Reinforced Concrete Beam Project

Herff College of Engineering
2026 Reinforced Concrete Competition

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Reinforced Concrete Beam Project

- The objective of this project is to develop the strongest reinforced concrete (RC) beam as measured by the ***cost-adjusted strength-to-weight ratio.***
- The strength-to-weight ratio (***SWR***) is:

$$SWR = \frac{Ultimate\ Load(lb.)}{Beam\ Weight(lb.)}$$

- The strength of the beam is the ultimate load recorded during testing.

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- A cost factor will be computed as follows:

If cost < \$2.25 then: $Cost\ Factor = 1$

If cost > \$2.25 then: $Cost\ Factor = \frac{\$2.25}{Cost}$

- Using your *Cost Factor*, the cost-adjusted $SWR_{Adjusted}$ is computed as:

$$SWR_{Adjusted} = SWR \times Cost\ Factor$$

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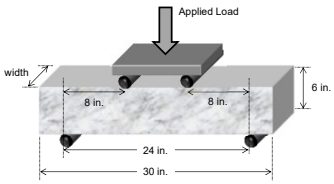
- The concrete beam ***must*** have a length of 30 in., a height of 6 in., and have a prismatic cross-section. The maximum width of the beam is 6 in.



- When designing reinforced concrete beam groups, admixtures, various types of reinforcement, multiple types of cement and aggregates, and non-rectangular cross-sections may be considered.

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The reinforced concrete beam problem poses several challenges to the student:

1. selection of the shape and size of the cross-section of the beam;
2. design of a concrete mix based on strength and workability;
3. design of the reinforcement (type of reinforcement, amount, and position in the beam), and
4. the prediction of the ***SWR*** of the beam.

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The reinforced concrete beam project schedule:

Date	Activity
February 24-26	Introduction; concrete beam #1
March 3-5	Break beam #1; develop concrete beam #2
March 17-19	Break beam #2; develop concrete beam #3
March 24-26	Break beam #3; develop concrete beam #4
March 31 - April 2	Break beam #4; develop final concrete beam
April 7-9	Break final concrete beam

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The cost of each beam will be estimated using the following data:

Material	Cost
Portland Type I cement	$150/ton
Coarse aggregate	$25/ton
Fine aggregate	$15/ton
Steel reinforcement	$1,000/ton
Admixtures - water reducer	$15/gal.
Admixture - silica fume	$500/ton
Fiber reinforcement	Market value (see Dr. Camp)

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The cost of steel may be estimated as follows:

$$Cost\ of\ steel = \frac{A_s L}{1{,}728\,\text{in.}^3/\text{ft.}^3}\left(490\,\frac{\text{lb.}}{\text{ft.}^3}\right)\left(\frac{\$1{,}000}{\text{ton}}\right)\left(\frac{\text{ton}}{2{,}000\,\text{lb.}}\right)$$

where $\boldsymbol{A_s}$ is the cross-sectional area of steel rebars, $\boldsymbol{L}$ is the length of the steel rebars, and 490 lb./ft.^{3} is the unit weight of steel.

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For example, if one #5 rebar is placed in the beam, the steel cost is estimated as follows:

Bar #	Diameter (in)	As (in^2)
2	0.125	0.0245
3	0.375	0.11
4	0.500	0.20
5	0.625	0.31
6	0.750	0.44
7	0.875	0.60
8	1.000	0.79
9	1.128	1.00
10	1.270	1.27
11	1.410	1.56

Cost of steel

$$= \frac{(0.31\,\text{in.}^2)(30\,\text{in.})}{1{,}728\,\text{in.}^3/\text{ft.}^3}\left(490\,\frac{\text{lb.}}{\text{ft.}^3}\right)\left(\frac{\$1{,}000}{\text{ton}}\right)\left(\frac{\text{ton}}{2{,}000\,\text{lb.}}\right)$$

$$= \$1.32$$

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Consider the following mix for a cubic yard of concrete developed using the ACI mix design procedure.

Component	Amount (lb.)
Water	304
Cement	708
Coarse aggregate	1,824
Fine aggregate	1,131

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The cost of the concrete required for a 4 in. by 6 in. by 30 in. beam is estimated as:

$$Cost\ of\ cement = \frac{4\,\text{in.}(6\,\text{in.})30\,\text{in.}}{1{,}728\,\text{in.}^3/\text{ft.}^3}\left(\frac{708\ lb.}{27\ ft.^3}\right)\left(\frac{\$150}{\text{ton}}\right)\left(\frac{\text{ton}}{2{,}000\,\text{lb.}}\right)$$

$$= \$0.82$$

$$Cost\ of\ coarse\ aggregate = \frac{4\,\text{in.}(6\,\text{in.})30\,\text{in.}}{1{,}728\,\text{in.}^3/\text{ft.}^3}\left(\frac{1{,}824\ lb.}{27\ ft.^3}\right)\left(\frac{\$25}{\text{ton}}\right)\left(\frac{\text{ton}}{2{,}000\,\text{lb.}}\right)$$

$$= \$0.35$$

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The cost of the concrete required for a 4 in. by 6 in. by 30 in. beam is estimated as:

$$Cost\ of\ fine\ aggregate = \frac{4\,\text{in.}(6\,\text{in.})30\,\text{in.}}{1{,}728\,\text{in.}^3/\text{ft.}^3}\left(\frac{1{,}131\ lb.}{27\ ft.^3}\right)\left(\frac{\$15}{\text{ton}}\right)\left(\frac{\text{ton}}{2{,}000\,\text{lb.}}\right)$$

$$= \$0.13$$

The cost of concrete is estimated as: $1.30

The cost of the reinforced concrete beam is estimated as: $2.62

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The cost adjustment for the reinforced concrete beam is :

If cost < \$2.25 then: $Cost\ Factor = 1$

If cost > \$2.25 then: $Cost\ Factor = \frac{\$2.25}{Cost}$

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For example, if the unadjusted ***SWR*** for a beam is 210 and the cost is \$2.62, then the cost-adjusted ***SWR*** is:

If cost > \$2.25 then: $Cost\ Factor = \frac{\$2.25}{Cost}$

$$SWR_{Adjusted} = 210 \times \frac{\$2.25}{\$2.62} = 180.3$$

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If the cost were \$2.05, then the cost-adjusted ***SWR*** is:

If cost < \$2.25 then: $Cost\ Factor = 1$

$$SWR_{Adjusted} = SWR \times Cost\ Factor$$

$$SWR_{Adjusted} = 210 \times 1 = 210$$

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Any questions?

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