Rules of thumb

Preliminary design Rules of thumb

1. The cost of reinforce concrete (in place) is usually somewhere between $100/m3 and $800/m3. This illustrates the fact that for a "rule of thumb" to be any good, the background for its development needs to be known. That in turn means that most of the "rules of thumb" are most applicable by the engineer that came up with them; and that everybody else better be careful in using them.
2. If placing concrete directly from a truck or concrete pump, place concrete vertically into the face of concrete already in place. Never allow the concrete to fall more than 1 to 1.5 metres.
3. The possible spans, and associated depths, depend on the loading to which the beam is subjected. The figures given assume 'normal' commercial building loads. They do not apply to more heavily loaded situations (e.g. plant rooms) or to unconventional loading scenarios.
4. This information is given without prejudice and is for guidance purposes only. It is suitable for possibly initial sizing of structural elements for architectural scheme or costing purposes
for actual building projects the size of structural elements must be veri?ed through detailed design by a quali?ed structural engineer.
5. Prepare drawings properly & accurately if possible label each bar and show its shape for clarity
6. Indicate proper cover-clear cover, nominal cover or effective cover to reinforcement.
7. Decide detailed location of opening/hole and supply adequate details for reinforcements around the openings.
8. Use commonly available size of bars and spirals. For a single structural member the number of different sizes of bars shall be kept to a minimum.
9. Show enlarged details at corners, intersections of walls, beams and column joint and at similar situations.
10. Congestion of bars should be avoided at points where members intersect and make certain that all rein. Can be properly placed.
11. In the case of bundled bars, lapped splice of bundled bars shall be made by splicing one bar at a time; such individual splices within the bundle shall be staggered.
12. Make sure that hooked and bent up bars can be placed and have adequate concrete protection.
13. Indicate all expansion, construction and contraction joints on plans and provide details for such joints.
14. The location of construction joints shall be at the point of minimum shear approximately at mid or near the mid points. It shall be formed vertically and not in a sloped manner.

DO NOT'S-GENERAL:

15. Bonded reinforcement shall not extend across an expansion joint and the break between the sections shall be complete.
16. Flexural reinforcement preferably shall not be terminated in a tension zone.
17. Bars larger than 36mm dia. Shall not be bundled.
18. Lap splices shall be not be used for bars larger than 36mm dia except where welded.
19. Where dowels are provided, their diameter shall not exceed the diameter of the column bars by more than 3mm.
20. Primary movement joints are required to prevent cracking where buildings (or parts of buildings) are large, where a building spans different ground conditions, changes height considerably or where the shape suggests a point of natural weakness. Without detailed calculation, joints should be detailed to permit 15–25 mm movement unless seismic pounding is an issue then this should be increased to min 200mm. Advice on joint spacing for different building types can be variable and conflicting. While rules of thumb are provided be sure to seek guidance of an experienced engineer. Expansion joint is a movement (functional) joint which is installed to accommodate volume change due to temperature changes, shrinkage,

and change in moisture content.. The other members of this family of joints are:

- o Control (contraction) joints
- o Shrinkage strips.

According to MARK FINTEL the use of Expansion joints in a building is a controversial issue. There is a great divergence of opinion concerning the importance of expansion joints in concrete construction. Some experts recommend joint spacing's as low as 30 ft while others consider expansion joints entirely unnecessary.

Joint spacing's of roughly 100 to 200 ft for concrete structures seem to be typical ranges recommended by various authorities. For steel structures a spacing of 200 ft is normal.

However, the spacing is most of the times also dictated by the following factors which determine the location of such joints:

- New building adjoining existing building
- Long low building abutting higher building
- Wings adjoining main structure
- Long low connecting wings between buildings
- Intersections at wings of 'L', 'T', or 'U' shaped buildings.
- Soil strata in length of structure vary in nature -- better to have joints (such situation is very rare)
- Different type of foundations in structure (i.e. building founded piles and raft)

21. Actual concrete deflections are influenced by many factors which cannot be fully taken into account.

- Tensile strength of concrete a change in strength from 2.7 to 2.1 can increase deflections by 50%
- Modulus of concrete +/- 20%
- Early construction loading
- Shrinkage wrapping

Always remember load can only be estimated and even dead loads cannot usually be calculated to within 5% accuracy. With this in mind not calculation need have more than 2 significant figures.

22. For high-risks facilities such as public and commercial tall buildings, design considerations against extreme events (bomb blast, high velocity impact) is very important. It is recommended that guidelines on abnormal load cases and provisions on progressive collapse prevention should be included in the current Building Regulations and Design Standards. Requirements on ductility levels also help improve the building performance under severe load conditions.

Concrete:
Initial Estimations:
"To design even a simply supported beam, the designer needs to guess the beam size before

he can include its self-weight in the analysis."

BEAMS:

OVERALL DEPTH OF BEAMS:

MEMBER   SPAN/OVERALL DEPTH RATIO reinforced   Max recommended span   SPAN/OVERALL DEPTH RATIO
Pre-stressed/post-tensioned   Max recommended span
Rectangular BEAM width >250mm or span/15 but less than 5D.   10 TO 14 (con't 20-26)   8m (con't12m)   13-20   12m (con't 15m)
Flanged beams   12-18 (con't 18-21)
cantilever   2-6   5m
Band beams (b?3D) or span/5   18-20   8-12   25-30   14 (18m con't)
For non band beams -Concrete beams: 2 to 1 depth to width ratio
the width (b) of a rectangular beam should be between 1/3 and 2/3 of the effective length (d). The larger fraction is used for relatively larger design moments.

Band width - L/4 to L/3 max at slab soffit (L for average transverse span) I would normally taper the sides of the band with a 1 to 1.5' taper for the L/25 or a 2' taper for the L/33 to save weight but that depends on formwork costs)
Band   depth - L/25 to L/30 (L for longitudinal span)

Notes Note:
1. Beams need more depth to fit sufficient reinforcing in section so check detailing early
2. The maximum spans listed here are not absolute limits. Longer spans are possible with every type, but may not be economical. As a rule of thumb for estimates of thickness above the span on deflection ratio's should be multiplied by "maximum recommended span"/"actual span")
3. The higher number are given for light loadings (about 1.5 kpa) and the lower numbers for heavy loadings (about 10kpa)
Common band beam widths are 1200,1800 and 2400

b For flanged sections with the ratio of the flange to the rib width greater than 3, the Table value for beams should be multiplied by 0.8.
c For members, other than flat slab panels, which support partitions liable to be damaged by excessive deflection of the member, and where the span exceeds 7m, the Table value should be multiplied by 7/span.
d For flat slabs where the greater span exceeds 8.5m, the Table value should be multiplied by 8.5/span.
e The values may not be appropriate when the formwork is struck at an early age or when the construction loads exceed the design load. In these cases the deflection may need to be calculated using advice in specialist literature.
Sizing:
For non-cantilevers: d (mm) = span (mm)/26 + 300, round the result to nearest 25mm.
For cantilevers: d (mm) = span (mm)/7 + 300, round the result to nearest 25mm.
For non-cantilevers:
If span < 6000mm, b (mm) = 300
If 6000 < span < 9000, b = 350
If 9000 < span < 12000, b = 400
For cantilevers, b (mm) = 300

Earthquake Loading:
The total earthquake load on a building is called the Base Shear, V. Estimate this loading V as,

V = 0.1W, where W is the total weight of the building.

1. Beam sections should be designed for:
- Moment values at the column face & (not the value at centre line as per analysis)
- Shear values at distance of d from the column face. (not the value at centre line as per analysis)
- Moment redistribution is allowed for static loads only.

2. Use higher grade of concrete in most of the beams that are doubly reinforced.
3. Whenever possible try to use T-beam or L-beam concept so as to avoid compression reinforcement.
4. Use a min. of 0.2% for compression reinforcement to aid in controlling the deflection, creep and other long term deflections.
5. Length of curtailment shall be checked with the required development length.
6. Keep the higher diameter bars away from the N.A (i.e. layer nearest to the tension face) so that max. Lever arm will be available.
7. The maximum area of either the tension or compression reinforcement in a horizontal element is 4% of the gross cross-sectional area of the concrete.
8. Shear where shear stress (v) is considered to be critical, it can be calculated as follows:

23. v =V/bd for beams ideally it should be less than 2 N/mm2 to avoid congestion, but this may not be possible for transfer beams where shear is critical.
24. Where splices are provided in bars, they shall be , as far as possible, away from the sections of maximum stresses and shall be staggered.
25. Were the depth of beams exceeds 750mm in case of beams without torsion and 450mm with torsion provide face rein.
26. Deflection in slabs/beams may be reduced by providing compression reinforcement.
27. Only closed stirrups shall be used for transverse rein. For members subjected to torsion/"compatibility torsion" and for members likely to be subjected to reversal of stresses as in Seismic forces.
28. To accommodate bottom bars, it is good practice to make secondary beams shallower than main beams, at least by 50mm.

SLABS:

OVERALL SLAB DEPTH:

Span to depth ratio's:

One way:
- Single: L/24
- Continuous: L/30
- Cantilever: L/7

Two way:
- Single: L/28
- Continuous: L/36

Note:

- The maximum spans listed here are not absolute limits. Longer spans are possible with every type, but may not be economical.
- for flat plates and flat slabs with drop panels, the longer of the two orthogonal spans is used in the determination of the span-to-depth ratio, while for edge-supported slabs, the shorter span is used.
- minimum fire resistance normally require a depth of at least 125mm, 150 is best for fitting the reo in.
- The higher span to depth ratios are for light loadings (about 1.5 kPa) and the lower span to depth ratio's for heavy loadings (about 10kpa). The spans assume roughly 1.50 kPa for superimposed dead loading (SDL).

Notes

- For two-way spanning slabs (supported on beams), the check on the ratio of span/effective depth should be carried out on the shorter span. For flat slabs, the longer span should be taken.
- For flanged sections with the ratio of the flange to the rib width greater than 3, the Table value for beams should be multiplied by 0.8.
- For members, other than flat slab panels, which support partitions liable to be damaged by excessive deflection of the member, and where the span exceeds 7m, the Table value should be multiplied by 7/span.
- For flat slabs where the greater span exceeds 8.5m, the Table value should be multiplied by 8.5/span.
- The values may not be appropriate when the formwork is struck at an early age or when the construction loads exceed the design load. In these cases the deflection may need to be calculated using advice in specialist literature.

1. Provide a max spacing of 250mm(8") for main reinforcement in order to control the crack width and spacing.
2. A min. of 0.24% shall be used for the roof slabs since it is subjected to higher temperature. Variations than the floor slabs. This is required to take care of temp. Differences.
3. Spans are defined as being from centreline of support to centreline of support. Although square bays are to be preferred on grounds of economy, architectural requirements will usually dictate the arrangement of floor layouts and the positioning of supporting walls and columns. Pinned supports are assumed.
4. Particular attention is drawn to the need to resolve lateral stability, and the layout of stair and service cores, which can have a dramatic effect on the position of vertical supports. Service core floors tend to have large holes, greater loads but smaller spans than the main area of floor slab.
5. Eliminating drops results in simpler false work and formwork arrangements, enables rapid floor construction and giving maximum flexibility to the occupier.
6. The benefits of using in-situ concrete flat slab construction should be investigated at the conceptual design stage. Consider not only the benefits in terms of potential design efficiencies but also the major advantages for the overall construction process, notably in simplifying the installation of services and the savings in construction time.
7. To optimise the slab thickness, consider all factors such as the method of design, the presence or absence of holes, the importance of deflections, and previous experience.
8. Deflections will generally be greatest at the centre of each panel. However, as partitions may be placed along column lines, it is usual to check deflections here also. The possible effect of deflections on cladding should also be considered carefully. Edge thickenings, up stand and down stand beams should be avoided, as they disrupt the construction process.
9. There is evidence that early striking and early loading through rapid floor construction has some impact on long-term deflections.
10. Thin flat slab construction will almost certainly require punching shear reinforcement at columns.
11. Minimum recommended thickness for slabs for fire is 120mm
12. Drape slab tendons to high points at the faces of the bands at the slab soffit and run flat over band width at minimum top cover, except at end columns where they are draped to the centerline of the column and centroid of the slab (Dslab/2 from the top surface).
13. When openings in floors or roofs are required such openings should be trimmed where necessary by special beams or reinforcement so that the designed strength of the surrounding floor is not unduly impaired by the opening. Due regard should be paid to the possibility of diagonal cracks developing at the corners of openings. The area of

reinforcement interrupted by such openings should be replaced by an equivalent amount, half of which should be placed along each edge of the opening. For flat slabs, openings in the column strips should be avoided.

14. When is it an advantage to use fabric mesh in suspended concrete slabs?

Designing slabs with mesh reinforcement is a proposition that can produce substantial cost savings when consideration is given to the following points.

a) Mesh should be sufficient for shrinkage control without additional reinforcement.

b) The structural system should be predominantly a "one way slab" system, with extra bars at the maximum moment.

c) Lapping of mesh should be minimal.

d) Lapping locations should be clearly documented so as to eliminate any possibility of top and bottom laps being coincident and so as to maximise usage and minimise cutting.

e) Lapping should be achieved using bar splices so that each mesh remains in the same plane.

f) Mesh lengths should be factor of the sheet length preferably using full sheets to minimise wastage.

PRESTRESS:

1. Maximum length of slab

50m, bonded or unbounded, stressed from both ends.

25m, bonded, stressed from one end only.

2. Mean prestress

Typically P/A:

- Slabs: 0.7 – 2.5 mPa
- Beams: 1.0 – 3.0 mPa

3. Cover Take minimum cover to be 25mm.

4. Allow sufficient cover for (at least) nominal bending reinforcement over the columns, in both directions (typically T16 bars in each direction).

5. Effect of restraint to floor shortening

All concrete elements shrink due to drying and early thermal effects but, in addition, prestressing causes elastic shortening and ongoing shrinkage due to creep. Stiff vertical members such as stability walls restrain the floor slab from shrinking, which prevents the prestress from developing and thus reducing the strength of the floor. This should be considered in the design of the stability system or allowed for in the method of construction

COLUMNS:

1. Use higher grade of concrete when the axial load is predominant.

2. Go for higher section properties when the moment is predominant.

9. Restrict the maximum % of reinforcement to about 3%. In an in-situ column the absolute maximum reinforcement is 6% or 10% at laps.

3. Approximate method for allowing for moments: multiply the axial load from the floor Immediately above the column being considered) by:

1.25-interior columns (allows for pattern loading)

1.50-edge columns

2.00-corner columns

But try keep the columns to constant size for the top two storeys.

4. Preliminary sizing- best to aim for coulmns with 1 to 2 % reinfcoing

o Column- H/10-20,

o edge columns H/7-9,

o corner column H/6-8
o Ac can be estimated for stocky columns by Ac= N/15 (1% reo), Ac=18 (2% reo) or N/20 (3% reo) for N32 concrete. (N in newtons)
5. A column should have minimum section 200-250 sq, if it is not an obligatory size column.
6. In addition, all columns shall be designed for minimum eccentricity equal to [(unsupported length of column /500)+(lateral dimension /30] subject to minimum eccentricity of 20mm.
7. A reinforced column shall have at least six bars of longitudinal reinforcement for using in transverse helical reinforcement.-for CIRCULAR sections.
8. A min four bars one at each corner of the column in the case of rectangular sections.
9. Keep outer dimensions of column constant, as far as possible, for reuse of forms.
10. When does a column change to wall? generally this considered at about 4 times the thickness, however for fire purposes if the fire can get to all four sides it should be considered as a column.
11. For service load keep the total stress about 0.3fc' for gravity load keep this about 0.15f'c.
12.

REINFORCED CONCRETE COLUMNS:

Sizing:

For preliminary design use square columns.

If the building height is 3 stories or less:
If beam span < 6000mm, h (mm) = 300
If 6000 < beam span < 9000, h = 350
If 9000 < beam span < 12000, h = 400

If the building height is 4 to 9 stories:
If beam span < 6000mm, h (mm) = 400
If 6000 < beam span < 9000, h = 500
If 9000 < beam span < 12000, h = 600

REINFORCED CONCRETE WALLS:

1. Walls H/30-45
2. Generally H/50 is a good starting point for tilt panels
3. Expansion joint spacing's

- Concrete large thermal differences 25 m (e.g. for roofs) otherwise refer below
- Author Spacing
- Lewerenz (1907) 75 ft (23 m) for walls.
- Hunter (1953) 80 ft (25 m) for walls and insulated roofs, 30 to 40 ft (9to 12 m) for uninsulated roofs.
- Billig (1960) 100 ft (30 m) maximum building length without joints. Recommends joint placement at abrupt changes in plan and at changes in building height to account for potential stress concentrations.
- Wood (1981) 100 to 120 ft (30 to 35 m) for walls.
- Indian Standards Institution (1964) 45 m (? 148 ft) maximum building length between joints.
- PCA (1982) 200 ft (60 m) maximum building length without joints.
- ACI 350R-83 120 ft (36 m) in sanitary structures partially filled with liquid (closer spacing's required when no liquid present).

4. Movement joints should be provided to minimise the effects of movement caused by shrinkage, temperature variations, creep and settlement. The effectiveness of a movement joint depends on there location, movement joints should divide the building into a number of individual sections. Movement joints should pass through the whole structure above ground in one plane. The structure should be framed both sides of the joint.
5. Shear walls are essentially vertical cantilevers, and may be sized as such; therefore a span-to-depth ratio of 7 is reasonable for a shear wall. However, at this aspect ratio it is highly likely that tension will be developed at the base and this requires justification in the

design (see Figure 2.15). Pad foundations should be designed to resist overturning and piles may be required to resist tension. The wall should be checked to ensure that it is 'short', the minimum practical thickness is 200 mm. The wall should be 'braced', i.e. there should be another shear wall in the orthogonal direction.

RETAINING WALLS:

1. Approximate thickness h/10-14
2. For cantilever sheet pile retaining walls, the penetration below the bottom should equal approximately the unsupported height above.
3. T-shaped with horiz. fill: Footing length

o 0.46*height with 1/3 in front of exposed face.

4. L-shaped with horiz. fill:

o Footing length ~ 0.65*height with all of footing at toe.

o Footing length ~ 0.55*height with all of footing at heel.

5. Retaining walls should be attempted with "traditional" dimensions first, and make every effort to correctly size and balance the heel and toe. There are good reasons why these shapes (toe to heel from 0.45 of height to 0.55, etc) are so commonly found. Stability, sliding, etc are easy to satisfy with an oversized heel or toe, but the strength of these members will be very difficult to achieve.

SLAB ON GRADE:

Typical application Rating of subgrade Minimum thickness of pavement
Domestic Medium good 100mm (4")
poor 125mm (5")
Commercial/Institutional/Barns up to 5kPa Medium to good 130mm (5")
poor 150mm(6")
Industrial/gas stations/garages up to 20kpa Medium to good 180mm (7")
poor 200mm (8")

1. With the following reinforcement:

1. With the following reinforcement:

- 100mm-one layer SL72 WWF 6x6-W1.4xW1.4
- 125-150mm- one layer SL82 WWF 6x6-W2.9xW2.9
- 180mm- one layer SL92 WWF 6x6-W2.9xW2.9
- 200mm - two layers (SL72) WWF 6x6-W1.4xW1.4

2. Joints spacing:

- Rule of thumb is 24 to 36 times the thickness (gives the spacing in mm/inches).
- Keep the thickness variation to -5mm (-1/4") / +10mm (3/8"), and the subgrade as flat as possible with no abrupt change greater than 15mm (1/2") in about 1.2m (4'). This keeps the "sudden" restraint potential down.

3. For slabs 180mm greater a crack initiator is suggested.
4. No greater than 21m (70') between Dowel sawn joints
5. No greater than 8m (27') between joints
6. Make your joint pattern as square as practicable and with no more than a 2 to 1 ratio of length to width.
7. Always check with client at to preferred Joints system
8. For small-medium projects

Max area in pour: 600m^2 (60000 sq ft)
Max joints spacing for external expansion joints 40-50m, internal stop pour slab joints: 60m (200').

9. For large project

Max area in pour: 800m^2 aim for 600m^2 (60000sq ft)
Max joints spacing for external expansion joints 60m (200'), internal stop pour slab joints: 80m (250')

.

STEEL BUILDINGS (NON-COMPOSITE)
Choice of beam system
Element Typical Span/depth Typical Span (m) Span/depth
Maximum span
Plate girder 10-12 25m (80')
Floor Joist (steel only) 17 6-9m (20-30')
Castellated UB's* 14-17 12-20m(40-70')
Roof trusses (pitch>20) 14-15 17m (55')
Space Frames 15-30 100m (300')
Primary beams (supported by columns) 10-15 12m (40')
Secondary beams (supported by other beams) 15-25 10m (33')
Portal frame leg 35-40 60m (200')
Simple span rafter 24 30m (100')
Simple span roof beam 15 25m (80')
Con't beam or joist .85 * simple span value
* Avoid if high point loads; increase Ireq by 1.3 As a rule of thumb, the defection of a castellated beam is about 25% greater than the deflection of an equivalent beam with the same depth but without web openings.

Expansion joints
- Steel industrial buildings 100 m typical–150 m maximum c /c.
- Steel commercial buildings 50 m typical–100 m maximum c /c
- Steel/Tilt-up building 50m typical
- Steel roof sheeting 20 m c/c down the slope, no limit along the slope.

1. Deeper is cheaper. All other things being equal, a deeper wide-flange beam will be more economical than a shallower one. There are exceptions to this rule, but it is generally correct.
2. One common misconception is that all steel members have an actual depth equal to their nominal depth.
3. The braces may be designed for a capacity of 2% of the force resisted by the compression portion of the beam.

4. Cantilever "one-to-three".

- Cantilevered steel beams are commonly used to support architectural features, giving the illusion of an unsupported or "flying" edge. How far is too far for a cantilever to stick out? Generally speaking, if a cantilever exceeds 1/3 of the total back span, economy is lost and may lead to design difficulties. So if your beam has a 9m (30') back span, try to keep an adjacent cantilever to less than 3m (10') long.

5. TRUSS:

An optimal depth/span ratio for a planar truss is approximately 1/10. Although forces in the CHORDS decrease with increasing depth, forces in the WEB are practically UNCHANGED and increasing the depth increases the lengths of these members. Approximately half the web members are in COMPRESSION and increasing their lengths reduces their efficiency due to the increased susceptibility to BUCKLING.

6. Struts and ties

Slenderness limits:

- Members resisting load other than wind: 8#180
- Members resisting self weight and wind only: 8#250
- Members normally acting as a tie but subject to load reversal due to wind: 8#350

STORIES	LATERAL LOAD RESISTING SYSTEM
<30	Rigid frame
30 to 40	Frame - shear truss
41 to 60	Belt truss
61 to 80	Framed tube
81 to 100	Truss - tube w/ interior columns
101 to 110	Bundled tube
111 to 140	Truss - tube without interior columns

7. Avoid over-welding:
- A weld never needs to exceed the connected part strength.
- Excessive welding can cause serious problems (distortion, cracking, etc.). This can lead to expensive repairs or even rejections.
- Select fillet welds over full-penetration groove welds when possible.
- Small and long fillet welds are more economical than large and short welds.
- Keep weld sizes at 6mm. or less for fillet welds (accommodates a single pass); increase length if needed.

8. Bolts work in most connections.
- Specify snug tight bolted joints, rather than bearing joints.
- Don't just fill up beam webs with bolt rows. Use the appropriate number of rows for strength requirements.
- Provide for tolerances. Use oversized, short-slotted, and long-slotted holes in bolted connections if permitted for connections to concrete, and leave extra space for welded connections.

9. Use single-sided connections, shear tabs, or single angles wherever possible.
10. Orient columns in moment frames so that moment connections are to the column flanges whenever possible.
11. Show connection concepts in sufficient realistic detail to accurately depict what the finished connection may look like. Make embedded plates a minimum 6 in. to 8 in. larger than required for connections as a rule of thumb. Field fixes for embedded plates that are mis-located are time-consuming and expensive.

12. Rule of thumb: The more pieces there are in a connection detail, the more expensive it is to fabricate and erect.
13. Do not over-economize connections. If the overall connection configuration is virtually the same, reducing the amount of weld or bolt count in a single non-repetitive connection, by even a large percentage(e.g., in excess of 25% to 30%), will probably increase the overall time and expense of the project. Repeating connections will reduce connection design, detailing, layout, fabrication, and erection costs due to the reduced learning curve.

14. When showing stiffeners or other plate material, use popular flat bar sizes
- Select member sizes with sufficient depth to provide reasonable connections.
- Use heavier columns to eliminate stiffener plates and/or web doubler plates at moment connections if possible.
- Standardize member sizes as much as possible. Steel may often be purchased at lower costs in bulk quantities. If a mill order is required, there may be a minimum order.
- Do not reinforce beam web penetrations if not absolutely necessary.

15. Review member sizes for connection economy:
• Preferably, a supporting beam should have at least the same depth as the supported beam.

16. SUMMARY FOR ECONOMIC FABRICATION
The rate of erection of steel in a structure is controlled by five main factors:
(a) Connection simplicity
(b) Number of members
(c) Number of bolts and/or amount of field welding
(d) Size and efficiency of erection crew, and the equipment at their Disposal
(e) Timely supply of steel.

17. The use of the transportation length may have to be curtailed to avoid damage during transportation try to keep member lengths less than 15m.
18. One rule of thumb for ?llet welds on both faces opposite each other is to make the gusset thickness twice the weld size.

19. Simple connections - use grade 8.8, 20mm diameter bolts fin plates} t = 8mm for UB's < 457mm deep partial depth end plates} t = 10mm for UB's > 457mm deep web cleats}
20. Moment connections -use grade 8.8, 20mm or 24mm diameter. Assume end plate thickness equal to bolt diameter (25 thick with M24)
21. Holding down bolts - assume grade 4.6 where possible.
Standard sizes: M16 x 300
M20 x 450, 600
M24 x 450, 600
M30 x 450, 600
M36 x 450, 600, 750

22. Welded
Use 6mm fillet where possible.
Relative costs: 6mm fillet in downhand position 1.0
6mm fillet in vertical position 2.0
6mm fillet in overhead position 3.0
For each additional run multiply above by 1.75.
Note: 6mm weld 1 run
Single butt weld in 10mm plate 6.0
For each 5mm of plate thickness multiply above by 4.0.