

Unitized Curtain Walls Installation and Some Health and Safety Aspects

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ABSTRACT

This paper discusses good practices and industry experience in the safe installation of unitized curtain walls. An overview of the relevant standards and regulations is presented. Sequence of the installation works and health and safety strategies, methods and appropriate equipment are described and analysed. A reference to the project construction program of works some required preconditions for the facade installation to commence and provisions by the main contractor are discussed. The recommendations and guidance for the Health and Safety planning, provided in this paper, are aimed specifically at unitized curtain walls. The analysis of the discussed aspects is aided by project examples mainly from the United Kingdom, where the unitized curtain wall industry is on the rise and considered well developed.

Keywords: Health and Safety, installation, unitized curtain walls, façade engineering

1. INTRODUCTION.

Construction of high rise residential and administrative buildings in densely urbanised global cities is on the rise. For example, London, which is one of Europe's construction hot spots, Figure 1, is set to see nearly 250 buildings with more than 20 storeys, expected to be finished in the coming years [1].



Figure 1. Some new tower developments planned in London, according to [1].

Typically, the envelopes of such structures are constructed as unitized curtain walls. By definition a **unitized curtain wall** is an enclosing structure consisting of prefabricated glazed or solid panels which are transported to site from a factory and coupled together with minimum field installation works. Thus the benefits of using unitized curtain wall

system are: speed, lower installation costs, improved quality control due to sealing in controlled factory environment and minimal reliance on site labour, Figure 2.

34.5% of the injuries in the construction industry are caused due to handling accidents [2]. Utilizing a unitized system minimises the amount of manual handling and the number of operatives involved in potentially hazardous site conditions. Although the unitization of the building skin presents obvious health and safety benefits, the need of comprehensive published guidance documents should not be neglected, especially as global cities prove the continuing trend of using this construction type.

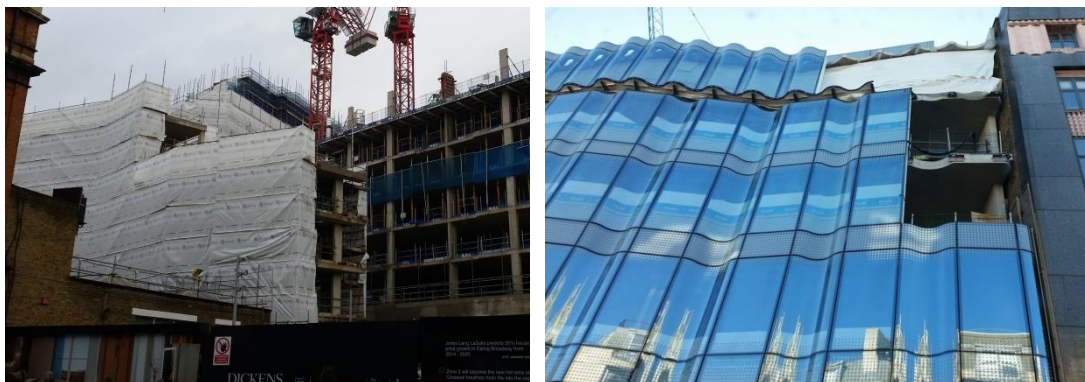


Figure 2. Comparison of stick and unitized facade constructions (a stick curtain wall, left, requires scaffolding and is labour intensive on site; unitized curtain walls, right, minimise the safety hazards on site due to the reduced field handling).

2. OVERVIEW OF RELEVANT STANDARDS AND REGULATIONS.

„The Health and Safety at Work Act 1974 and the Management of Health and Safety at Work Regulations 1999 are fundamental pieces of health and safety law in Great Britain. They place responsibility upon employers and employees to produce together their own solutions to health and safety problems, as far as is reasonably practicable. The Act contains provisions for the health and safety of people at work and the protection of others against health and safety risks from work activities“ [3]. Some of the regulations associated with certain types of activities during unitized facade installation are:

The Work at Height Regulations 2005: Work at height means work in any place where, if there were no precautions in place, a person could fall a distance liable to cause personal injury. Falls from height are one of the biggest causes of workplace fatalities and major injuries. [4]

The Manual Handling Operations Regulations 1992: The Regulations apply to a wide range of manual handling activities involving the transporting or supporting of a load. This includes lifting, lowering, pushing, pulling, carrying or moving. [2]

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER): these regulations place duties on people and companies who own, operate or have control over lifting equipment. In most cases, lifting equipment is also work equipment so the Provision and Use of Work Equipment Regulations (PUWER) will also apply. All lifting operations involving lifting equipment must be properly planned by a competent person, appropriately supervised and carried out in a safe manner. [5]

Even where engineering controls and safe systems of work have been applied, some hazards might remain- for example injuries to head and feet, eyes and ears, head and body. PPE is needed in these cases to reduce the risk. **The Personal Protective Equipment at Work**

Regulations 1992 and **The Personal Protective Equipment Regulations 2002** give the main requirements. [5]

In the UK the Health and Safety Executive is the enforcement agency for Health & Safety at Work on Construction Sites. It acts in the public interest to reduce work-related death and serious injury across Great Britain's workplaces.

3. THE CONSTRUCTION SITE- SAFE WORK ENVIRONMENT.

Before setting up a construction site, the principal contractor must draw up a construction phase plan. The construction phase plan must set out the health and safety arrangements, duties and site rules and where applicable, must include specific measures [6]. All site activities should be carried out as per method statements and task specific risk assessments, in accordance with the Project Health and Safety plan.

In the instance of unitized curtain wall clarifying the required storage and working areas within the perimeter of the building are very important. Generally, as the facade at each level is being installed, the full extent of the floor slab is used for temporary panel storage, sub-assembly and preparation of the cladding panels. Commonly, as a safety measure, exclusive use of the floor plate during facade installation is required. A clear line of sight to permit setting-out from the core walls to perimeter edges of the building structure should be granted. The floor slabs should have sufficient load bearing capacity to allow storage and movement of materials, Figure 3, and the operation of floor cranes and manipulators, where applicable. A comprehensive and agreed plan of the off-loading and storage areas, and safe routes to the relevant horizontal and vertical distribution equipment should be present prior to commencement of installation works. An example of facade delivery zone plan is shown on Figure 4.



Figure 3. Element distribution and storage throughout the floors.

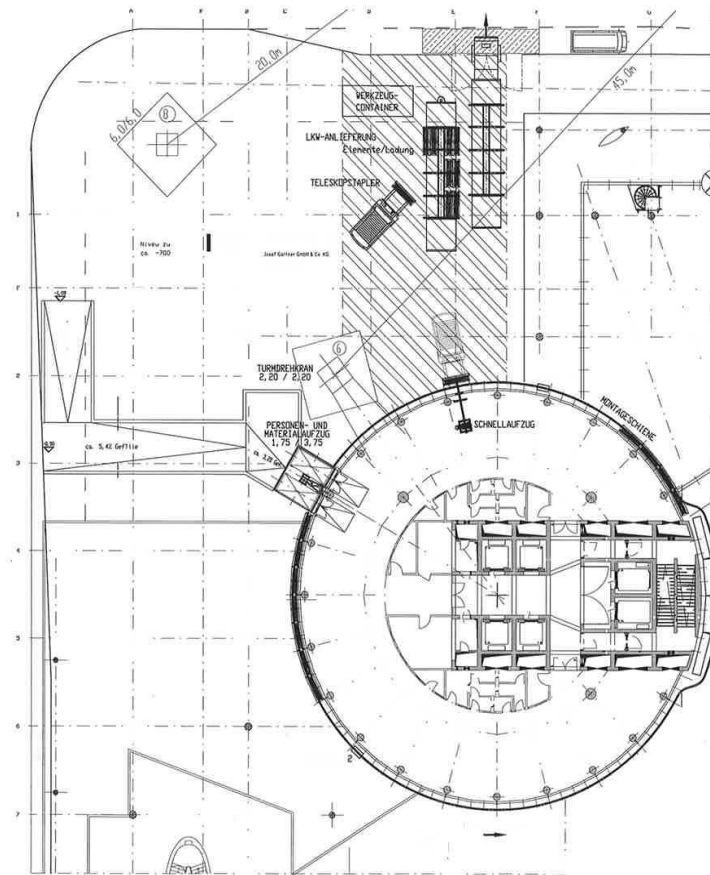


Figure 4. Typical Site Plan showing facade delivery zone [7].

4. SEQUENCE OF THE INSTALLATION WORKS AND RELEVANT SPECIFIC PROTECTION EQUIPMENT.

Edge protection and safety requirements.

The Main Contractor shall provide protection near all exposed slab edges, Figure 5. Their designed locations are to be agreed by the façade contractor prior to installation. Usually the main protective handrail is positioned between 250 to 300mm from the outer edge of the floor slab to provide a first line of safety. The protective safety handrail must not clash with bracket locations. Tubing and toe boards that interfere with the facade structure and facade installation activities are to be modified.

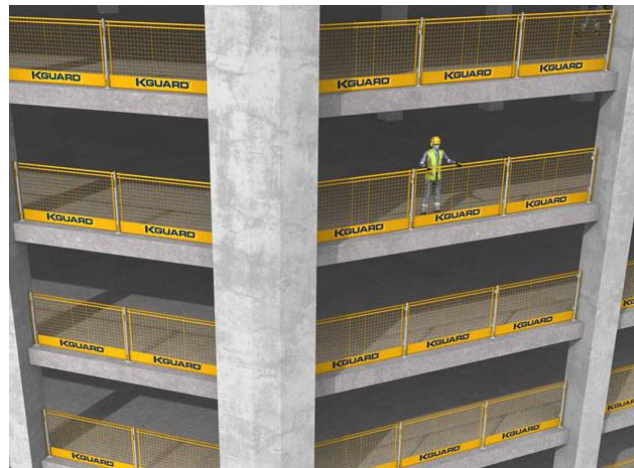


Figure 5. Adaptable edge Protection with Integral kick plate [8].

The edge protection must be easily adaptable so that the lower panels can allow access for façade brackets installation.

When the edge protection is required to be entirely removed to allow access for the installation of the elements, this area of the building should become an exclusion zone and all operatives should use a personnel restraint system. In some cases, it is particularly designed for the project.

Protective scaffold/fan.

The Main Contractor shall provide a protective scaffold/fan to locations where other trades are working above the floors where facade installation works are taking place, or where the facade installation is finished. A protection fan is necessary to protect personnel working below from falling objects and also to protect the curtain wall elements.

The protective scaffold should be coordinated with the façade contractor in order to minimize any obstruction for the installation work.

Such protection may be used and required also in the areas where façade bracket installation is taking place.

Bracket installation.

The brackets for the curtain wall elements are fixed to the main structure. Where applicable, prior to installation of the brackets, the insert cast-ins should be checked for accuracy. Any errors should be communicated to the Main Contractor for rectification. Based on the building grids and vertical levels the brackets are pre-installed and adjusted to the exact position. The slab edge protection should be designed to allow access through the handrail to the bracket installation area, as described above. Brackets situated to the underside of slabs (on the edge beam) may be accessed in general via compact scissor lift or movable cantilever scaffold. On completion of the bracket installation at each level a general check should be carried out and all bracket fixings should be torqued according to the relevant calculations. Finished brackets should have the completed bolts marked to indicate correct torque is achieved and the bracket is complete and safe to receive the panel, Figure 6. Hand tools and other small items such as curtain wall brackets which are used close to or outside of the handrail should be secured. This might be a physical tether secured to the item with a karabiner clip which is temporary attached to the handrail section.



Figure 6 Unitized curtain wall corner bracket

Installation of the elements.

Installation by floor crane:

The mini crane is usually electrically operated and controlled by a manual or radio control. It is usually positioned one or two floors above the installation level and moved as required along the perimeter of the building. The panel is placed on a launching table, which could be cantilevered beyond the edge protection or positioned on a cantilevered platform as shown on Figure 7. The glass is facing upwards, and positioned adjacent of its final installation position. The clearance above the launching table should allow safe handling of the unit during the operation. As illustrated on Figure 8, the panel is attached to the crane hook, lifted off the launching platform and suspended in front of its final position. The panel is rotated 180 degrees, so that the glass is facing to the outside, before being lowered onto the fixing brackets. The edge protection remains in place throughout this operation. The panel should stay attached to the crane hook until it is safely mounted to the fixing brackets.

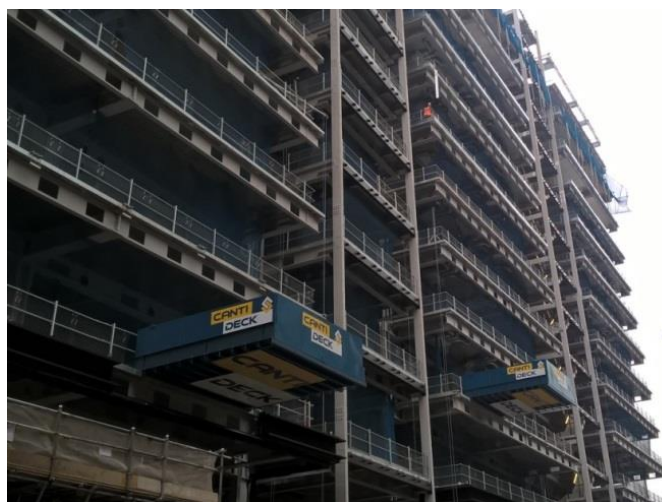


Figure 7 Cantilevered platform

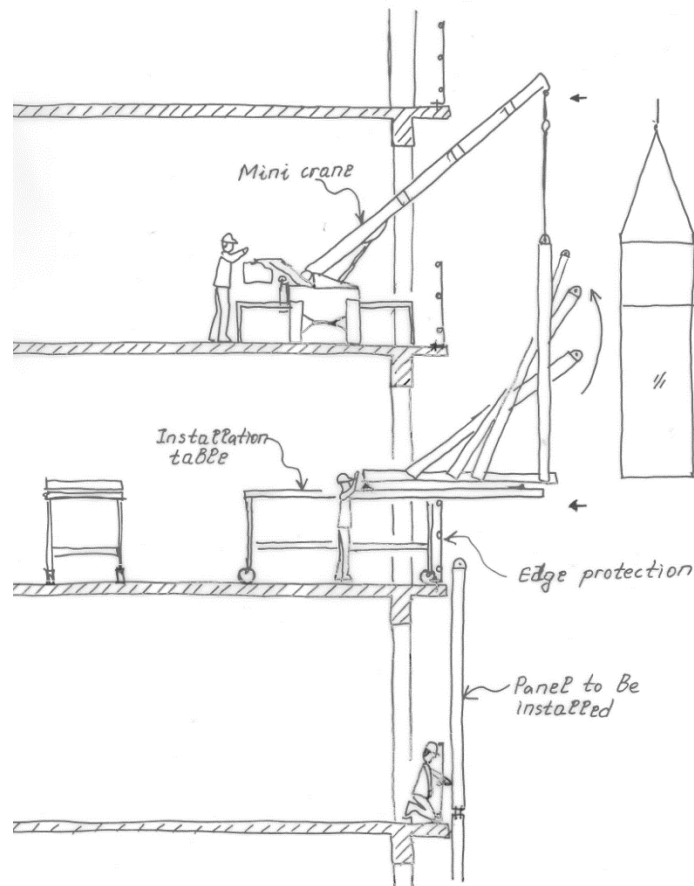


Figure 8. Sketch of unitized curtain wall installation using mini crane.

Installation by automated remote manipulator:

The glazing robots (manipulators), Figure 9, provide practicality and efficiency, can access difficult to reach areas and allow glass installation from the inside out. The manual handling of the elements is reduced significantly. Once the element is securely attached to the vacuum lifting device of the manipulator, it is easily positioned for installation. The edge protection stays in place.



Figure 9. Glazing Robot [9].

Installation by monorail:

Generally, the monorail system is positioned at level 10 for example and then it could be moved in increments of approximately 10 floors. The panel may either be placed on a launching table (as illustrated in the previous section), on an off-loading deck positioned on the ground close to the building, or on a cantilevered launching platform as illustrated below, Figure 10

The winch hook is attached to the panel, which is lifted off the launching platform and rotated through 180 degrees, so that the glass is facing to the outside. The winch is then traversed across the monorail to bring the panel to its final location, before being lowered on to the fixing brackets. The cantilevered platform forms part of the edge protection, which remains in place throughout this operation.

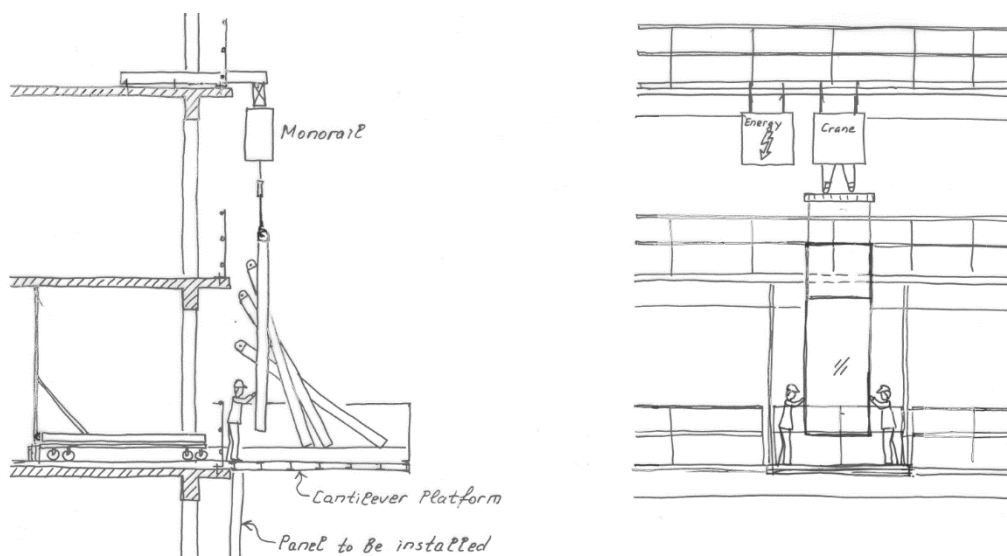


Figure 10. Sketch of unitized facade installation by monorail, using cantilevered platform- part of the edge protection.

Installation by tower crane:

The use of tower crane is generally required when the façade element is too heavy to be lifted by other types of lifting machinery or the panel needs to be installed at an otherwise inaccessible location, Figure 11. During tower crane lifts, guide ropes should be attached to stop the panel rotating. After carefully lifting the panel to the vertical position, it is transported to the point of installation clear from the structure and clear from any potential hazard by the crane and lowered to connect with the panel below.



Figure 11. Unitized panel being installed by tower crane, within the edge protection [10].

5. HEALTH AND SAFETY PLANING.

BS OHSAS 18001 is an internationally applied standard for occupational health and safety management systems. It exists to help all kinds of organizations put in place demonstrably sound occupational health and safety performance. It is widely recognized by the façade contractors operating in Great Britain and other countries.

As a requirement under the Health and Welfare Act 2005, the façade contractors should have a Company's Health & Safety Policy. The Health & Safety Policy generally includes Policy Statements (Mission Statement, Safety Policy Statement, Environmental Policy Statement), The organisation chart and duties of individuals, a set of health and safety guidelines appropriate to the activities undertaken by the company.

In addition, and as a best practice recommendation, for each project the façade contractors develop method statements. The method statements describe in detail all work activities undertaken by the contractor and give specific instructions on how to safely perform each task.

As part of the Health and Safety planning, task specific risk assessments and weekly and even daily toolbox talks and audits are widely acknowledged.

CONCLUSIONS

The regulations and standards in the construction industry do not currently address the installation of unitized curtain walls. Like other types of construction works, e.g. main load bearing structures, there is a high degree of variation in the methods of erecting unitized curtain walls, but in the case of unitized facades- very little published technical information available to the construction engineers. The installation technology, safety procedures and quality assurance depend not only on the type of the building and system used, but also on the good practices and traditions in the region and the facade company involved in the construction. Currently the availability of technical guidance does not reflect the increased popularity of this

construction type. Having presented and analysed the various existing techniques in the field, this paper sets out the framework for a more structured and universal know-how in the field.

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