4.5. Design space

Each design variable X_1, X_2 ...is viewed as one dimension in a design space a particular set of variable as a point in this space. In the general case of n variable, we have an n-dimensioned space. In the example where we have only two variables, the space reduces to a plane figure shown in (Fig 4.6(b)). The arrows indicate the inequality representation and the shaded zone shows the feasible region. A design falling in the feasible region is an unconstrained design and the one falling on boundary is a constrained design.

An infinite number of feasible design is possible. In order to find the best one, it es necessary of form a function of the variables to use for comparision of feasible design alternatives. The objective (merit) function is a function whose least value is sought in an optimisation procedure. In other words, the optimisation problem consists in the determination of the vector of variables X that will minimise a certain given objective functions.

$$Z = F(\{X\})$$

In the example chosen, assuming the volume of material as the objective function, we get

$$Z = 2(141\ X_1) + 100\ X_2$$

The locus of all points satisfying F ({X}) = constant, form a straight line in a two -dimensional space. (In this general case of n-dimensional space, it will form a surface). For each value of constraint, a different straight line is obtained. Fig 4.6(b) shows the objective function contours. Every design on a particular contour has the same volume or weight. It can be seen that the minimum value of F ({X}) in the feasible region occurs at point A.

There are different approaches to this problem which constitute the various methods of optimization. The traditional approach searches the solution by pre-selecting a set of critical constraints and reducing the problem to a set of equations in fewer variables. Successive reanalysis of the structure for improved sets of constraints will tend towards the solution. Different re-analysis methods can be used, the iterative methods being the most attractive in the case of space structures.