# 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

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