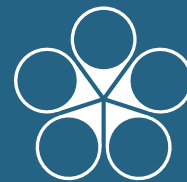


HYDRAULICS OF PRECAST CONCRETE CONDUITS

Pipes and box culverts



**Concrete Pipe
Association
of Australasia**

ACN 007 067 656

HYDRAULIC DESIGN MANUAL

NEW ZEALAND
EDITION





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PREFACE

This manual has been prepared to assist engineers with the hydraulic design of precast concrete conduits. It is hoped it will also be useful in the field of engineering education. It consolidates information from several sources and presents it in practical and usable form. The first section is a precis treatment of theoretical hydraulic concepts used in the manual. It should be used when necessary to assist with the understanding of the subsequent subjects. The remaining five sections consider the practical design aspects of individual subjects, namely, runoff, culverts, drains, sewers and pressure pipes. Each of the latter sections concludes with worked examples which may be used as models for many practical problems. If more detailed information is required, references are listed at the end of each section. The Concrete Pipe Association of Australasia is indebted to individual and institutional researchers and scientists for the information given. Some publications stand out as key works in their own field and rate a special mention because they form the main source material for two of the sections in this manual.

They are:

‘Australian Rainfall and Runoff’ published by the Institution of Engineers, Australia 1977.

Hydraulic Engineering Circulars No’s 5 and 10 published by United States Bureau of Public Roads 1965.

The use of these publications is gratefully acknowledged.

The selection, preparation and assembly of the data in this manual has been made by P. Aagren, Chief Civil Engineer, Humes Ltd. with special contributions by:

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Comments and suggestions for improvements to the manual will be welcomed and should be directed to the Association’s Executive Director.

**CONCRETE PIPE ASSOCIATION OF AUSTRALASIA
TECHNICAL COMMITTEE**

1983

PREFACE TO THE NEW ZEALAND EDITION

The New Zealand edition of the manual recognises current New Zealand practice and includes a revised chapter on stormwater runoff (Section 2) and reworked design examples in Section 4. The assistance of Works Consultancy Services Ltd in the preparation of this edition is acknowledged with thanks.

Partick V. McGuire
Executive Director



NOTATIONS AND SYMBOLS

A	Cross sectional area of conduit, or catchment area
C	Hazen Williams coefficient or coefficient of runoff
D	Pipe diameter
E	Modulus of elasticity
F	A coefficient
F_p	Passive soil resistance
H	Energy head or height of thrust block
H_b	Bend head loss
	Contraction or expansion head loss
H_e	Entry head loss
H_f	Uniform head loss
H_o	Outlet head loss
H_s	Specific energy
H_v	Valve head loss
HW	Headwater
I	Rainfall intensity or infiltration allowance
K	Bulk modulus of compression for water
L	Length of conduit
P	Wetted perimeter
Q	Discharge
R	Hydraulic Radius
R_e	Reynolds number, vD/ν
T	Thrust
TW	Tailwater
a	Pressure wave velocity or speed
c	Soil cohesion
d	Peak factor
d_c	Critical depth
e	Thickness of pipe wall
f	Resistance factor
g	Acceleration due to gravity
h	A height
k	Roughness factor
k_b	Bend loss coefficient
k_c	Contraction or expansion loss coefficient
k_e	Entry head loss coefficient
k_o	Outlet head loss coefficient
k_v	Valve head loss coefficient
n	Manning's or Kutter's n
p	Hydraulic pressure
s	Tangent to slope of the energy line
s_c	Tangent to critical slope
s_o	Tangent to slope of culvert invert
t	Critical time or time of concentration
v	Flow velocity
y	Depth of flow
z	Conduit elevation above base level
β	An angle
γ	Unit weight of water
γ_s	Unit weight of soil
θ	An angle
ν	Kinematic viscosity of water
ρ	Density of water
τ	Boundary shear
[]	Brackets surrounding reference number listed at end of section.