



Calculation Basis

ForgeWorks Estimator | Engine forgeworks.1.2 | Issue 1

PRELIMINARY - NOT FOR FABRICATION

1. Purpose and permitted use

This document describes the formulas, assumptions, and control boundaries implemented in the ForgeWorks Estimator browser application. It is written to make an estimate reviewable. It is not a certificate of compliance with BS 8666, ACI 318, CRSI, IS 2502, AS 3600, or any machine vendor dialect.

- Permitted: preliminary quantity takeoff, theoretical-weight estimating, indicative nested stock purchasing, bid comparison, and early shop planning.
- Not permitted: released bar schedules, structural design, development or lap design, machine control, fabrication release, or code-compliance certification.
- A competent checking engineer must verify dimensions, bend radii, hook rules, laps, grades, coatings, stock assumptions, and every released output.

2. Document control

Field	Value	Control
Calculation engine	forgeworks.1.2	Printed and exported with each result
Application mode	Estimator / preliminary	All operational outputs are watermarked
Primary units	mm, kg, m, tonne, degree	Internal lengths are millimetres unless stated
Persistence	IndexedDB with localStorage fallback	JSON export is the portable backup
Method owner	Product owner	Independent engineering review is not yet complete

3. Calculation sequence

Step	Input	Output
1. Normalize	Imported or entered schedule rows	Non-negative dimensions, integer quantity, catalog defaults
2. Geometry	Shape, dimensions, diameter	Developed cut length in mm
3. Theoretical mass	Cut length, quantity, kg/m	Scheduled pay weight in kg
4. Nest	Eligible pieces, stock lengths, kerf, remnants	New stock purchase, reusable offcut, scrap
5. Bid	Rate book, theoretical or purchase basis	Material, labour, couplers, indicative steel value

Review rule

If the engine version, project revision, shape definition, stock lengths, kerf, reusable-offcut threshold, or rate book changes, the estimate must be regenerated and checked. Schedule mutations invalidate the current nest and its cached remnants.



Rebar geometry and mass

Implemented arithmetic - not a published design-code implementation

4. Nominal mass

For catalog diameters, the engine uses a fixed nominal mass lookup. For an uncatalogued diameter, it falls back to $d^2 / 162.28$ kg/m and displays a warning.

```
row mass [kg] = cut length [mm] / 1000 x nominal mass [kg/m] x quantity
```

Diameter (mm)	6	8	10	12	14	16	20	25	28	32	36	40	50
kg/m	0.222	0.395	0.617	0.888	1.21	1.58	2.47	3.85	4.83	6.31	7.99	9.86	15.4

5. Generic bend development

The current kernel applies a generic centreline deduction to the sum of entered leg dimensions. The centreline radius is $r + d/2$. This model does not select mandrels from grade, coating, seismic class, or machine capability.

```
developed = max(0, sum(legs) - sum[2 x centre x tan(angle/2) - centre x angle(rad)])
```

Diameter band	Implemented internal bend radius
$d \leq 16$ mm	2d
$16 \text{ mm} < d \leq 25$ mm	3.5d
$d > 25$ mm	5d

6. Simplified hook allowances

Hook	Implemented allowance	Important limitation
90 degree	12d	No grade, coating, bar-size band, or stirrup distinction
135 degree	max(6d, 75 mm)	Not a seismic design check
180 degree	max(4d, 65 mm)	Not a development-length check
BS-style closed/link hook C	max(10d, 100 mm)	Simplified internal minimum only

7. Shape coverage

The BS-style catalog contains 00, 11, 21, 33, 41, 51, 61, 77, and 99. The ACI/CRSI-style catalog contains internal estimator types T1 to T8. Type 99 supports custom legs with signed bend angles; sign is retained in the preliminary BVBS text. This limited catalog is not a substitute for a complete standard shape schedule.

Known exclusions

- No lap length, development length, cover, congestion, chairs, mesh, native imperial bar sizes, or grade-dependent bend tables.
- Shape sketches are schematic previews. They are not scaled fabrication drawings and do not show a verified mandrel.
- Preliminary BVBS text has not been certified against a bender or vendor dialect and must not be loaded into a machine.



Nesting and bid basis

Theoretical pay weight and new-stock purchase weight are intentionally separate

8. Cutting-stock heuristic

Eligible pieces are grouped by diameter and sorted from longest to shortest. Each piece is placed in the feasible retained-remnant or stock bin that leaves the smallest remaining length. If no bin fits, the smallest configured stock length that fits is purchased. This is a best-fit-decreasing heuristic; no optimality claim is made.

- Kerf is charged only between consecutive pieces in a bin. A first piece exactly equal to stock length is valid and receives no trailing kerf.
- A piece longer than the longest stock is isolated as oversize. Purchase pricing is unavailable until the oversize condition is resolved.
- Remainders at or above the reusable-offcut threshold are retained. Re-running an unchanged nest uses the same starting-remnant snapshot for deterministic comparison.
- No clamp, grip, heat, grade, mill bundle, machine, transport, splice, or multi-job inventory constraint is modeled.

9. Bid formulas

$\text{theoretical material} = \text{theoretical mass [t]} \times \text{steel rate [currency/t]}$
$\text{purchase material} = \text{nested new-stock mass [t]} \times \text{steel rate [currency/t]}$
$\text{labour} = \text{theoretical mass [t]} \times \text{labour rate [currency/t]} \times \text{shop factor}$
$\text{line estimate} = \text{selected material basis} + \text{labour}$

The shop factor is a commercial estimating control: 1.00 for straight, 1.15 for up to two bends, 1.35 for up to four bends, and 1.50 above four bends. It is not a measured productivity standard.

10. Worked estimator example

Input / result	Value	Comment
Bar	24 x 5800 mm, diameter 16	Straight estimator shape
Theoretical length	139.2 m	24 x 5.8 m
Theoretical mass	219.936 kg	139.2 x 1.58 kg/m
Stock / kerf	12000 mm / 5 mm	Two pieces use 11605 mm
New stock purchase	12 bars = 144.0 m	No incoming remnants
New-stock mass	227.520 kg	144.0 x 1.58 kg/m
Purchase delta	+7.584 kg / +3.45%	Before valuing retained offcut

Interpretation

Contracts may pay theoretical mass while a fabricator buys stock mass. The Bid view therefore displays both and requires the estimator to choose the commercial basis. Labour remains tied to scheduled mass because the current model does not estimate handling of scrap or retained inventory.



Quality controls and release boundary

Minimum review workflow for preliminary estimating

11. Automated controls in build 1.2

Control	Current implementation	Residual risk
ID generation	Crypto-backed random values with fallback	Fallback is weaker on legacy browsers
Input constraints	Minimums, integer quantity, visual invalid state	Semantically wrong positive values still pass
Nest invalidation	Schedule mutation clears nest and cached remnants	No warehouse-grade remnant ledger
Export safety	CSV formula neutralization; safe sheet names	SpreadsheetML is not native XLSX
Offline update	Versioned cache with save-and-reload prompt	Deployment process must still bump engine and cache together
Output status	Print, CSV, XML, and BVBS marked preliminary	Users can still alter files after export

12. Required human check

- Confirm the project revision, standard family, units, bar grade, coating, stock lengths, kerf, and reusable-offcut threshold.
- Check every shape against the governing project standard and approved bending schedule. Replace simplified hooks and mandrels where required.
- Resolve every validation warning and oversize item. Do not use purchase-weight pricing when the nest reports oversize pieces.
- Compare theoretical and purchase weight by diameter. Explain material delta and the disposition of retained remnants.
- Check rate dates, currency, steel and labour inclusions, couplers, taxes, freight, escalation, and commercial risk allowances outside this kernel.
- Export a JSON backup and archive this calculation-basis issue with the bid revision.

13. Fabrication release gate

There is no fabrication-release state in forgeworks.1.2. A professional workflow must add an independently reviewed kernel, complete catalog for one governing standard, immutable calculation snapshot, named checker, revision comparison, release signature, and machine-vendor certification before any preliminary watermark can be removed.

14. Change-control rule

Any change to geometry formulas, mass tables, hook allowances, nest placement, kerf treatment, bid formulas, or import normalization requires: (1) a new engine version, (2) updated golden tests, (3) a service-worker cache bump, (4) an updated calculation-basis issue, and (5) regeneration of affected estimates.

15. Validation evidence

The repository validator parses the application JavaScript, checks unique and referenced element IDs, validates PWA assets, and executes focused kernel checks for ID uniqueness, sheet-name safety, CSV formula protection, first-cut kerf, signed-angle preservation, remnant invalidation, and steel treatment normalization. These checks support software integrity; they are not engineering certification.

Commercial statement

ForgeWorks Estimator is positioned as an offline-first estimating workbook for teams moving beyond spreadsheets. Estimator Pro does not include a fabrication warranty, code certification, or machine-control entitlement.