

# 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	120.0 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 lbs/cubic feet
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 Center of Mass	102.386 in
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:

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

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

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

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

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

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

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

### 1.4.2 MiddleSection Mathematical Representation

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

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

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

### 1.4.3 BackSection Mathematical Representation

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

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

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

## 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 concept:

- 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:

*Define :  $A \equiv CrossSectionShapefactor$*

$$Area = Width \times Depth - \int_0^{Width} (Depth \times (\frac{x}{Width})^A) dx \quad (4)$$

$$Area = Width \times Depth - \frac{Width \times Depth}{A + 1}$$

$$Area = \frac{A \times Width \times Depth}{A + 1} \quad (4a)$$

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:

*Define :  $B \equiv LengthtoWidthShapefactor$*

*Define :  $C \equiv LengthtoDepthShapefactor$*

$$Volume = 2 \times \sum_{i=0}^{Length} \frac{A \times Width(i) \times Depth(i)}{A + 1}$$

$$Volume = 2 \times \frac{A}{A + 1} \int_0^{Length} Width \times (\frac{x}{Length})^B \times Depth \times (\frac{x}{Length})^C dx \quad (5)$$

## 2.2 Formula List

### 2.2.1 Front Section Volume Formula

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

$$ThicknessInclude : 4937.33 = 2 \times \frac{10.0}{10.0 + 1} \int_0^{36.75} 12.75 \times (\frac{x}{36.75})^{0.95} \times 12.75 \times (\frac{x}{36.75})^{0.25} dx$$

### 2.2.2 Middle Section Volume Formula

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

$$ThicknessInclude : 35468.18 = 2 \times \frac{10.0}{10.0 + 1} \int_0^{120.0} 12.75 \times (\frac{x}{120.0})^{0.0} \times 12.0 \times (\frac{x}{120.0})^{0.0} dx$$

### 2.2.3 Back Section Volume Formula

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

$$ThicknessInclude : 7241.42 = 2 \times \frac{10.0}{10.0 + 1} \int_0^{36.75} 12.75 \times \left(\frac{x}{36.75}\right)^{0.25} \times 12.75 \times \left(\frac{x}{36.75}\right)^{0.25} dx$$

## 2.3 Other Calculation

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

$$F_{buoyancy} = \rho_{liquid} \times Volume \times 0.160111447518 \times g \quad (6)$$

**Weight** is donated by:

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

**Weight-bearing (Capability)** is donated by:

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

**Predicate** for Floating Test is donated by:

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

**Predicate** for Submerging Test is donated by:

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

### 2.3.1 Calculation Detail

$$7628.82_{buoyancy} = \rho_{liquid} \times 47646.93 \times 0.160111447518 \times g$$

$$376.73_{lbs} = \left( \frac{5660.82_{inch^2}}{1728} \right) \times 115.0_{feet^3}$$

$$1716.48_{lbs} = \left( \frac{7628.82_{buoyancy}}{g} \right) \times 2.205$$

$$True_{flow} = \forall x \in 1716.48_{lbs}, \forall y \in 976.73_{lbs} (Passfloatingtest \implies x \geq y)$$

$$True_{submerge} = \forall x \in 584.64_{lbs}, \forall y \in 376.73_{lbs} (Passsubmergingtest \implies x \geq y)$$