

**GUYANA STANDARD**

**Building Code - Section 11 : High-rise buildings**

Prepared by  
GUYANA NATIONAL BUREAU OF STANDARDS

Approved by  
NATIONAL STANDARDS COUNCIL

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## **Foreword**

This Guyana Standard was adapted by the Guyana National Bureau of Standards in 2003, after the draft was finalised by the **Technical Committee - Civil engineering** and approved by the National Standards Council.

This standard was developed to specify requirements for the design and construction of high-rise buildings in Guyana.

This standard is intended to be made mandatory.

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## **Building Code - Section 11 : High-rise buildings**

### **1 Scope**

This Code of Practice specifies requirements for the design and construction of high-rise buildings.

### **2 Definitions**

For the purpose of this Code, the following definitions shall apply:

- 2.1 accessory:** Device, other than current using equipment associated with such equipment or with the wiring of an installation.
- 2.2 attic or roof space:** The space between the roof and ceiling of the top storey or between a dwarf wall and a sloping roof.
- 2.3 bearing pressure (allowable):** The maximum pressure that may be safely applied to a soil or rock foundation unit considered in design under expected loading and subsurface conditions.
- 2.4 bearing pressure, design:** The pressure applied by a foundation unit to a soil or rock

which is not greater than the allowable bearing pressure.

- 2.5 **building:** Any structure used or intended for supporting or sheltering any use of occupancy.
- 2.6 **building area:** The greatest horizontal area of a building above grade within the outside surface of exterior wall or within the outside surface of exterior walls and the centre line of fire-walls.
- 2.7 **building height:** The number of storeys contained between the roof and the floor of the first storey.
- 2.8 **business and services occupancy:** The occupancy or use of a building or a part thereof for the transaction of business or the rendering or receiving of professional or personal services.
- 2.9 **cladding, exterior:** Those components of a building which are exposed to the outdoor environment and are intended to provide protection against wind, water or vapour.
- 2.10 **dead load:** The weight of all permanent structural and non-structural components of a building.
- 2.11 **dwelling unit:** A suite operated as a housekeeping unit, used or intended to be used as a domicile by one or more persons and usually contains cooking, eating, living, sleeping and sanitary facilities.
- 2.12 **exit:** That part of a means of egress that leads from the floor area it serves, including any doorway leading directly from a floor area, to a public thoroughfare or to an acceptable open space.
- 2.13 **exit, access to:** That part of a means of egress within a floor area that provides access to an exit serving the floor area.
- 2.14 **exit horizontal:** That type of exit connecting 2 floor areas at substantially the same level by means of a doorway, vestibule, bridge or balcony, such floor areas being located either in different buildings or located in the same building and fully separated from each other by a firewall.
- 2.15 **exit level:** The lowest level in an enclosed exit stairway from which an exterior door provides access to a public thoroughfare or to any acceptable open space with access to a public thoroughfare at approximately the same level either directly or through a vestibule

or exit corridor.

- 2.16 **exit storey:** A storey from which an exterior door provides direct access to approximately the same level to a public thoroughfare or to an acceptable open space with access to a public thoroughfare.
- 2.17 **fire resistance:** The property of a material or assembly to withstand fire or give protection from it. As applied to elements of buildings, it is characterised by the ability to confine a fire or to continue to perform a given structural function, or both.
- 2.18 **fire-resistance rating:** The time in hours or fraction thereof that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under the specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in this Code.
- 2.19 **fire separation:** A construction assembly that acts as a barrier against the spread of fire and may not be required to have a fire-resistance rating or a fire-protection rating.
- 2.20 **fire stop:** A draft-tight barrier within or between construction assemblies that acts to retard the passage of smoke and flame.
- 2.21 **firewall:** A type of fire separation of non-combustible construction which subdivides a building or separates adjoining buildings to resist the spread of fire and which has a fire-resistance rating as prescribed in this Code and has structural stability to remain intact under fire conditions for the required fire-rated time.
- 2.22 **floor area:** The space on any storey of a building between exterior walls and required firewalls, including the space occupied by interior walls and partitions, but not including exists and vertical service spaces that pierce the storey.
- 2.23 **foundation:** A system or arrangement of foundation units through which the loads from a building are transferred to supporting soil or rock.
- 2.24 **groundwater level:** The top surface of a free standing body of water in the ground, often referred to as the water table.
- 2.25 **live load:** The load other than dead load to be assumed in the design of the structural members of a building. It includes loads resulting from rain, earthquake and wind, and those due to occupancy.

- 2.26 means of egress:** A continuous path of travel provided by a doorway, corridor, exterior passageway, balcony, lobby, stair, ramp or other egress facility or combination thereof, for the escape of persons from any point in a building, floor area, room or contained open space to a public thoroughfare or other acceptable open space.
- 2.27 occupancy:** The use or intended use of a building or part thereof for the shelter or support of persons, animals or property.
- 2.28 plumbing system:** A drainage system, a venting system and a water system or parts thereof.
- 2.29 private sewage:** A privately owned plant for the treatment and disposal of sewage disposal system.
- 2.30 public way:** A sidewalk, street, highway, square or other open space to which the public has access, as of right or by invitation, expressed or implied.
- 2.31 storey:** That portion of a building which is situated between the top of any floor and the top of the floor next above it, and if there is no floor above it, that portion between the top of such floor and the ceiling above it.
- 2.32 service floor:** Storey assigned to location and safe functioning of mechanical gear and plant, and storage of water reservoirs as a fire-safety precaution.
- 2.33 service exit:** Exit in bulk supply, heavy parking and ramped management of specialised service vehicles.

### **3 General construction principles**

#### **3.1 Site preparation**

##### **3.1.1 Preliminary investigation**

Before any construction work commences, a preliminary inspection and thorough geotechnical investigation of the site and its adjoining abutments shall be undertaken so that preparation may be made for any problems or difficulties that may arise. An avianational section and environmental impact assessment report shall be submitted with proposal for approval. Details of the roof's current and potential use as a heliport, evacuation platform, as well as a communications support base (for masts, etc.) shall be provided. A detailed plan shall also show how the construction site will be organised so that a logical layout of

materials, equipment with adequate egress, access and general on-site mobility may be achieved. Completion of this checklist will provide enough information about the site and its conditions to permit construction to begin.

**3.1.2 Checklist for site conditions**

- (a) Take note of general topography of site and other physical conditions likely to cause hazards.
- (b) Is there adequate natural provision for removal of storm water?
- (c) Is the area normally subject to land slippage?
- (d) Will there be a need for the removal of large trees?
- (e) Will construction endanger public utility services?
- (f) Are water, sewage disposal facilities and electricity available on site?
- (g) Is easy access to site available?
- (h) Is there evidence of termite infestation in soil or trees?
- (i) Determine the depth of foundation stratum.
- (j) Determine the height of the water table if appropriate.
- (k) Determine whether the soil is suitable for the construction intended. What do the results of a geotechnical investigation show?
- (l) Select suitable areas for stockpiling aggregate.
- (m) Select area for location of luffing-boom, hammerhead and/or mobile tower cranes, if to be used.
- (n) Has provision been made for the safe use of the guy derrick, which will be disassembled by a small hoist, in turn, itself to be disassembled and taken down the elevator.
- (o) Select location of materials storage sheds. Make arrangements for traffic re-routing, signs, etc.

- (p) Has planning permission been obtained ? Has the Civil Aviation Department and other land traffic authorities approved the traffic changes and implications.
- (q) Do you have a surveyor's drawing of the site ?
- (r) Have you found the location of all boundary markers ?

Having completed the above checklist, possible construction problems will have been highlighted and requirements of plant and materials made known. It is recommended that an engineer or other appropriate professionals be consulted when foundation problems are evident.

### **3.1.3 Site clearance**

- (a) Care shall be given to preserve any trees on the site. Natural soil surface, not less than 30% of the entire site shall be preserved, with necessary revetments. If trees have to be removed, special care shall be taken to remove totally, all roots and stumps of felled trees. This vegetation shall be removed from the site.
- (b) The State's Director of Public Building Works or Planning Authority or his agent may require an inspection of the site before the site is cleared of trees and other overgrowth. Endangered species under protection of existing trust or protectionist act shall be preserved.
- (c) The area where the building will be situated shall then be stripped of top soil and these materials stock piled in a suitable area for later use during landscaping.
- (d) Construction site cover with any permanent and impervious finish, shall not exceed 70%.

### **3.1.4 Construction site layout**

- (a) A plan of storage of materials and equipment shall be submitted for review and approval by the State's Public Construction Works Department or Planning Authority. (See Appendix 2 to 4).
- (b) Approval shall be obtained from the State for temporary re-routing of traffic during

construction. (See Appendix 5).

### **3.1.5 Material and equipment storage**

- (a) Materials storage shall allow the use of cranes and other wide-base heavy duty equipment, and facilitate efficient supply to the various sections of the building construction site, when required.
- (b) Areas shall be allocated on the cleared site for the storage of materials. Coarse and fine aggregate for the mixing of concrete and mortar shall be placed in separate heaps in a location near to the concrete mixer and/or concrete mixing area.
- (c) Building materials requiring protected storage shall be stored in sheds or containers which are weather tight and have a wooden or impervious floor raised not less than 10 cm off the ground.
- (d) Reinforcement and other building materials prone to rapid degradation shall be stacked off the ground to reduce corrosion.
- (e) Provision shall be made for the temporary storage of heavy-duty equipment, and the efficient locating of cranes allowing for their swings and mobility. (See Appendix 2 to 5) for examples of such site layouts, with provision for crane swings.

## **4 Earth moving**

### **4.1 Excavations**

- 4.1.1** Excavations for foundation shall be carried out along the building lines to the depth of the foundation stratum identified as suitable. It may be desirable to seek the assistance of an experienced engineer in determining the appropriate level for the foundation.
- 4.1.2** Generally, drilling is done by larger auger drills. Hand excavation is used only when the soil is too bouldery for the drill. A temporary cylindrical steel casing may be lowered around the drill as it progresses, to support the soil around the hole. A bell is created at the bottom of the drilled shaft, either by hand excavation or by a special belling bucket on the drill.
- 4.1.3** Excavations will invariably exceed 1.5 m. For excavations exceeding 1.5 m the extent of

planking and strutting necessary shall be determined by the nature of the soil and the location of the water table. In deep foundations the soil around the excavations may be supported with a site cast concrete slurry wall. Most of this wall may be tied back, or may be additionally supported with struts or rakers. (**See Appendix 11**).

- 4.1.4** In high-rise construction the use of large piles or caissons is highly recommended. A caisson is similar to a column footing in its functions, but normally extends through strata of unsatisfactory soil beneath the substructure of a building until it reaches a satisfactory bearing stratum, such as rock, dense sands and gravels, or firm clay. A caisson is constructed by drilling or hand-digging a hole, bellling out at the bottom as necessary to achieve the required bearing area, and filling the hole with concrete.
- 4.1.5** Soil restraining support for excavated pits shall be referred to an approved foundation (structural) engineer.
- 4.1.6** Where the foundation is in rock, it is necessary to excavate at least 0.6 m to 1.2 m so as to provide a key for the foundations.
- 4.1.7** The bearing surface of the soil at the bottom of all excavations shall be inspected to ensure that it is of the specified quality.
- 4.1.8** When excavations have been carried beyond their generally required depth, either by accident or design, the deep areas shall be back filled with compacted, approved material or with concrete of proportions 1:3:6 volume.
- 4.2 Back filling**
  - 4.2.1** Back filling especially in cases where caissons are employed, is done with concrete and carried out in stages. Reinforcement is seldom used, except near the tops of caissons where they join columns of the superstructure, or when extremely high load bearing strengths are required, and heavy H-steel sections are lowered into the drilled shafts and filled in with concrete.
  - 4.2.2** Suitable fill material may be brought to the site or obtained from excavated material, provided always that such material is free of substantial amounts of clay or organic matter.
  - 4.2.3** All back fill shall be well compacted in layers not exceeding 15.2 cm thickness where compaction is by hand or small mechanical compactors. Where vibratory rollers are used, the thickness of layers may be increased to 22.9 cm.
  - 4.2.4** Where back fill under floor slabs has been effected using hard core, a 0.6 m layer of sand shall be applied to the top of the compacted hard core to protect damp proof membranes



from puncture.

**4.2.5** A damp proof course of polythene sheeting is sometimes applied between the top of the fill and the bottom of the floor slab to prevent damp travelling upwards from the foundations to the wall, especially in areas of high water table. However this polythene sheeting may be punctured during construction and therefore act as a damp proof course. In addition, synthetic rubber waterstops may be used to seal against water penetration at movement joints and at joints between pours of concrete in a foundation. Some types are split at one end, half way across the width of the stop, so its halves can be placed flat against the inner face of the formwork. After that formwork is removed from the first pour, the split end is put back together before pouring of the next batch of concrete.

**4.2.6** Other preferred methods of providing a damp proof course may be used, such as a dense concrete layer or bitumen on the foundation course. Any such measure should be discussed with the foundation engineer, and should be a proven method of preventing the upward movement of moisture.

**4.2.7** As a general rule, essential storage and habitable spaces should be kept above grade, so as to minimise the need for expensive methods of waterproofing to the floors or parts of the structure in contact with the ground, especially along the Northern Sea Coast of Guyana, and where the water table is very high.

### **4.3 Compaction**

**4.3.1** Compaction of some soils is necessary to increase the bearing value of the soil. However the characteristics of the soils may best be known through local experience of the behaviour of the soils. For example, the compaction of organic clays is poor to very poor, while the compaction of sandy soils or sand clay mixtures by a rubber tired roller should provide good results.

**4.3.2** It is recommended that where clay is encountered, professional advice be sought before planning the foundations. (See **Appendix 12 to 14**) for principles of pile support.

## **5 Earth tremor considerations**

### **5.1 Earth tremor resistant construction**

#### **5.1.1 General**

(a) It is widely recognised in the Guyanese building industry, that it is uncommon to

have severe tremors, however at the high-rise scale, this factor needs to be catered for, since even the miniscule tremors at ground level may inflict severe lateral movement at the higher floor levels.

- (b) Because of this situation, buildings shall be designed and constructed so that they have some resistance to or compensation for the shaking or lateral forces produced by tremors. This factor shall be clearly defined and catered for in the design proposal submitted for build approval, with sufficient calculations and descriptions allowing the involvement of trained structural engineers during the review of such proposal.

### **5.1.2 Effect of the soil type**

The type of soil at the site may have a significant effect upon the resistance of the building to an earth tremor. The earth tremor may also, due to shaking of the ground, compact loose sands or fill material, and if a building is constructed on such material, the building will be damaged.

### **5.1.3 Effect of high seas**

Buildings on coastal areas may suffer due to high waves produced by earth tremors, and therefore the siting of the building in relation to the sea level is very important. Especially along the coastal regions, proposals for high-rise buildings and structures shall compensate for the general lack of refuge to high ground in the event of a flooding catastrophe. Our history and experience with traditional coastal timber structures has taught us the importance of building on stilts. This practice shall be readily exploited when designing high-rise structures especially along the coast. (See **Appendix 16 to 17**) for recommended high-rise building forms for Guyana.

### **5.1.4 Building shape**

- (a) The success with which a building survives an earth tremor is greatly affected by its shape in plan, the way the building is tied together and the quality of construction. (See **Appendix 20 to 27**) for examples of high-rise floor plan from around the developed world.
- (b) Most building plans with a simple rectangular shape with no projections (or only short projections) perform well under earth tremor conditions, provided the construction is adequate.
- (c) Long narrow building plans shall be avoided by limiting the length to three times the width. If the building must be longer, then it shall be divided into separate blocks with adequate separation.

- (d) Rectangular buildings with well inter-connected cross walls are inherently strong and therefore desirable. The thickness of walls at the base of the structure may be gradually reduced to safe limits at the top. (See **Appendix 21**) for example of the United States building, employing this principle.

### 5.1.5 Appendages

Where buildings have decorative or functional additions or appendages such as window hoods, parapets and wall panels etc. extreme care shall be taken to ensure that they are securely fixed, since many of such items tend to fall easily and may cause damage during an earth tremor (See **Clause 6**).

## 6 Considerations for the construction of high wind resistant buildings

### 6.1 Building site

- 6.1.1 Buildings sited in exposed areas (for example, on the brow of a hill) are most vulnerable, while those sheltered by natural topography are less vulnerable. Buildings sited in gullies or in river beds are very vulnerable as they are subject to severe damage by floods caused by the heavy rains which often accompany high wind storms.
- 6.1.2 In siting the building, steep slopes and edge of cliffs shall be avoided, as well as other conditions such as steep sided valleys where exceptionally high wind speeds are found.
- 6.1.3 Spacing between a series of high-rise or a combination of high and medium risers is a very significant factor which can produce severe turbulence and low pressure features. The diagrams in **Appendix 28** and **Appendix 29** attempt to explain this.
- 6.1.4 Structurally, high-rise buildings shall be designed to compensate for lateral movements induced by wind speeds of up to 322 km/h.
- 6.1.5 Footings may not legally extend beyond the property lines, and as such constructing standard footings may pose a problem. A system of cantilevered beam, column and footing may be employed. It is advisable however to seek professional assistance for such construction.

## 6.2 Roofs

**6.2.1** Roofs on high-rise buildings are usually flat. They shall be designed to provide a secure landing and launching of small aircraft such as helicopters. Secure shelter with sufficient fire resistance shall also be provided to allow the holding of personnel and materials to allow evacuation from the roof, in the event of a fire or other catastrophe, forcing exit from this elevated space.

**6.2.2** Attention shall be given to the location of fixings used for the roof cladding. It is necessary to provide additional fixings at the roof edges and ridge, since high-localised pressures are produced in these locations. (See **Appendix 30 and Appendix 31**) for recommended considerations and safety buffer zones.

**6.2.3** The high suction along the roof edge can be reduced by the use of a parapet, but then this has to be adequately strengthened, so that it does not become a hazard during a high wind or in the event of severe shaking of the building. Parapets allow protection for even controlled recreation and viewing of the surrounding landscape (See **Appendix 32 to Appendix 37**) for examples of roof details.

**6.2.4** Roof overhangs also experience high local pressures and, where possible, these shall be kept to a minimum or removed completely.

## 6.3 Windows and doors

Special attention shall be paid to the installation of doors and windows, since the loss of a door or window during a high wind storm will greatly alter the internal pressure of the building, thus adversely affecting its safety. For this reason, glazed windows and doors shall be securely fitted. High-resistant shatter-proof glass shall be used in all external windows and doors in storeys above the tenth floor.

## 6.4 Walls

Although it may not be common for the walls of a concrete block building to be destroyed during a high wind storm, it is important that the wall reinforcement be properly anchored at the foundation and the ring beam levels. It is more common in recent developments to specify the use of relatively lighter and more functional curtain walls. These are non-loadbearing external claddings. (See **Appendix 38 and Appendix 39**) for examples of curtain wall details.

## **7 Timber in high-rise buildings**

### **7.1 General**

Since Guyana is known for its rich variety of timber, which in many cases has become synonymous with construction, it is natural to assume that attempts will be made to utilise as many timber elements in high-rise structures. It is advisable that the use of timber be limited to internal walls and nonstructural elements. Maximum use shall be made of plaited cane panels, doors, shelves and other forms of finishing. These would minimise the dead load of the overall structure. Maximum care shall be taken to minimise the use of traditionally bulky furniture, exploiting, rather lighter *nibi* and *kofu* units. For optimum flexibility, a shift in the direction of fold-away beds, tables and even chairs, hitherto under-utilised in Guyanese living spaces, shall be encouraged.

**7.2** As far as timber walls are concerned, in addition to bracing corners in both directions, diagonal braces or steel straps shall be installed at the level of the top plate to provide rigidity of the corners at that level.

## **8 Steel in high-rise structures**

**8.1** The principles for the design and construction of high-wind resistant steel buildings are:

**8.1.1** Ensure that the manufacturer has been provided with the proper information regarding the design wind speeds so that the building frame design can be in accordance with this Code.

**8.1.2** Ensure that there are adequate numbers and sizes of foundation holding down bolts, and that they are all in place and properly fixed.

**8.1.3** Ensure that there is adequate lateral support provided by cross bracing or horizontal ties or by cast in place concrete or masonry walls.

**8.1.4** Where concrete walls or concrete masonry are used, the connections between the steel frames and the walls shall be carefully designed and constructed.

**8.1.5** Ensure that the manufacturer's recommendations with regards to the construction of the roof and roof covering are followed.

## 8.2 Reinforcement

- 8.2.1 Reinforcement shall be specified by a trained structural engineer. All calculations must be submitted along with application for development for approval. (See **Appendix 40 and Appendix 41**) for examples of reinforcement designs.

## 8.3 Fixing and welding

- 8.3.1 See **Appendix 1** for presentations dealing with the importance and nature of steel connections and **GCP 9 - 10 : 2002**, “**Building Code - Section 10 : Medium rise buildings.**”

## 8.4 Construction sequence

The use of heavy-duty and highly specialised equipment is an integral part in the construction of high-rise structures in Guyana. Traditional building equipment will prove immensely inadequate at this scale of operations. There is therefore expected that an influx of a new generation of tower cranes, guy derricks, augers, etc., will need to be brought into the local building industry, temporarily or on a permanent basis, for the accomplishment of this type of construction.

See **Appendix 42** and **Appendix 43** for clarification of the sequences of erecting a tall steel building frame, using a guy derrick and two types of tower or boom cranes.

### 8.4.1 Using a guy derrick:

- (a) The first tier is erected with a mobile crane.
- (b) The first tier is plumbed up, and a temporary plank floor is placed.
- (c) The mobile crane erects the guy derrick. This is usually done at the highest level the mobile crane can reach (but in **Appendix 42**, it is shown at the second floor to keep the drawing to a reasonable size).
- (d) An upper tier of framing is erected and plumbed.
- (e) The boom of the guy derrick is disconnected from the mast, mounted on a temporary block, and braced with guy cables. The boom then lifts the derrick mast to the next tier.
- (f) The mast is secured in its new position and lifts the boom up to be reconnected to

- the mast. This jumping of the derrick is repeated every two stories.
- (g) The frame is topped out, after which the derrick is disassembled and lowered to the ground in pieces by a small hoist. The small hoist, in turn is disassembled and taken down the elevator.

**8.4.2** Using two types of tower cranes:

- (a) The luffing-boom crane can be used in congested situations where the movement of the hammerhead boom would be limited by obstructions.
- (b) Both cranes may be mounted on either external or internal towers.
- (c) The internal tower is supported on the frame of the building, while the external tower is braced by the building.
- (d) The tower cranes climb as the building rises by means of self-contained hydraulic jacks.

## **Appendix 1**

### **Designing steel connections**

- A-1.1** Steel connections account for a very substantial portion of the design time and construction cost of a steel building frame. The factors that bear on the efficient design of a connection are many; they can be summarized as follows:
- A-1.1.1** The connection shall perform with complete structural reliability. It shall carry safely the loads indicated by the structural engineer, and it shall offer the required degree of rigidity or flexibility.
  - A-1.1.2** The connection shall be aesthetically acceptable to the engineer, the architect, and the owner of the building, particularly if it will be exposed in the finished structure.
  - A-1.1.3** The connection shall keep within its allotted space in the building. It shall avoid conflict with other steel members coming into the same joint, and it shall keep out of the way of piping, duct-work, wiring, and finish surfaces.
  - A-1.1.4** The connection shall use the most economical, readily available material, to minimise cost and avoid delays. **ASTM A36** steel usually satisfies this requirement.

- A-1.1.5** The connection shall utilise the fabricator's equipment and manpower to best advantage. Some fabricators are set up to do punching and bolting economically; others are better equipped for welding; some can do both equally well.
- A-1.1.6** The connection shall require the minimum number of shop operations, and the minimum of materials handling in the shop. Each shipping piece shall be designed to require only one method of connecting, either bolting or welding, but not both, so as to avoid having to move the piece about the shop to several different machines and work areas.
- A-1.1.7** The connection shall have no superfluous parts, such as stiffener plates that are not structurally required, or extra connecting plates and angles.
- A-1.1.8** The connection shall utilise fasteners to best advantage. Bolts in bearing generally carry a greater load than bolts in friction, bolts in double shear carry more than bolts in single shear; bolting and welding can often be used in combination to bring out the best characteristics of each.
- A-1.1.9** Fillet welds, which require no edge preparation, shall be used instead of groove welds wherever possible.
- A-1.1.10** The connection shall be designed with normal mill, fabrication, and erection tolerances in mind. Adjustments shall be provided for, but unnecessary precision shall be avoided.
- A-1.1.11** The connection shall be designed to permit rapid, simple, safe erection.
- A-1.1.12** The connection shall be designed to require a feasible minimum of inspection. Bolts in shear, for example, can be inspected visually for tightness, while welds, and bolts in friction-type connections, may require more elaborate inspection procedures.
- A-1.1.13** In general, simpler is better, and usually less expensive.

See **Figures 1 to 5** for the application of some of these principles.



**Figure 1**

**Framed connection - Shop welded to column**

This connection is commonly known as a knife connection.

**Advantages**

- A. No holes in column flange.
2. Very safe, simple, fast to erect.
3. Bay length can be accurately controlled.
4. Ample erection clearance.
5. Does not interfere with connections to other sides of column.
6. Bolts are in double shear, which doubles their capacity.
7. Beam requires only routine web punching.

**Disadvantages**

1. Requires coping the bottom flange so beam can be inserted from above.
2. Burrs must be removed from beam web so it will slide easily between the angles.

**Figure 2**

**Framed connection - Shop welded to beam**

**Advantages**

1. Bottom flange is not coped.
2. Useful for a wide range of beam sizes and loads.

**Disadvantages**

1. Requires holes in column flanges, which might not otherwise require punching.
2. Bolts through flange may foul beams connecting to web of column.
3. Requires twice as many field bolts as a “knife” connection.
4. Has no tolerance for variation in column spacing or fabrication tolerances, other than expensive shimming.

**Figure 3**

**Framed beam connection to column web**

**Advantages**

1. Useful for a large range of beam sizes and loads.
2. Beam flanges do not require punching, unless for erection seat.
3. Doesn't require a subsequently installed piece such as the stabilising angle clip for a seated connection.

**Disadvantages**

1. Difficult to use with small columns.
2. May have to interact with a connection on the far side of the web, as shown.
3. Beam may be difficult to erect if it must be tilted into place.
4. Bolts may be hard to install if there are also bolts in the column flanges.
5. An erection seat is usually required (as shown) for temporary support of one beam, if two beams share the same bolts.

**Figure 4**

**Shop welded seated beam connection**

**Advantages**

1. Column shaft does not require punching.
2. Beam requires only routine flange punching.
3. Ample erection clearance.
4. Erection is fast, safe and simple.
5. Connection parts are clean and require only routine shop operations.
6. Requires only 2 field bolts.
7. Useful for a wide range of beam and column sizes.
8. Does not affect connections on other 3 sides of column.
9. Column spacing is easy to maintain.
10. Simple to detail.

**Disadvantages**

1. Delivers load to column with a slight eccentricity.
2. The stabilizer clip angle must be installed after the plumbing up of the structure.

**Figure 5**

**Single angle framed beam-girder connection**

**Advantages**

1. Ample erection clearance.
2. Erection is fast, simple, and safe.
3. Simple to detail.
4. The connection angle may also be shop welded to the girder.
5. The bay spacing is easily maintained. Short slotted holes may be used in the angle leg against the beam to facilitate this.
6. The beam requires only routine web punching.
7. A second connection angle may be added to increase the load capacity.

**Disadvantages**

1. The load is delivered to the girder with a slight eccentricity.
2. Should not be used if the beam is subject to severe torsion at the connection.
3. Bolts may have to be staggered to assure driving clearances.



## **Appendix 2**

### **Simple construction site layout**

**Key:**

1. Tracks for crane
2. Access roadway to construction site
3. Ramps for containers and prefab elements
4. Concrete mixing base
5. Construction cranes (Alimac) at wall
6. Location for weighing elements
7. Traverse and hanging rails
8. Stockpiles
9. Parking area for construction equipment
- W Watch hut

## **Appendix 3**

### **Complex construction site layouts**

#### **Figure 1**

#### **Point building**



**Figure 2**  
**Staggered building**

**Appendix 4**  
**Multiple construction site layout**

**Key:**

- 1., 2., 3. Residential flats
- 4. Kindergarten
- 5. Water
- 6. Store
- 7. Administration
- 8. Material storage
- 9. Tracks for cranes
- 10. Cement mixing base
- 11. Stockpile of prefab elements
- 12. Temporary access roadway

## Appendix 5

**Location of tower cranes in relation to building under construction**

**Appendix 6**  
**Intensive building scheme**

**Appendix 7**  
**Ramp and road access for physically challenged**

**Appendix 8**  
**Typical stair plans and sections**

**Appendix 9**  
**Ground floor arrangements for high-rise buildings**





## **Appendix 10**

### **Point block**

**(12-storey system built structure providing 4 flats on each storey)**

## **Appendix 11**

### **Pouring a large foundation mat**

**(Soil around this excavation is supported by a cast-in-situ concrete slurry wall)**

**Appendix 12**  
**Foundation pile arrangements**  
**(Demonstrating load support variety)**

**Appendix 13**  
**Principle of pile support**

**Appendix 14**  
**Pile support for foundation mat**

**Appendix 15**  
**Footing options at restrictive boundaries**





**Appendix 16**  
**High-rise building with sprawling base**

**Appendix 17**



**High-rise building with regular base**

**Appendix 18**  
**High-rise building with podium**

**Appendix 19**  
**Typical ground floor entrance lobby for controlled access**

**Key**

(1) Room for prams, cycles and trolleys. (2) Service, (3) Meeting room for residents and administrators (4) Post boxes, (5) Grocery deposit boxes (home delivery system), (6) Newspapers and light haberdashery (7) Fruit and light vegetable shop, (8) Extra business point.

## Appendix 20

**High-rise hotel with 300 mm reinforced brick walls bearing the concrete floor and roof structure**

## **Appendix 21**

### **High-rise Monadnock building**

**(With un-reinforced brick walls, sixteen floors tall. Walls are 460 mm thick at the top, and 1830 mm thick at the base of the building)**



**Appendix 22**  
**High-rise buildings with parking on lower floors**

**Appendix 23**  
**High-rise building with flats**

**Key**

1. Lift
2. Staircase
3. Living quarters
  
4. Loggia
5. Kitchen
6. m
7. Bath
8. Heating and water tank



**Appendix 24**  
**High-rise building with 'Y' shaped plan**

## **Appendix 25**

**Twin-plan high-rise building, 10 flats/floor  
(Escape stairwall protected, but travel distances considered too great)**

## **Appendix 26**

**American high-rise apartment building  
(Small service flats surrounding 16 storey circulation core)**

## **Appendix 27**

### **Swedish point block high-rise apartment building**

**(Fire precautions rely on containing fire in the flat where it originates and preventing smoke penetration by double doors at flat entrance, escape hatches provided in balcony floors: accepted that stairway and access landings may not be useable during a fire)**

## **Appendix 28**

### **Wind pattern between two parallel high-rise buildings**

**(Distance between buildings less than rebound sphere)**

**(a) Side view, (b) Plan**

## **Appendix 29**

**Wind pattern between two parallel high-rise buildings  
(Distance between buildings greater than rebound sphere)  
(a) Side view, (b) Plan**

## **Appendix 30**

**Buffer fields for fire and collapse of high-rise buildings  
(The prevailing winds are expected to come mainly from the North East,  
but not exclusively)**



## **Appendix 31**

### **Sections of fire, topple and collapse fields**

(Angles and distances are a function of (h). Defined as the highest vertical distance between the ground and a fixed point of the structure. The spread(s) distance is anticipated, as debris from the building may be expected to travel some additional distance under impact or during rubble fall or tumble)

## **Appendix 32**

### **A conventional inset cast-iron roof drain**



**Appendix 33**  
**Protecting a vent stack**

**Appendix 34**  
**Detail at roof junction**

**Appendix 35**  
**Detail at apex of roof**

**Appendix 36  
Guttering detail**

**Appendix 37**  
**Detail of coping at parapet**

## **Appendix 38**

**Example of curtain wall  
(Typical of high-rise structures)**

**Appendix 39**

**Curtain wall  
(Typical of high-rise structures)**

## **Appendix 40**

**Example of reinforcement in beam-girder-slab connection  
(U-stirrups are shown in beam; stirrup-ties, as shown in (b) are more  
often used)**



## **Appendix 41**

**Isometric view of a one-way solid slab system under construction  
(The slab, beams, and girders are created in a single pour)**

**Appendix 42**  
**Steps in erecting a tall steel building frame using a guy derrick**





## **Appendix 43**

**Two types of tower cranes used in the construction of high-rise buildings  
(Tower cranes climb as the building rises by means of self-contained  
hydraulic jacks)**