# Pricing Concrete Work

# Major Tasks in Concrete Work

1. Supply and Placement of concrete
2. Construction and removal of formwork
3. Supply and placement of reinforcing steel
4. Miscellaneous items associated with concrete work

- All concrete work in the *Quantity Takeoff* sheet is reorganized in the *Recap* sheet under these categories

# Supply & Placement of Concrete

- Concrete is supplied mostly by Ready Mix Concrete Plants. Ready Mix Plants will prepare and deliver concrete to the required specifications. Price is quoted by the supplier.
- On very large projects or in remote areas, a concrete batch plant may be constructed to supply the project concrete needs. In this case, price is determined by pricing material for each concrete mix in addition to a plant charge rate.
- On site small concrete mixers are used only in rare occasions.

# Productivity of Placing Concrete

- Productivity is affected by JOB factors and LABOR & MANAGEMENT factors
- These were previously discussed.
- However, there are also specific factors that impact  productivity of placing concrete. They include:
  - Method of placing concrete
  - Rate of delivery of ready mix concrete
  - Properties of concrete mix to be placed
  - Size and shape of concrete structure
  - Amount of rebar in the structure

# 1. Methods of Placing Concrete

| | |
|---|---|
| Direct by Chutes | Most economical (if applicable) |
| Buggies (manual/powered) | Rarely used |
| Crane and Bucket | Used in large projects where crane is already setup |
| Concrete Pump | Especially economical on large projects w/o cranes |
| Conveyors | Used on large project where massive amount of concrete is needed continuously |
| Combination | |

# Concrete Placer 1

# Concrete Placer 2

# Example for Method Selection

- Concrete Foundation 100 ft x 150 ft
- Concrete Requirement: 3,000 cy in a single continuous pour
- Delivery rate: 75 cy per hour

| | Wages & Prices |
|---|---|
| Laborer | $ 21/hr |
| Labor Foreman | $ 24/hr |
| Equipment Operator | $ 30/hr |
| 25 ton mobile cranes | $ 1,015/day |
| 5” concrete pump | $ 1,250/day |
| Conveyor system | $ 1,150/day |

A. Crane & Bucket: 2 w/ 1.25 cy buckets (estimated productivity 50 cy/hr)
Crew: 1 foreman, 12 laborers, 2 operators

Time required = (3000 cy/50 cy/hr) + 3 hrs for startup and finishing = 63 hours

| Cost | Labor ($) | Equip ($) |
|---|---|---|
| Mobile crane 2 x 3 days x $1,050 | | 6,090 |
| Foreman 1 x 63 x $24 | 1,512 | |
| Laborers 12 x 63 x $21 | 15,876 | |
| Operators 2 x 63 x $30 | 3,780 | |
| Totals | 21,168 | 6,090 |
| Price per Cy (/3000) | 7.06 | 2.03 |

## B. Concrete Pumps: 2; 60 cy/hr
## Crew: 1 foreman, 14 laborers, 2 operators

Time required = (3000 cy/60 cy/hr) + 3 hrs for startup and finishing = 53 hours

| Cost | Labor ($) | Equip ($) |
|---|---|---|
| Pumps 2 x 3 days x $1,250 | | 7,500 |
| Foreman 1 x 53 x $24 | 1,272 | |
| Laborers 14 x 53 x $21 | 15,582 | |
| Operators 2 x 53 x $30 | 3,180 | |
| Totals | 20,034 | 7,500 |
| Price per Cy (/3000) | 6.68 | 2.50 |

## C. Conveyors: 2; 72 cy/hr
## Crew: 1 foreman, 18 laborers, 2 operators

Time required = (3000 cy/72 cy/hr) + 3 hrs for startup and finishing = 47 hours

| Cost | Labor ($) | Equip ($) |
|---|---|---|
| Mobile crane 2 x 2 days x $1,150 | | 4,600 |
| Foreman 1 x 47 x $24 | 1,128 | |
| Laborers 18 x 47 x $21 | 17,766 | |
| Operators 2 x 47 x $30 | 2,820 | |
| Totals | 21,714 | 4,600 |
| Price per Cy (/3000) | 7.24 | 1.53 |

# 2. Rate of Delivery of Concrete

- Rate of delivery is a constraining factor in the placement
- The method of placing concrete and the crew need to be compatible with the delivery rate. If the method used (equipment and crew) results in placement at a faster rate than delivery, there will be a wasted waiting time for delivery trucks.

# 3. Properties of Concrete

- Higher slump concrete (more fluid) is more workable. Consequently productivity is improved.
- Similarly Superplastecizer additives can improve productivity
- Use of Fiber Reinforced Concrete reduces the need for reinforcing bars and therefore improves the productivity of placing concrete

# 3. Size and Shape of Concrete Structure

- Large-volume structures generally result in lower unit prices (e.g. wide column/slender column
- Structures where concrete pouring is continuous result in higher productivity (e.g. strip footing/isolated footing)
- Size and shape also has impact on placement method selection (crane & bucket is more suitable to place concrete in columns than pumping).

# 4. Amount of Rebars in the Forms

- Reinforcement bars make it difficult to place concrete and vibrate it to remove air pockets

# Concrete Materials Pricing

- Estimator should get a firm price from supplier for the duration of the project
- It must be clarified that the price quoted by the concrete supplier is for concrete that meets the specification required.
- Quotes must also include any special requirement such as:
  - Special type of cement
  - Additives such as air entrainment or other admixtures
- What are the charges, if any, for requesting concrete outside normal working hours.
- Allow for waste by increasing the price or adjusting the quantities in the quantity takeoff.

# Formwork

- Cost of Formwork includes
  - Cost of Material
  - Cost of fabrication of form system
  - Cost of setting up (erecting) the system
  - Cost of stripping the system, including the cost of cleaning, oiling, and repairing the system
  - Other costs such as transportation, handling, and storage

# Formwork Productivity

- In addition to the general Job factors and Labor & Management factors, productivity of formwork maybe particularly affected by
  1. Potential for reuse of formwork
  2. Complexity of formwork design
  3. Use of Gang forms
  4. Number of form ties required for the system

# 1. Number of Reuses

- Number of reuses will reduce the unit cost (per $m^2$) of formwork because the number of $m^2$ formed by the system is increased.
- Learning curve effect: As crew becomes more familiar with system, efficiency of system setup increases.
- On the adverse side, as the number of uses increases the requirement for more costly repairs also increases.

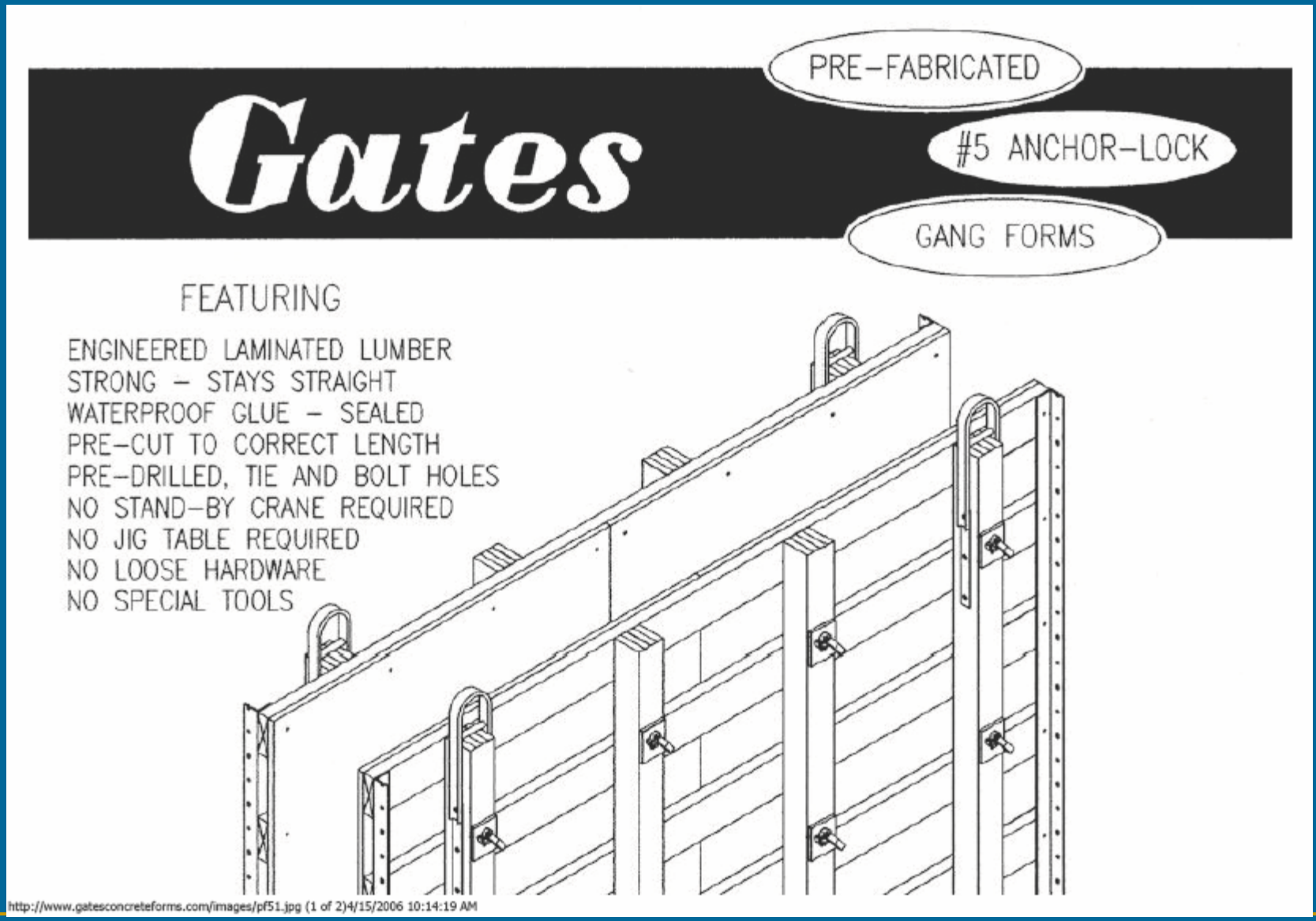
# 2. Complexity of Formwork Design

- Complicated formwork shapes results in higher costs because:
  - Fabrication of the formwork will take more time.
  - Formwork may not be reusable.

# Use of Gang forms

- Gang Forms is a formwork system pre-built in large modules and used repeatedly over the course of the project. The modules are moved from one location to another to erect the formwork. Erecting the forms is simplified because of the use of these large modules.

# Gang Formwork



# Number of Form Ties Required

- The number of form ties required to construct the formwork will impact productivity because it is a time consuming process.
  - Form ties hold the formwork together before concreting and to withstand the pressure of concrete after

# Formwork Productivity Rates

| CREWS | CREW MEMBERS |
|---|---|
| CREW A | 1.0 Carp. Foreman<br>6.0 Carpenters<br>2.0 Laborers |
| CREW B | 0.3 Carp. Foreman<br>2.0 Carpenters |
| CREW C | 1.0 Labor Foreman<br>1.0 Carpenter |

| ITEM | OPERATION | CREW | OUTPUT | |
|---|---|---|---|---|
| 1. | Continuous Strip Footings | A | 115–150 sq. ft./hr. | 11–14 m²/hr. |
| 2. | 2 × 4 Keyways | B | 150–170 sq. ft./hr. | 46–52 m/hr. |
| 3. | Isolated Footings and Pile Caps | A | 95–130 sq. ft./hr. | 9–12 m²/hr. |
| 4. | Grade Beams | A | 110–130 sq. ft./hr. | 10–12 m²/hr. |
| 5. | 4" × 8" Void Forms | B | 150–170 ft./hr. | 46–52 m/hr. |
| 6. | Pilasters | A | 55–80 sq. ft./hr. | 5–7 m²/hr. |
| 7. | Foundation and Retaining Walls | A | 80–105 sq. ft./hr. | 7–10 m²/hr. |
| 8. | Bulkheads | A | 30–40 sq. ft./hr. | 3–4 m²/hr. |
| 9. | Blockouts up to 8 SF | B | 0.5–2.0 no./hr. | 0.5–2.0 no./hr. |
| 10. | Above-grade Walls | A | 60–90 sq. ft./hr. | 6–8 m²/hr. |
| 11. | Columns—Rectangular | A | 55–80 sq. ft./hr. | 5–7 m²/hr. |
| | —Circular | A | 25–50 sq. ft./hr. | 2–5 m²/hr. |
| 12. | Sumps and Manholes | A | 60–80 sq. ft./hr. | 6–7 m²/hr. |
| 13. | Edges of Slab-on-Grade | A | 80–100 sq. ft./hr. | 7–9 m²/hr. |
| 14. | Construction Joints—SOG | A | 45–60 sq. ft./hr. | 4–6 m²/hr. |
| 15. | Edges of Suspended Slab | A | 65–85 sq. ft./hr. | 6–8 m²/hr. |
| 16. | Soffit of Suspended Slabs | A | 90–120 sq. ft./hr. | 8–11 m²/hr. |
| 17. | Soffit of Stairs | A | 35–40 sq. ft./hr. | 3–4 m²/hr. |
| 18. | Edges and Risers of Stairs | A | 60–80 sq. ft./hr. | 6–7 m²/hr. |
| 19. | Edges of Slab-on-Metal Deck | A | 45–60 sq. ft./hr. | 4–6 m²/hr. |
| 20. | Edges of Equipment Bases and Curbs | A | 40–90 sq. ft./hr. | 4–8 m²/hr. |
| 21. | Sides and Soffits of Beams | A | 45–90 sq. ft./hr. | 4–8 m²/hr. |
| 22. | Edges of Sidewalks | A | 80–100 sq. ft./hr. | 7–9 m²/hr. |
| 23. | Stripping Forms | C | 120–350 sq. ft./hr. | 11–33 m²/hr. |
| 24. | Shoring Frames | B | 3–5 no./hr. | 3–5 no./hr. |

**Figure 11.3** Formwork Productivities

# Pricing Formwork

- Determine cost of material
- Determine cost of fabrication
- Determine cost of erecting formwork
- Determine cost of stripping formwork
- Determine cost of material and fixing of form ties (as % or by calculation)
- Determine cost of shoring system, if applicable
- Add wastage factor where applicable
- Convert to cost per $m^2$ ($ft^2$) contact area

# EXAMPLE - FORMWORK PRICING

- Figure 11.5 shows the design of a formwork system for use in forming an elevated beam.
- A number of long sections are to be constructed and each section of formwork will be used 6 times.
- The contractor has never used this form system before, therefore a detailed analysis is required to obtain the most accurate assessment of the costs of the system.
- The labor price for this system is calculated using the labor productivity of crews fabricating the, setting up, and stripping (including cleaning/oiling) the forms. These productivities are based on prior similar operations

# EXAMPLE - FORMWORK PRICING

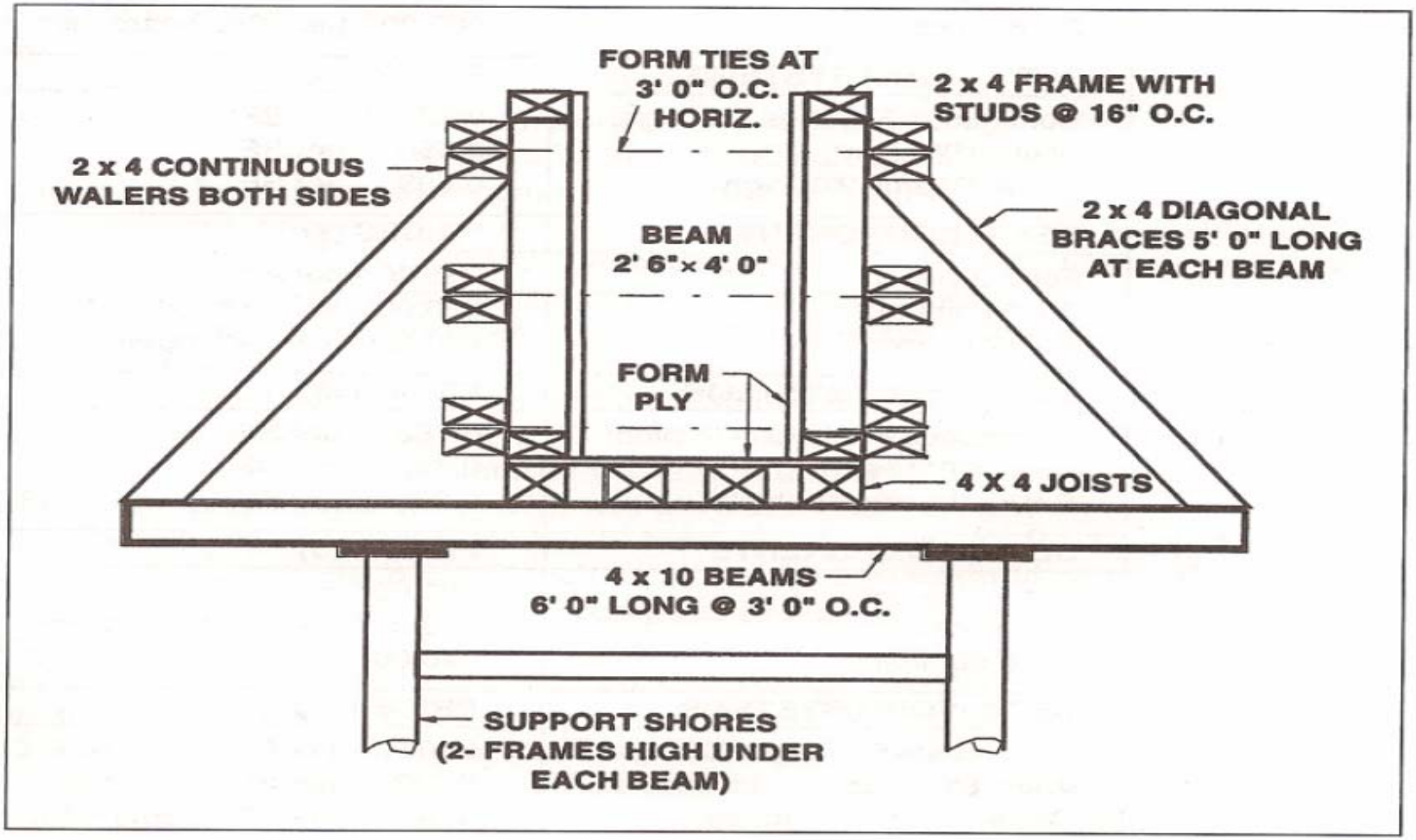



**Figure 11.5** Formwork System to Elevated Beam

# Labor Cost – Fabricating & Erecting Crew (1 laborer required for stripping)

| | | | |
|---|---|---|---|
| Carpenter foreman | 1 | 31.00 | 31.00 |
| Carpenter | 5 | 28.00 | 140.00 |
| Laborers | 2 | 21.00 | 42.00 |
| Total (Crew cost per hour) | | | 213.00 |

# Material Cost & Fabrication Productivity

| Component | Material Price | | Fabricating Productivity |
|---|---|---|---|
| ¾" Formply | $ 40.00/sheet | = $1.25/sq. ft. | 250 sq. ft./hr. |
| 2 x 4 Lumber | $480.00/1000 bd. ft. | = $0.48/bd. ft. | 200 bd. ft./hr. |
| 4 x 4 Lumber | $520.00/1000 bd. ft. | = $0.52/bd. ft. | 240 bd. ft./hr. |
| 4 x 10 Lumber | $580.00/1000 bd. ft. | = $0.58/bd. ft. | 300 bd. ft./hr. |
| Form oil | $ 4.00/gal. | = $0.04/sq. ft. | not applicable |

# Material Price (based on 12 ft Section)

| *Components* | | | | | *Materials Price $* |
|---|---|---|---|---|---|
| 4 × 10 | Beams | 4 × 6'0" | = 24 ft. = 80 bd. ft. @ $0.58 | = | 46.40 |
| 4 × 4 | Joists | 4 × 12'0" | = 48 ft. = 64 bd. ft. @ $0.52 | = | 33.28 |
| 2 × 4 | Walers | 12 × 12'0" | = 144 ft. | | |
| | Frames | 4 × 12'0" | = 48 ft. | | |
| | | 2 × 10 × 4'0" | = 80 ft. | | |
| | Braces | 2 × 4 × 5'0" | = 40 ft. | | |
| | | | 312 ft. = 208 bd. ft. @ $0.48 | = | 99.84 |
| ¾" Formply—sides: | | 8'0" | | | |
| —bottom: | | +3'0" | | | |
| | | = 11'0" × 12' = 132 sq. ft. @ $1.25 | | = | 165.00 |
| | | | | | 344.52 |
| Waste and repairs add 20% | | | | = | 68.90 |
| | | | | | 413.42 |
| Price per use (/6 uses) | | | | = | 68.90 |
| Material price per sq. ft. (/126 sq. ft. contact area) | | | | = | 0.55 |
| Add the cost of form oil required for each use | | | | = | 0.04 |
| Total material price per sq. ft. | | | | = | 0.59 |

# Labor Cost (based on 12-ft Section)

| *Components* | | | *Labor Price $* |
|---|---|---|---|
| 4 × 10 Beams | 80 bd. ft.@ $213.00/300 bd. ft. | = | 56.80 |
| 4 × 4 Joists | 64 bd. ft.@ $213.00/240 bd. ft. | = | 56.80 |
| 2 × 4 Pieces | 208 bd. ft.@ $213.00/200 bd. ft. | = | 221.52 |
| ¾" Formply | 132 sq. ft.@ $213.00/250 sq. ft. | = | 112.46 |
| | | | 447.58 |
| | Waste and repairs add 20% | = | 89.52 |
| | | | 537.10 |
| | Price per use (/6 uses) | = | 89.52 |
| | Fabrication price per sq. ft. (/126 sq. ft. contact area) | = | 0.71 |
| | Erecting price per sq. ft. = $213.00/75 sq. ft. | = | 2.84 |
| | Stripping price = $21.00/30 sq. ft. | = | 0.70 |
| | Total labor price per sq. ft. | = | 4.25 |

# Summary – Cost of Formwork per SFCA

| | |
|---|---|
| Material | 0.59 |
| Labor - Fabrication | 0.71 |
| Labor - Erecting | 2.84 |
| Labor - Stripping | 0.70 |
| Ties & other Hardware (@ 20% of material) | 0.12 |
| Total | 4.96 |
| | |
| ❖ Shoring cost was not included here. See text for shoring cost analysis | |

# Reinforcing Steel

- Reinforcing Bars
- Welded Wire Mesh

# Cost of Reinforcing Bars

| | |
|---|---|
| Cost of preparation of shop drawings | Normally by Subcontractor |
| Cost of material | |
| Cost of handling, cutting and bending | |
| Cost of delivery to site | |
| Cost of accessories such as spacers, ties, chairs. | |
| Labor cost for placement | |
| Cost of preparation of shop drawings | |

# Reinforcing Steel – Installation Productivity

- Particular factors include
  - Size and length of reinforcing bars
  - Shape of bars
  - Complexity of concrete design
  - Amount of tolerance Allowed in spacing between bars
  - Amount of tying required

# Productivity – Reinforcing Bars

**1. STEEL BAR REINFORCING**

CREW: 1 Foreman
5 Rodmen

| ITEM | OPERATION | BAR SIZE | |
|---|---|---|---|
| | | #3 TO #6 | #7 AND OVER |
| 1. | Footings | 0.39—0.40 tons/hr. | 0.42–0.68 tons/hr. |
| 2. | Walls | 0.56—0.57 tons/hr. | 0.58–0.75 tons/hr. |
| 3. | Columns | 0.28—0.29 tons/hr. | 0.30–0.43 tons/hr. |
| 4. | Beams | 0.30—0.31 tons/hr. | 0.32–0.51 tons/hr. |
| 5. | Suspended Slabs | 0.54—0.55 tons/hr. | 0.56–0.75 tons/hr. |
| 6. | Slabs-On-Grade | 0.43—0.44 tons/hr. | 0.43–0.72 tons/hr. |

| ITEM | OPERATION | METRIC BAR SIZE | |
|---|---|---|---|
| | | 10 M TO 20 M | 25 M AND OVER |
| 1. | Footings | 0.35—0.36 tonnes/hr. | 0.38–0.62 tonnes/hr. |
| 2. | Walls | 0.51—0.52 tonnes/hr. | 0.53–0.68 tonnes/hr. |
| 3. | Columns | 0.25—0.26 tonnes/hr. | 0.27–0.39 tonnes/hr. |
| 4. | Beams | 0.27—0.28 tonnes/hr. | 0.29–0.46 tonnes/hr. |
| 5. | Suspended Slabs | 0.49—0.50 tonnes/hr. | 0.51–0.68 tonnes/hr. |
| 6. | Slabs-On-Grade | 0.39—0.40 tonnes/hr. | 0.39–0.65 tonnes/hr. |

# Cost of Wire Mesh

- Supply of material
- Delivery of Material
- Labor cost of placement

# Productivity – Wire Mesh

## 2. WIRE MESH REINFORCING

CREW: 1 Foreman
3 Laborers

| ITEM | SIZE OF MESH | OUTPUTS | |
|---|---|---|---|
| | | SMALL AREAS | LARGE AREAS |
| 1. | 6 × 6—10/10 | 800 sq. ft./hr. | 1480 sq. ft./hr. |
| 2. | 6 × 6—8/8 | 750 sq. ft./hr. | 1370 sq. ft./hr. |
| 3. | 6 × 6—6/6 | 680 sq. ft./hr. | 1260 sq. ft./hr. |
| 4. | 6 × 6—4/4 | 630 sq. ft./hr. | 1160 sq. ft./hr. |
| 5. | 4 × 4—10/10 | 720 sq. ft./hr. | 1330 sq. ft./hr. |
| 6. | 4 × 4—8/8 | 660 sq. ft./hr. | 1200 sq. ft./hr. |
| 7. | 4 × 4—6/6 | 600 sq. ft./hr. | 1100 sq. ft./hr. |
| 8. | 4 × 4—4/4 | 540 sq. ft./hr. | 1000 sq. ft./hr. |

| ITEM | SIZE OF MESH | OUTPUTS (METRIC UNITS) | |
|---|---|---|---|
| | | SMALL AREAS | LARGE AREAS |
| 1. | 150 × 150—W1.4 × W1.4 | 74 $m^2$/hr. | 137 $m^2$/hr. |
| 2. | 150 × 150—W2.1 × W2.1 | 70 $m^2$/hr. | 127 $m^2$/hr. |
| 3. | 150 × 150—W2.9 × W2.9 | 63 $m^2$/hr. | 117 $m^2$/hr. |
| 4. | 150 × 150—W4.0 × W4.0 | 59 $m^2$/hr. | 108 $m^2$/hr. |
| 5. | 100 × 100—W1.4 × W1.4 | 67 $m^2$/hr. | 124 $m^2$/hr. |
| 6. | 100 × 100—W2.1 × W2.1 | 61 $m^2$/hr. | 111 $m^2$/hr. |
| 7. | 100 × 100—W2.9 × W2.9 | 56 $m^2$/hr. | 102 $m^2$/hr. |
| 8. | 100 × 100—W4.0 × W4.0 | 50 $m^2$/hr. | 93 $m^2$/hr. |