CHAPTER 3

PRESENTATION OF ANALYTICAL AIDS

3.1 The Rigidity Ratio

Expressed as the ratio of the flexural rigidity to the torsional rigidity the parameter m plies with the expressions for redundants as derived in Chapter 2. As this research identifies solely with rectangular beam sections of reinforced concrete the rigidity ratio m can be written in terms of the cross-sectional dimensions t and b, the thickness t being always greater than, at least equal to, the width b. The imposition of a Poisson's ratio of 0.15 on the known relation

$$G = \frac{E}{2(1+\mu)}$$

results in $\frac{G}{E} = \frac{1}{2.3}$. The moment of inertia of the beam section with respect to the horizontal axis assumes the familiar expression

$$I = \frac{1}{12} bt^3$$

With reference to Timoshenko and Goodier[1] the expression for the polar moment of inertia of the beam section takes the form

$$J = Cb^3t$$

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[1] S. Timoshenko and J.N. Goodier, Theory of Elasticity (New York; McGraw-Hill Book Co., 1951), pp. 275-278.

wherein

$$C = \frac{1}{3}\left(1 - \frac{192}{\pi^5} \cdot \frac{b}{t} \sum_{n=1,3,5,\ldots}^{n=\infty} \frac{1}{n^5} \tanh \frac{n\pi t}{2b}\right)$$

It follows that

$$m = \frac{2.3}{12C} \cdot \frac{t^2}{b^2} \qquad (3.1)$$

3.2 <u>The S-beam</u>

Evidently the S-beam solution as directed by relations (2.9) to (2.16) exhibits a complex nature as they assimilate compound trigonometric terms. Such trait furnishes justification for development of a graphical presentation enabling a rapid handling of the problem in the design office. The graphical aids represented by Charts 3.1 and 3.2 bring forward values of the redundants M_o and T_o for practical ranges of values of ϕ and $\frac{t}{b}$. Computerised numerical values of M_o and T_o forming the basis for the institution of the graphical aids, as tabulated in Appendix B, draw on the following input values of ϕ and $\frac{t}{b}$:

ϕ = 15, 30, 45, ..., and 120 degrees; and

$\frac{t}{b}$ = 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.0, 2.5, 3.0, and 4.0

3.3 <u>The Z-beam</u>

Although expressions (2.23) and (2.24) for the redundant M_o and T_o appear relatively simple their graphical presentation, Charts

3.3, and 3.4 has been registered. Computerised numerical values of these redundants, as listed in Appendix B, correspond to identical input values of $\frac{t}{b}$ set forth in Article 3.2, and to the following input values of k:

$$k = 0, 0.1, 0.2, 0.3, \ldots\ldots\ldots\ldots, \text{and } 2.00$$

CHART 3.1 S-BEAMS

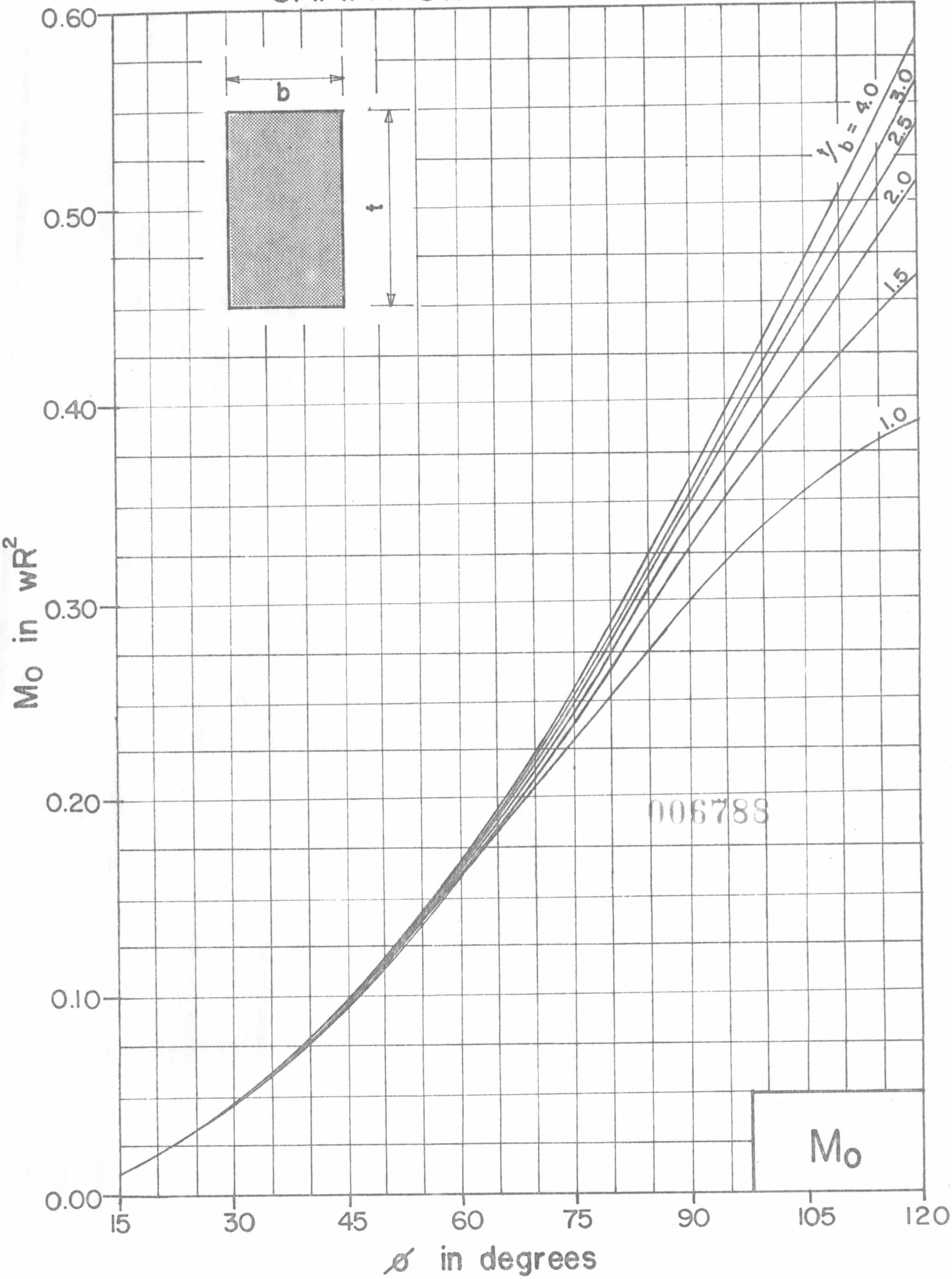


CHART 3.2 S-BEAMS

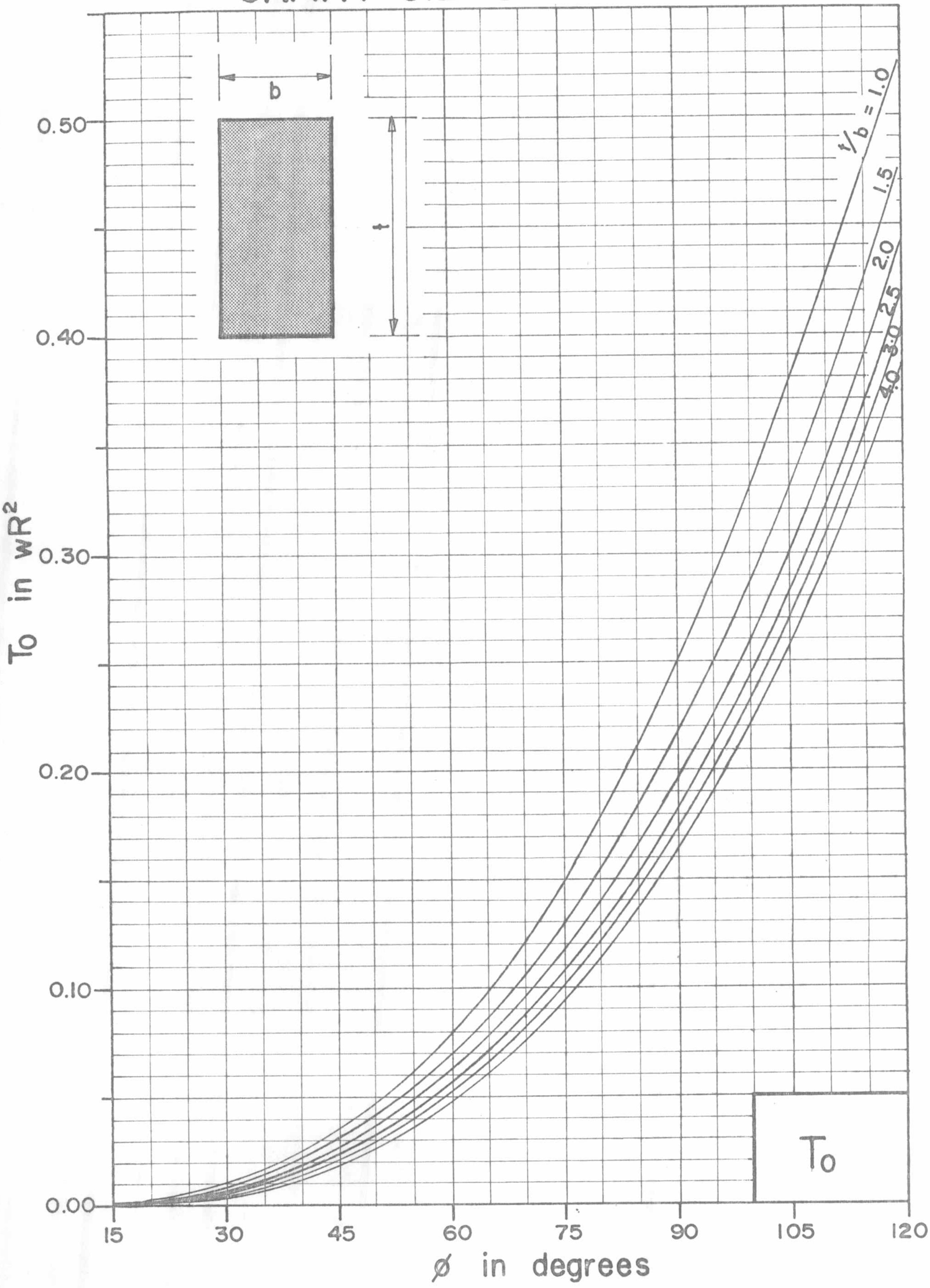
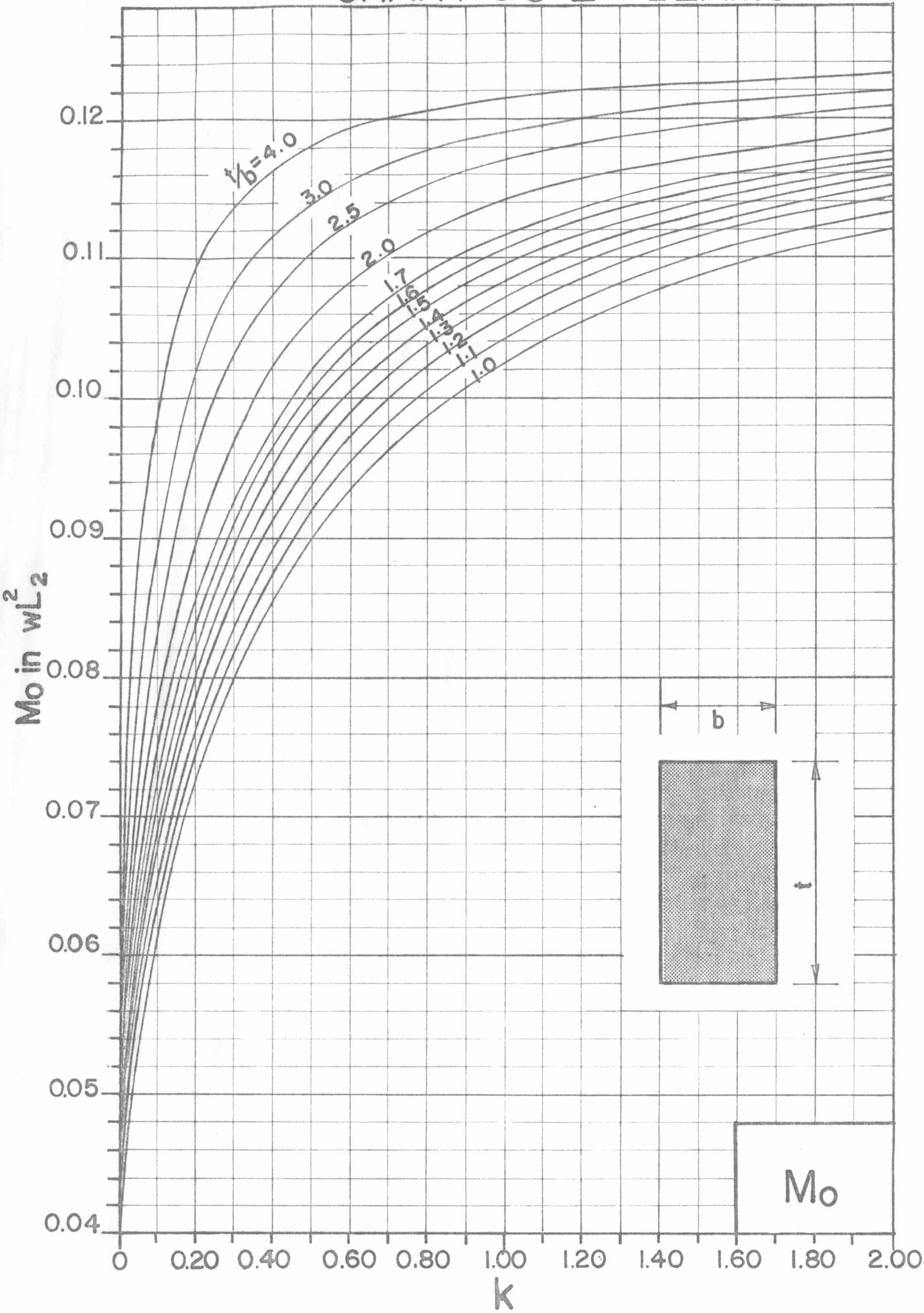


CHART 3.3 Z - BEAMS



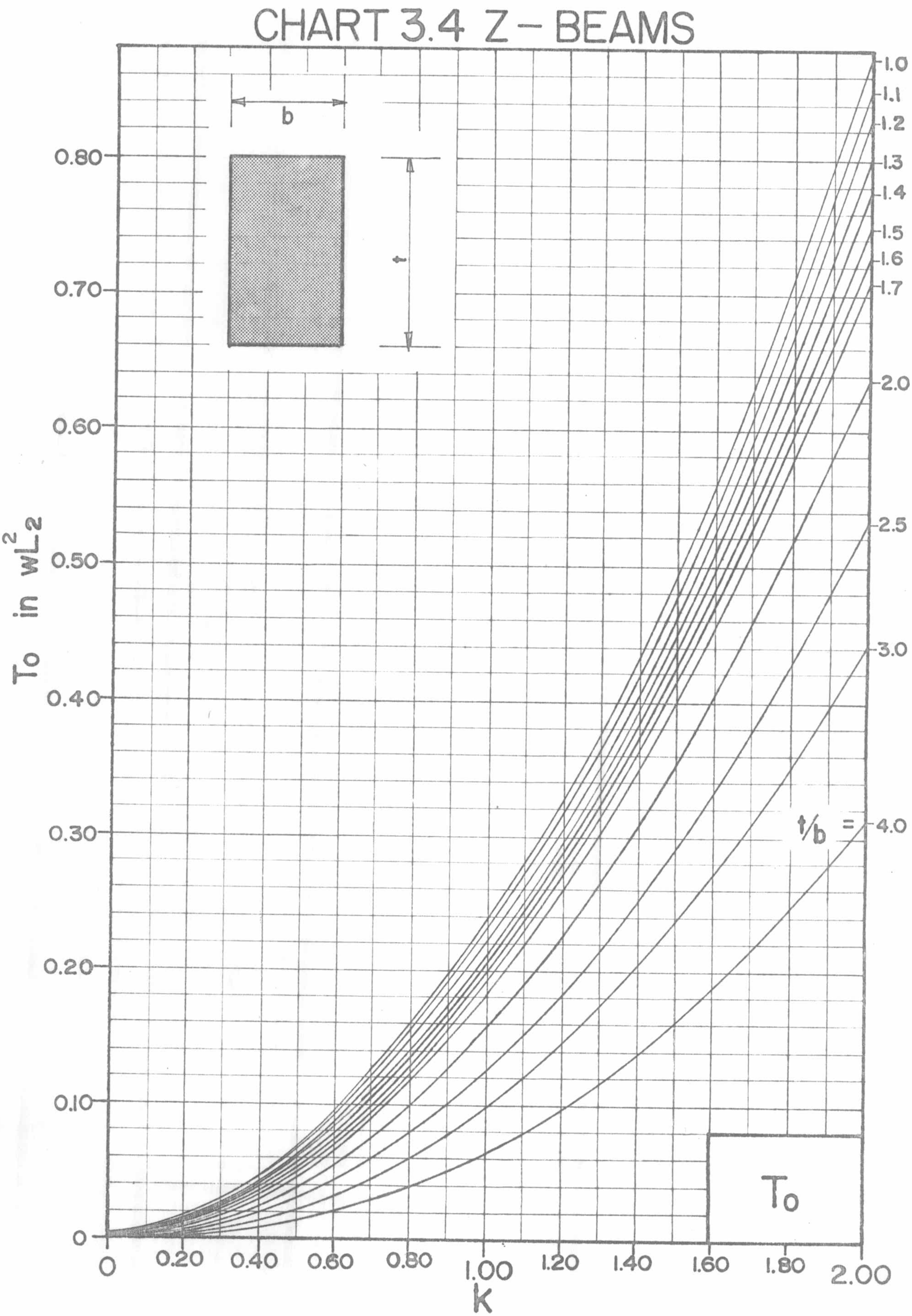


CHART 3.4 Z-BEAMS
b
t
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0
To in wL2²
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
2.0
2.5
3.0
t/b = 4.0
To
0
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
K