Canoe Design Report

automatically generated by Canoe Design Program

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1 Canoe Design and Specification

The Canoe Design and Specification Report is as follow:

1.1 Canoe Scale Specification

Canoe Total Length: 193.5 Inch

1.1.1 Front Section Scale

Canoe Length	36.75 Inch
Canoe Width	25.5 Inch
Canoe Depth	12.75 Inch
Cross-Section Shape factor	10.0
Length-to-Width Shape factor	0.95
Length-to-Depth Shape factor	0.25

1.1.2 Middle Section Scale

Canoe Length	120.75 Inch
Canoe Width	25.5 Inch
Canoe Depth	12.75 Inch
Cross-Section Shape factor	10.0
Length-to-Width Shape factor	0.0
Length-to-Depth Shape factor	0.0

1.1.3 Back Section Scale

Canoe Length	36.75 Inch
Canoe Width	25.5 Inch
Canoe Depth	12.75 Inch
Cross-Section Shape factor	10.0
Length-to-Width Shape factor	0.25
Length-to-Depth Shape factor	0.25

1.1.4 Other Specs

Concrete Density	115.0 Cubic Feet/lb
Concrete Thickness	0.75 Inch
Crew Weight	600.0 lbs

1.2 Canoe Data Specification

Canoe Volume	47646.9344 Cubic Inch
Canoe Buoyancy	7628.8196 N
Canoe Weight	376.7327 lb
Canoe Flow Test Boolean	True
Canoe Submerge Test Boolean	True

1.3 Canoe Detailed Data

Canoe Hull Type	Three Body
Canoe Hull Property	Asymmetric
Canoe Hull subProperty	Asymmetric_Constant Hull
Canoe Surface Area	7614.1507 Square Inch
Canoe Volume_Styrofoam	10567.93 Cubic Inch
Canoe Volume_Concrete	5660.82 Cubic Inch
Canoe Total Weight	976.73 lb
Canoe Buoyancy_Submerge	2598.41 N
Canoe Capability	1716.4844 lb
Canoe Capability_Submerge	584.642 lb

1.3.1 Front Section Data

Canoe SurfaceArea	1097.9679 Square Inch
Canoe Volume (Thickness Included)	4937.33 Cubic Inch
Canoe Volumes (Thickness Excluded)	4284.3 Cubic Inch

1.3.2 Middle Section Data

Canoe SurfaceArea	5210.5958 Square Inch
Canoe Volume (Thickness Included)	35468.18 Cubic Inch
Canoe Volumes (Thickness Excluded)	31418.18 Cubic Inch

1.3.3 Back Section Data

Canoe SurfaceArea	1305.5869 Square Inch
Canoe Volume (Thickness Included)	7241.42 Cubic Inch
Canoe Volumes (Thickness Excluded)	6283.64 Cubic Inch

1.4 Canoe Detailed Data

The Mathematical representation of the Canoe is as follows:

$$CrossSection(x) = Depth \times (\frac{x}{Width})^{CrossSectionShapefactor} \tag{1}$$

$$width(x) = Width \times (\frac{x}{Length})^{LengthtoWidthShapefactor} \tag{2}$$

$$depth(x) = Depth \times (\frac{x}{Length})^{LengthtoDepthShapefactor} \tag{3}$$

The General Formula for Cross-Section is donated by (1)
The General Formula for Cross-Section's Width at Length x is donated by (2)
The General Formula for Cross-Section's Depth at Length x is donated by (3)

1.4.1 FrontSection Mathematical Representation

$$CrossSection(x) = 12.0 \times (\frac{x}{12.0})^{10.0} \tag{1a}$$

$$width(x) = 12.0 \times (\frac{x}{36.0})^{0.95} \tag{2a}$$

$$depth(x) = 12.0 \times (\frac{x}{36.0})^{0.25} \tag{3a}$$

1.4.2 MiddleSection Mathematical Representation

$$CrossSection(x) = 12.0 \times (\frac{x}{12.0})^{10.0} \tag{1b}$$

$$width(x) = 12.0 \times (\frac{x}{120.0})^{0.0} \tag{2b}$$

$$depth(x) = 12.0 \times (\frac{x}{120.0})^{0.0} \tag{3b}$$

1.4.3 BackSection Mathematical Representation

$$CrossSection(x) = 12.0 \times (\frac{x}{12.0})^{10.0} \tag{1c}$$

$$width(x) = 12.0 \times (\frac{x}{36.0})^{0.25} \tag{2c}$$

$$depth(x) = 12.0 \times (\frac{x}{36.0})^{0.25} \tag{3c}$$

2 Canoe Calculation Process

Canoe Design Program automize multiples process of Calculation, including:

- Volume of **Canoe**, **Concrete**, **Styrofoam**
- Surface Area
- Weight
- Buoyancy
- Capability

Calculation Method, Formula and Process are as follows:

2.1 Calculation Method

The Hull Design Team mainly applied Calculus in the calculation process. Including following concepst:

- Calculus
- Integration
- Differential Equation

2.1.1 Explanation

Integration of function is the process of finding the area under the curve of a function, which is donated by (1). And the Area of CrossSection is donated by:

$$
\begin{aligned}
&Define: A \equiv CrossSectionShapefactor \\
&Area = Width \times Depth - \int_0^{Width} (Depth \times (\frac{x}{Width})^A \mathrm{d}x \qquad (4)\\
&Area = Width \times Depth - \frac{Width \times Depth}{A+1} \\
&Area = \frac{A \times Width \times Depth}{A+1} \qquad (4a)
\end{aligned}
$$

Where a is the shape factor of the cross section.We know the Width and Depth is governed by Length as (2) and (3).Thus, the Length-Aspect Volumn Formula is the Area under the curve of CrossSection Area Function. Donated by:

$$
\begin{aligned}
&Define: B \equiv LengthtoWidthShapefactor \\
&Define: C \equiv LengthtoDepthShapefactor \\
&Volume = 2 \times \sum_{i=0}^{Length} \frac{A \times Width(i) \times Depth(i)}{A+1} \\
&Volume = 2 \times \frac{A}{A+1} \int_0^{Length} Width \times (\frac{x}{Length})^B \times Depth \times (\frac{x}{Length})^C \mathrm{d}x \qquad (5)
\end{aligned}
$$

2.2 Formula List

2.2.1 Front Section Volume Formula

$$ThicknessExclude: 4284.3 = 2 \times \frac{10.0}{10.0+1} \int_0^{36.0} 12.0 \times (\frac{x}{36.0})^{0.95} \times 12.0 \times (\frac{x}{36.0})^{0.25} \mathrm{d}x$$

$$ThicknessInclude: 4937.33 = 2 \times \frac{10.75}{10.75+1} \int_0^{36.75} 12.75 \times (\frac{x}{36.75})^{1.7} \times 12.75 \times (\frac{x}{36.75})^{1.0} \mathrm{d}x$$

2.2.2 Middle Section Volume Formula

$$ThicknessExclude: 31418.18 = 2 \times \frac{10.0}{10.0+1} \int_0^{120.0} 12.0 \times (\frac{x}{120.0})^{0.0} \times 12.0 \times (\frac{x}{120.0})^{0.0} \mathrm{d}x$$

$$ThicknessInclude: 35468.18 = 2 \times \frac{10.75}{10.75+1} \int_0^{120.0} 12.75 \times (\frac{x}{120.0})^{0.75} \times 12.75 \times (\frac{x}{120.0})^{0.75} \mathrm{d}x$$

2.2.3 Back Section Volume Formula

$$ThicknessExclude : 6283.64 = 2 \times \frac{10.0}{10.0+1} \int_0^{36.0} 12.0 \times (\frac{x}{36.0})^{0.25} \times 12.0 \times (\frac{x}{36.0})^{0.25} \mathrm{d}x$$

$$ThicknessInclude : 7241.42 = 2 \times \frac{10.75}{10.75+1} \int_0^{36.75} 12.75 \times (\frac{x}{36.75})^{1.0} \times 12.75 \times (\frac{x}{36.75})^{1.0} \mathrm{d}x$$

2.3 Other Calculation

Buoyancy is donated by: **AmiArchimedes' principle**

$$F_{buoyancy} = \rho_{liquid} \times Volume \times 0.160111447518 \times g \tag{6}$$

Weight is donated by:

$$Weight_{lbs} = (\frac{ConcreteVolume_{inch^2}}{1728}) \times Density_{feet^3} \tag{7}$$

Weight-bearing (Capability) is donated by:

$$Weight_{lbs} = (\frac{F_{buoyancy}}{g}) \times 2.205 \tag{8}$$

Predicate for Floating Test is donated by:

$$Result = \forall x \in Capability_{lbs}, \forall y \in TotalWeight_{lbs}(PassFloatingTest \implies x \geq y) \tag{9}$$

Predicate for Submerging Test is donated by:

$$Result = \forall x \in SubmergeCapability_{lbs}, \forall y \in Weight_{lbs}(PassSubmergingTest \implies x \geq y) \tag{10}$$

2.3.1 Calculation Detail

$$\begin{aligned}
7628.82_{buoyancy} &= \rho_{liquid} \times 47646.93 \times 0.160111447518 \times g \\
376.73_{lbs} &= (\frac{5660.82_{inch^2}}{1728}) \times 115.0_{feet^3} \\
1716.48_{lbs} &= (\frac{7628.82_{buoyancy}}{g}) \times 2.205 \\
True_{flow} &= \forall x \in 1716.48_{lbs}, \forall y \in 976.73_{lbs}(Passfloatingtest \implies x \geq y) \\
True_{submerge} &= \forall x \in 584.64_{lbs}, \forall y \in 376.73_{lbs}(Passsubmergingtest \implies x \geq y)
\end{aligned}$$