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E-BOOK 12 PRACTITIONER EDITION

The Site Engineer's Calculation Handbook

Steel, Pipe, Water, Pump and Electrical Quick-Reference with Worked Examples

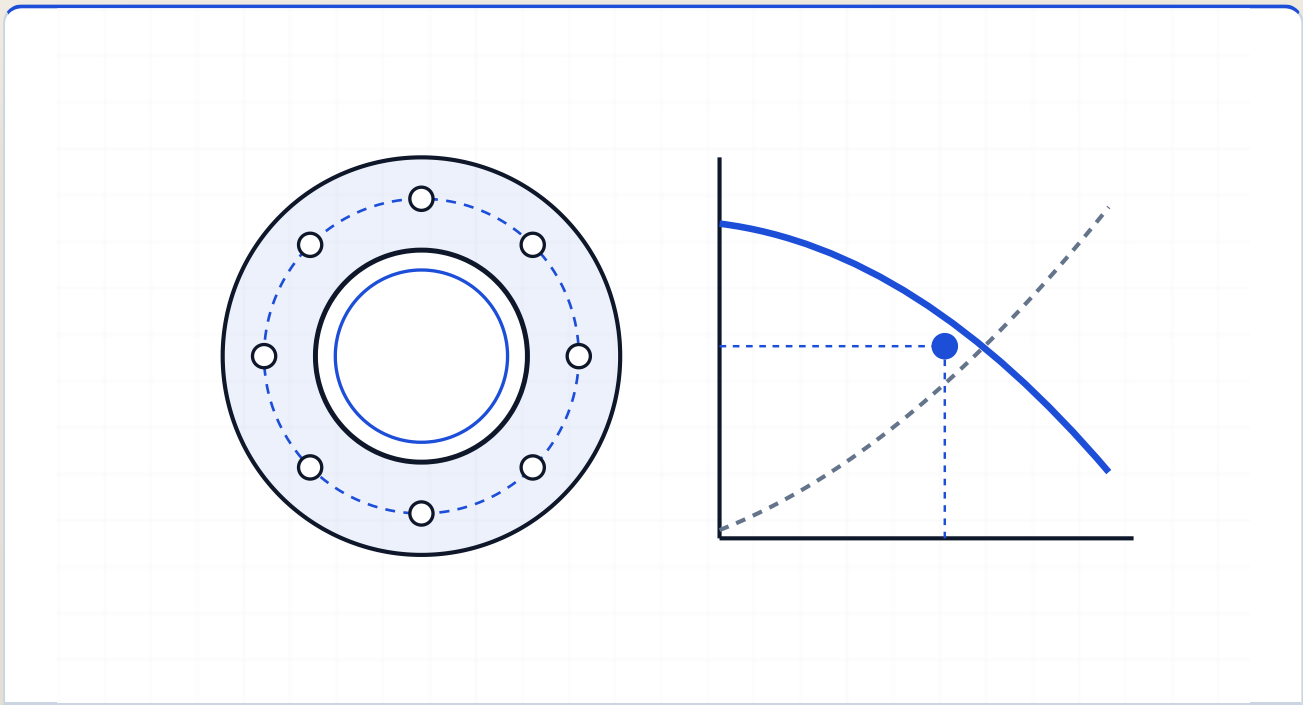


FIG 12.1 — PIPE SCHEDULE, HYDRAULIC VELOCITY & AMPERE DRAFTING SHEET

SYLLABUS
10 Structured Chapters

CALCULATIONS
Worked SI Examples & Tables

SITE READY
Forms & Hinglish Glossary

Shree Ganesh Enterprises (SGE) — AMC MEP 24x7
Fire Fighting · Fire Alarm · Electrical · Plumbing · HVAC · IBMS · AMC

1st Edition, 2026
sge.org.in/ebooks/site-engineer-calculation-handbook

The Site Engineer's Calculation Handbook

Steel, Pipe, Water, Pump and Electrical Quick-Reference with Worked Examples

A daily desk-and-site pocket handbook of engineering formulas and worked numerical checks: metric unit conversions, structural steel weights across 11 cross-sections (Angles, ISMB, ISMC, Bars, RHS/SHS, Sheets), circular pipe empty vs water-filled loads, wrapping tape roll estimation, Hazen-Williams fluid velocity & pump kW, motor FLA & APFC kVAr, basement CFM ventilation, BOQ cut-lists, and cross-checking on sge.org.in/tools.

Intended Audience: Civil, structural, and MEP site engineers, QS/billing engineers, fabricators, and contractors verifying BOQs, dead loads, and daily calculations on site.

Engineering Notice & Standards Policy

This publication is an educational and field-reference guide prepared by **Shree Ganesh Enterprises (SGE)**. It is **not** a substitute for a stamped project design, statutory approval, or the governing text of the National Building Code of India (NBC), Bureau of Indian Standards (BIS) codes, Indian Electricity Rules / CEA Regulations, or your State/Municipal Fire Service Bye-Laws. Standards are cited at document level; always verify the **current applicable edition**, manufacturer datasheets, and local amendments before design, procurement, testing, or certification.

Worked numerical examples across this book are illustrative engineering demonstrations. All design inputs, pipe friction factors, battery deratings, and protective clearances must be re-checked for project conditions by a competent licensed professional. High-voltage electrical testing, pump-room servicing, and gaseous fire suppression operations can be fatal if undertaken without qualified personnel, written Permits-to-Work, and Lockout-Tagout (LOTO) controls.

Roman-script Hindi/Hinglish site terms are included cleanly to assist execution teams; formal English engineering terminology governs contractual and code interpretations.

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What You Will Learn

- Convert metric pressure, head, flow, length, and area units instantly without calculator slips
- Calculate structural steel kg/m across MS Angles, Channels, I-Beams, Z-Purlins, Bars, Plates, and Hollow Sections
- Compute circular pipe empty metal weight, internal water volume, filled hanger weight, and IS 10221 wrapping tape rolls
- Size sump/water tank capacities, verify pipe fluid velocity limits, and estimate pump motor kW cleanly
- Verify site electrical currents, voltage drop %, APFC capacitor kVAr, and basement smoke exhaust CFM
- Build scrap-saving 6m bar cut-lists and verify every figure digitally using sge.org.in/tools calculators

Chapter 1: Field Units, Pressure Conversions and Engineering Constants

Convert Cleanly Before You Plug Anything Into a Formula

Half of all site calculation errors start with mixing millimetres into metre equations, confusing `bar` with `psi`, or reading `GPM` instead of `lpm`. Keep this conversion sheet pinned inside your site notebook:

Quantity	Conversion Identity (Standard Engineering Values)	Mental Site Quick-Check
Length	`1 m = 1,000 mm = 3.2808 ft = 39.37 in`	`1 ft ~ 0.3048 m` ; `1 inch = 25.4 mm`
Pressure & Water Head	`1 bar = 10.197 m water head = 1.0197 kgf/cm2 = 14.504 psi = 100 kPa`	Think `1 bar ~ 1 kg/cm2 ~ 10.2 m height` !
Water Flow Rate	`1 m3/hr = 16.667 lpm = 4.403 US GPM` | `1 L/s = 60 lpm = 3.6 m3/hr`	`2,280 lpm ~ 136.8 m3/hr ~ 600 US GPM` (standard hydrant!)
Steel & Metal Density	Mild Steel / Iron: **7,850 kg/m3** (`7.85 g/cm3`) | Stainless Steel ~ `7.95 g/cm3` | Aluminum ~ `2.70 g/cm3` | Copper ~ `8.96 g/cm3`	**Steel weighs ~7.85 kg per 1,000 cm3!**
Water Density	Fresh clean water @ 20 C: **1,000 kg/m3** (`1.0 kg per litre`)	`1,000 Litres = 1.0 m3 = 1.0 Metric Tonne`

HINGLISH

Unit conversion = inch, foot, metre, bar aur litre ko ek barabar paimane mein badalna taaki calculation galat na ho. Steel density = loha ka wajan (`7.85 g/cm3`).

Chapter 2: Structural Steel Weight Formulas Across All 11 Shapes

Compute Exact Unit Weight Without Carrying Printed Charts Everywhere

Weight per running metre is simply **Cross-Sectional Metal Area (`mm2`) x Material Density (`g/cm3`) / 1,000**!

Structural Profile Shape	Input Dimensions (mm)	Cross-Section Metal Area Formula (`mm2`)	Multiply by `(rho / 1,000)` -> `kg/m`
1. Circular Pipe (Round Tube)	Outer Dia `OD`, Wall `t`	`pi x (OD - t) x t`	Steel (`7.85`): `(OD - t) x t x 0.0246615`
2. Hollow Profile (RHS / SHS Tube)	Width `W`, Height `H`, Wall `t`	`2 x t x (W + H - 2t) - 0.8584 x t^2`	Accounts cleanly for corner roll radius
3. Solid Round Bar	Diameter `D`	`(pi / 4) x D^2`	Steel (`7.85`): `D^2 / 162.2` (~ `0.006165 x D^2`)
4. Solid Square Bar	Side `a`	`a^2`	Steel (`7.85`): `a^2 x 0.00785`
5. Solid Hexagonal Bar	Across Flats `AF`	`0.866025 x AF^2`	Steel (`7.85`): `AF^2 x 0.006798`
6. Equal / Unequal MS Angle (L)	Leg `A`, Leg `B`, Thick `t`	`t x (A + B - t)`	Area (`mm2`) x `0.00785` (for MS)
7. U Profile / Channel (ISMC)	Web `H`, Flange `B`, `tw`, `tf`	`2(B x tf) + (H - 2 tf) x tw`	Area (`mm2`) x `0.00785`
8. I / H Beam (ISMB / Wide)	Height `H`, Flange `B`, `tw`, `tf`	`2(B x tf) + (H - 2 tf) x tw`	Area (`mm2`) x `0.00785`
9. T-Profile	Flange `B`, Total `H`, `tf`, `tw`	`(B x tf) + (H - tf) x tw`	Area (`mm2`) x `0.00785`
10. Z-Purlin (Lipped)	Web `H`, Flanges `B1, B2`, Lips `C`, `t`	`(H + B1 + B2 + 2C) x t` (girth check)	Strip girth x `t` x `0.00785`
11. Flat Sheet / Metal Plate	Length `L` (m), Width `W` (m), Thick `t`	Surface Area `L x W` (`m2`)	**Per Piece kg** = `L_m x W_m x t_mm x rho`

NOTE (TOLERANCE CAUTION)

Theoretical geometric equations above ignore minor rolling root fillet curves and mill tolerance allowances (`+/-` roll tolerances). Indian Standard BIS handbooks (`IS 808`, `IS 4923`, `IS 1239`) publish standard nominal weights taking rounded fillets into account—differences within 1–3% vs simplified box math are normal! Check `sge.org.in/tools/pipe-schedules` where both presets and custom metal alloy densities (`40+` options) run automatically with 3D views!

WORKED EXAMPLE 1

MS Angle & Hollow Box Tube Weight Check (Illustrative). A site stores **IS Equal Angle 50 x 50 x 6 mm** and **RHS 100 x 50 x 4.0 mm** made of Mild Steel (`rho = 7.85 g/cm3`):

- **MS Angle (`50x50x6 mm`):** `Area = 6 x (50 + 50 - 6) = 6 x 94 = 564 mm2` -> `Weight/m = 564 x 7.85 / 1,000 = 4.43 kg/m` (BIS nominal table prints ~4.50 kg/m including corner fillet radius). For 20 standard 6 m bars (`120 m`): `120 x 4.43 = 531.6 kg`.
- **Hollow Section RHS (`100x50x4 mm`):** `Area = 2(4)(100 + 50 - 8) - 0.8584(16) = 1,136 - 13.73 = 1,122.3 mm2` -> `Weight/m = 1,122.3 x 7.85 / 1,000 = 8.81 kg/m` (`IS 4923` nominal ~8.60 kg/m accounting for larger exterior roll bend radii).

Chapter 3: Pipe Weights (Empty and Filled), Water Volumes and Wrapping Tape

Hangers Must Hold Water Dead Weight, Not Just Empty Steel!

A mistake engineers make constantly: ordering ceiling rod hangers capable only of empty steel weight while ignoring the heavy core of pressurized water inside big risers!

FORMULA

- `Inside Pipe Diameter: ID (mm) = OD - (2 x Wall_t)`
- `Empty Steel Weight ( kg/m ): pi x (OD - t) x t x rho / 1,000`
- `Water Volume Capacity ( Litres/m ): pi x (ID / 2,000)^2 x 1,000 ( = 0.0007854 x ID_mm^2 )`
- `External Coating Surface Area ( m2/m ): pi x OD_mm / 1,000`
- `Anti-Corrosion Wrapping Tape Area ( m2 ): Bare External Area / (1 - Overlap_%)`

WORKED EXAMPLE 2

150 NB Heavy Pipe Water-Filled Weight & Wrapping Rolls (Illustrative). Check **50 metres** of **150 NB Heavy Class MS Yard Pipe** (`OD = 165.1 mm` , `t = 5.4 mm` -> `ID = 154.3 mm` , Steel `rho = 7.85 g/cm3`) protected underground with **150 mm wide x 10 m long rolls of 4 mm Polymeric Tape** applied at **55% spiral overlap**:

- Empty Pipe Weight/m = `3.14159 x (165.1 - 5.4) x 5.4 x 7.85 / 1,000 = 21.27 kg/m` .
- Internal Water Volume/m = `0.0007854 x (154.3)^2 = 18.70 Litres/m` (`= 18.70 kg/m` water!).
- Total **Water-Filled Dead Weight/m** = `21.27 + 18.70 = 39.97 kg/m` ! Over 50 m = **`1,998.5 kg`** **(~2.0 Metric Tonnes total dead load vs just 1.06 T empty!)**.
- Bare Outer Pipe Area (`50 m`) = `3.14159 x 0.1651 m x 50 m = 25.93 m2` .
- Primer (~7 m2/L yield) = `25.93 / 7 = 3.70 Litres` .
- Effective Net Roll Coverage per 10 m roll at 55% overlap (`45% net advance`): `(0.15 m x 10 m) x 0.45 = 0.675 m2/roll` .
- Rolls Needed = `25.93 / 0.675 = 38.4` -> Order **39 to 40 Rolls** (verify directly on `sge.org.in/tools/pipe-schedules` Wrapping Module!).

HINGLISH

Water-filled weight = pipe ke lohe aur uske andar bhare paani ka kul wajan (hanger aur clamp iske hisaab se lena chahiye). Overlap factor = wrapping patti ko 55% chadha kar lapetne par lagne wali extra patti ka hisaab.