Calculation of the Plastic Section Modulus Using the Computer

DOMINIQUE BERNARD BAUER

ABSTRACT

A simple spreadsheet is presented which calculates the plastic section modulus of structural members. The method consists in dividing the cross section into rectangles and arranging all calculations conveniently into a spreadsheet program. The basic algorithm and the required spreadsheet formulas are given as well as a numerical example.

INTRODUCTION

With the increasing use of the limit states design of steel structures, engineers often have to calculate the plastic bending resistance, M_r, of structural members, which is a function of the plastic modulus, Z, of the cross section, that is,

$$M_r = \phi Z F_y \tag{1}$$

where

ϕ = performance factor
F_y = yield strength of steel.

Although the calculation of the plastic section modulus can be done easily by hand, it can also be done quickly and reliably using the computer. The following technical note presents a simple spreadsheet for the calculation of the plastic modulus. It is restricted to cross sections that can be approximated by a series of rectangles, which should cover most situations that structural engineers encounter in the design office.

SPREADSHEET ALGORITHM

The proposed algorithm is described below. The cross section to be analyzed must first be divided into N rectangles (Figure 1a). Each rectangle must comprise the entire width of the cross section at any particular height. Hence, the arrangement shown in Figure 1a is valid, while the one shown in Figure 1b is not valid.

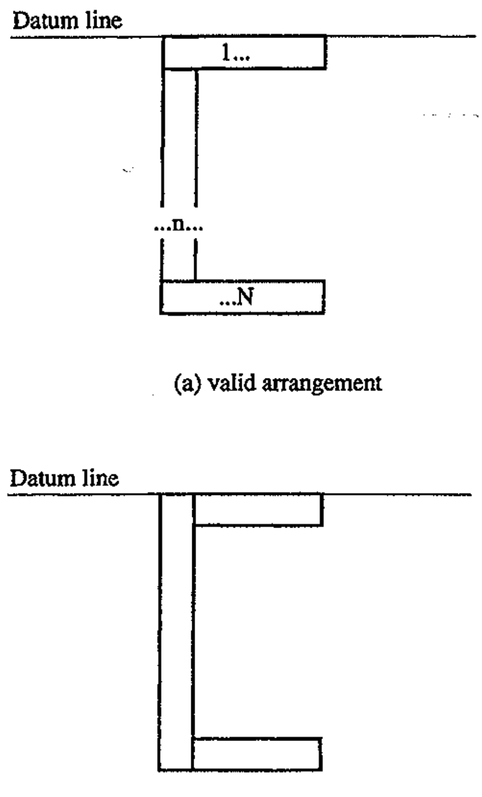
The width and the height of each rectangle will be entered into the spreadsheet, going consecutively from top to bottom of the cross section. These values are the only required input data. All the calculations presented below are arranged so that the equations can be expressed as spreadsheet formulas which will be evaluated automatically by the spreadsheet program.

With a datum line placed at the top of the cross section, the vertical distance from the datum line to the centroid, y_n, of the nth rectangle is equal to (Figure 2)

$$y_n = y_{n-1} + \frac{h_{n-1}}{2} + \frac{h_n}{2} \tag{2}$$

where

h_n = height of the nth rectangle



(a) valid arrangement

(b) invalid arrangement

Figure 1.

Dominique Bernard Bauer, P. Eng., MASCE, MCSCE, B. Eng., M. Eng., Ph.D., structural engineering consultant in Montreal.