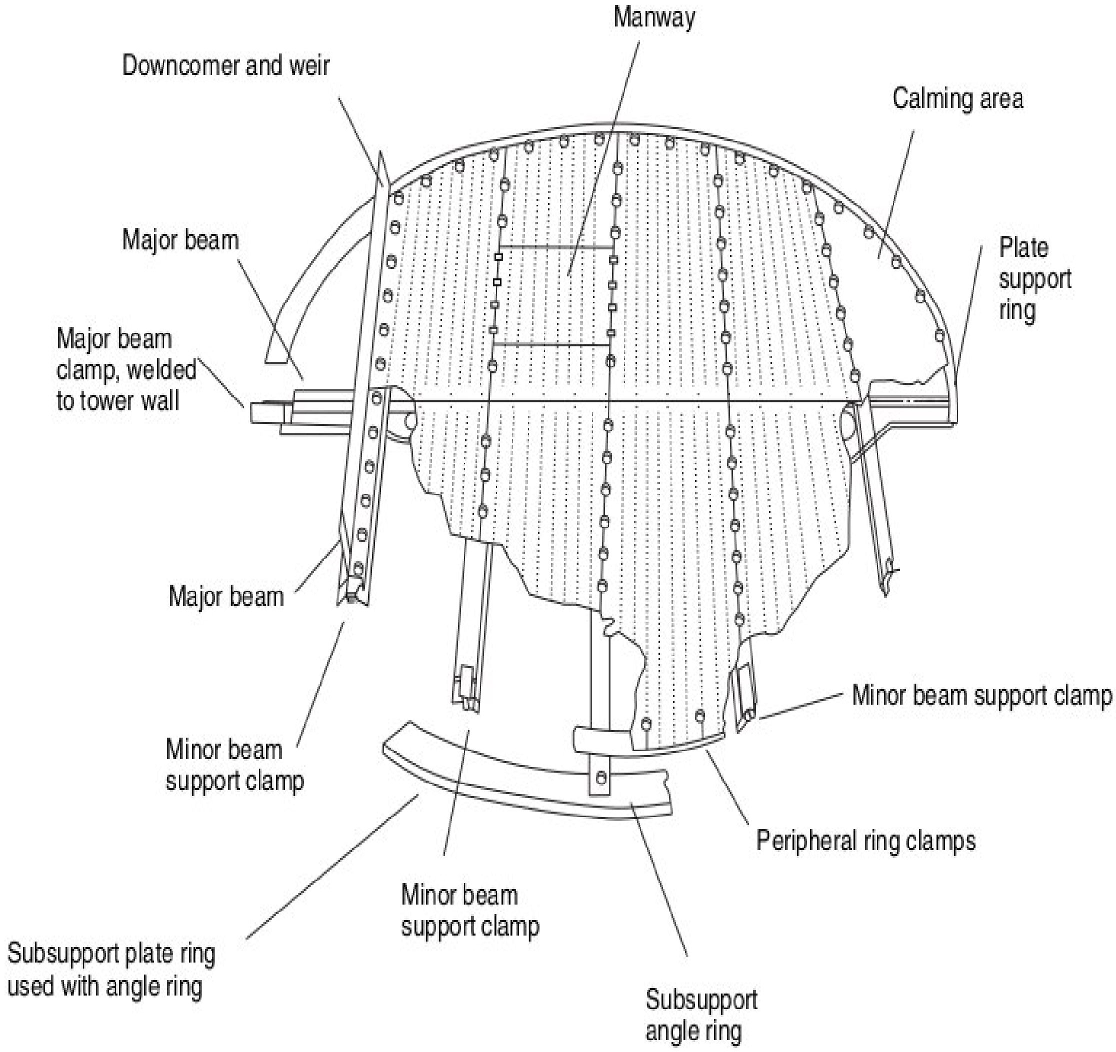

Figure 5.12: Typical sectional plate construction

5.13.1 Stacked plates (cartridge plates)

Why the stacked plate are used in some distillation column?

The stacked type of construction is used where the column diameter is too small for a man to enter to assemble the plates, say less than 1.2 m (4 ft). Each plate is fabricated complete with the downcomer, and joined to the plate above and below using screwed rods spacers.

✓ The plates are installed in the column shell as an assembly (stack) of ten, or so, plates.

✓ Tall columns have to be divided into flanged sections so that plate assemblies can be easily installed and removed.

✓ The weir, and downcomer supports, are usually formed by turning up the edge of the plate.

A small amount of leakage will occur in the stacked plate construction. Why?.

The plates are not fixed to the vessel wall, as they are with sectional plates, so there is no positive liquid seal at the edge of the plate.

Note:

In some designs the plate edges are turned up round the circumference to make better contact at the wall. This can make it difficult to remove the plates for cleaning and maintenance, without damage.

5.13.2 Downcomers

1- Vertical apron: The simplest and cheapest form of construction and is satisfactory for most purposes. The downcomer channel is formed by a flat plate, called an apron, which extends down from the outlet weir. See Figure 5.13a.

2- Inclined apron: The vertical apron is slopped to increase the plate area for perforation. See Figure 5.13b

3- Inlet weir: If a more positive seal is required at the downcomer at the outlet,an inlet weir can be fitted.See Figure 5.13c.

4- Recessed well: For the same purpose, more positive seal is required.See Figure 5.13d

5- Circular downcomers (pipes): It is sometimes used for low liquid flow rates.

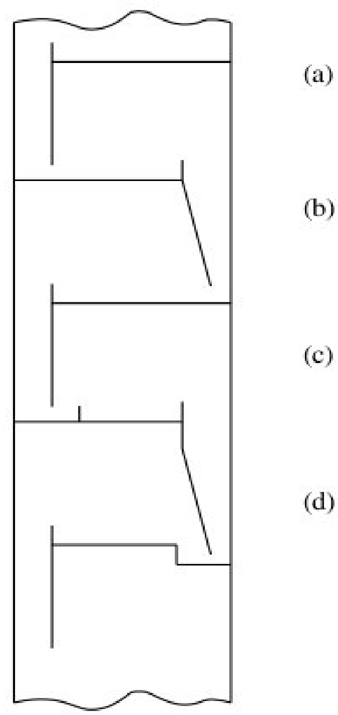

Figure 5.13: Segment (chord) downcomer designs. (a) Vertical apron (b) Inclined apron (c) Inlet weir (d) Recessed well

5.13.3 Side-stream and feed points

1- For side-stream points: There is modification to column when there side stream take off from the column, in order to provide a liquid seal at the take-off pipes as shown in Figure 5.14a.

2- For feed Stream: When the feed stream is liquid it will be normally introduced into the downcomer leading to the feed plate, and the plate spacing increased at this point as shown in Figure 5.14b.

5.14 Structural design

The plate structure must be designed to support the hydraulic loads on the plate during operation, and the loads imposed during construction and maintenance.

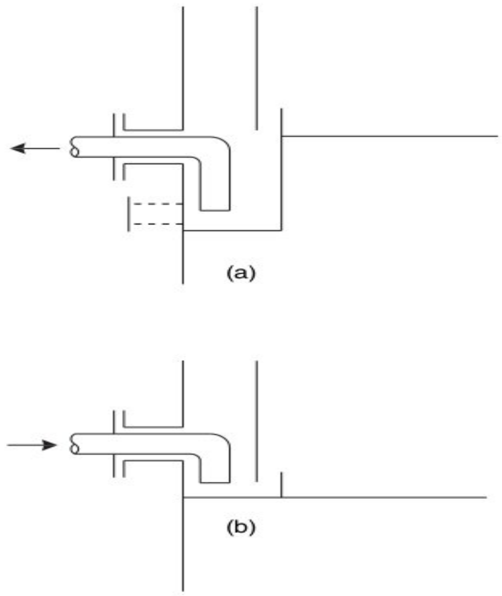

Figure 5.14: Feed and take-off nozzles

<u>Typical design values used for these loads are:</u>

Hydraulic load: 600 N/m^2 live load on the plate, plus 3000 N/m^2 over the downcomer seal area.

Erection and maintenance: 1500 N concentrated load on any structural member.

<u>Note:</u>

It is important to set close tolerances on the weir height, downcomer clearance, and plate flatness, to ensure an even flow of liquid across the plate. The tolerances specified will depend on the dimensions of the plate but will typically be about 3 mm.

5.15 Plate hydraulic design

<u>What are the basic requirements of a plate contacting stage?</u>

✓ Provide good vapour-liquid contact.

✓ Provide sufficient liquid hold-up for good mass transfer (high efficiency).

✓ Have sufficient area and spacing to keep the entrainment and pressure drop within acceptable limits.

✓ Have sufficient downcomer area for the liquid to flow freely from plate to plate.

5.15.1 Plate-design procedure

Procedure: 1. Calculate the maximum and minimum vapour and liquid flow-rates, for the turn down ratio required.

2. Collect, or estimate, the system physical properties.

3. Select a trial plate spacing (Section 5.11).

4. Estimate the column diameter, based on flooding considerations (Section 5.12).

5. Decide the liquid flow arrangement (Section 11.13.4).

6. Make a trial plate layout: downcomer area, active area, hole area, hole size, weir height.

7. Check the weeping rate, if unsatisfactory return to step 6.

8. Check the plate pressure drop, if too high return to step 6.

9. Check downcomer back-up, if too high return to step 6 or 3.

10. Decide plate layout details: calming zones, unperforated areas. Check hole pitch, if unsatisfactory return to step 6.

11. Recalculate the percentage flooding based on chosen column diameter.

12. Check entrainment, if too high return to step 4.

13. Optimise design: repeat steps 3 to 12 to find smallest diameter and plate spacing acceptable (lowest cost).

14. Finalise design: draw up the plate specification and sketch the layout.

5.15.2 Plate areas

The following areas terms are used in the plate design procedure:

$A_c =$ total column cross-sectional area,