the panel at the top fixing points and fasten to the concrete floor.
- Adjust level with levelling bolts
- Check verticality and alignment



Operation Flow 3

CASTING OF JOINT

- Fix the vertical joint rebars, followed by joint formwork
- Seal up the bottom horizontal joint with non-shrink mortar
- Upon installation of horizontal panel at ceiling level, check vertical continuity bars alignment, cast the vertical joint from the next floor

PROTECTION OF PRECAST ELEMENTS: Upon installation of precast components particularly the precast facades, it may be necessary to protect them from dirt, dust, stains and fallen debris. The face of façade panel may be protected using boards or plywood or plastic sheets to minimise damage. However, it is worthwhile to note that though the use of polythene shrink-wrapping is suitable for most panel finishes, it may cause condensation and subsequent discolouration to many surfaces. Hence, other proprietary products in aqueous form should be considered where necessary, to be applied on the precast elements upon removal from the moulds and prior to storage or delivery.