

STAPpp

1.0

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# Chapter 1

## Hierarchical Index

### 1.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

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## Chapter 2

# Class Index

### 2.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

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## Chapter 3

# File Index

### 3.1 File List

Here is a list of all files with brief descriptions:

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## Chapter 4

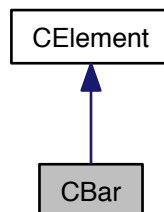
# Class Documentation

### 4.1 CBar Class Reference

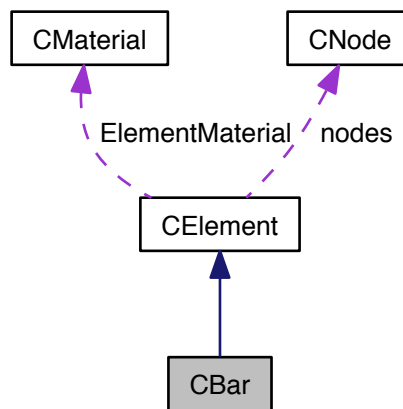
Bar element class.

```
#include <Bar.h>
```

Inheritance diagram for CBar:



Collaboration diagram for CBar:



## Public Member Functions

- [CBar \(\)](#)  
*Constructor.*
- [~CBar \(\)](#)  
*Destructor.*
- virtual bool [Read](#) (ifstream &Input, int Ele, [CMaterial](#) \*MaterialSets, [CNode](#) \*NodeList)  
*Read element data from stream Input.*
- virtual void [Write](#) (ofstream &OutputFile, int Ele)  
*Write element data to stream OutputFile.*
- virtual void [ElementStiffness](#) (double \*Matrix)  
*Calculate element stiffness matrix.*
- virtual void [ElementStress](#) (double \*stress, double \*Displacement)  
*Calculate element stress.*
- virtual unsigned int [SizeOfStiffnessMatrix](#) ()  
*Return the size of the element stiffness matrix (stored as an array column by column)*

## Additional Inherited Members

### 4.1.1 Detailed Description

Bar element class.

### 4.1.2 Constructor & Destructor Documentation

#### 4.1.2.1 CBar()

```
CBar::CBar ( )
```

Constructor.

#### 4.1.2.2 ~CBar()

```
CBar::~~CBar ( )
```

Desconstructor.

### 4.1.3 Member Function Documentation

#### 4.1.3.1 ElementStiffness()

```
void CBar::ElementStiffness (
    double * Matrix ) [virtual]
```

Calculate element stiffness matrix.

Implements [CElement](#).

#### 4.1.3.2 ElementStress()

```
void CBar::ElementStress (
    double * stress,
    double * Displacement ) [virtual]
```

Calculate element stress.

Implements [CElement](#).

#### 4.1.3.3 Read()

```
bool CBar::Read (
    ifstream & Input,
    int Ele,
    CMaterial * MaterialSets,
    CNode * NodeList ) [virtual]
```

Read element data from stream Input.

Implements [CElement](#).

#### 4.1.3.4 SizeOfStiffnessMatrix()

```
unsigned int CBar::SizeOfStiffnessMatrix ( ) [virtual]
```

Return the size of the element stiffness matrix (stored as an array column by column)

Implements [CElement](#).

#### 4.1.3.5 Write()

```
void CBar::Write (
    ofstream & OutputFile,
    int Ele ) [virtual]
```

Write element data to stream *OutputFile*.

Implements [CElement](#).

The documentation for this class was generated from the following files:

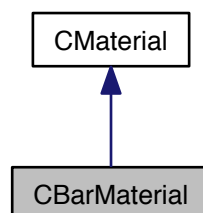
- [/Users/xzhang/GitHub/stapp/src/h/Bar.h](#)
- [/Users/xzhang/GitHub/stapp/src/cpp/Bar.cpp](#)

## 4.2 CBarMaterial Class Reference

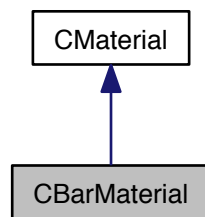
Material class for bar element.

```
#include <Material.h>
```

Inheritance diagram for CBarMaterial:



Collaboration diagram for CBarMaterial:



### Public Member Functions

- virtual bool [Read](#) (ifstream &Input, int mset)  
*Read material data from stream Input.*
- virtual void [Write](#) (ofstream &OutputFile, int mset)  
*Write material data to Stream OutputFile.*

### Public Attributes

- double [Area](#)  
*Sectional area of a bar element.*

#### 4.2.1 Detailed Description

Material class for bar element.

#### 4.2.2 Member Function Documentation

##### 4.2.2.1 Read()

```
bool CBarMaterial::Read (  
    ifstream & Input,  
    int mset ) [virtual]
```

Read material data from stream Input.

Implements [CMaterial](#).

#### 4.2.2.2 Write()

```
void CBarMaterial::Write (
    ofstream & OutputFile,
    int mset ) [virtual]
```

Write material data to Stream *OutputFile*.

Implements [CMaterial](#).

### 4.2.3 Member Data Documentation

#### 4.2.3.1 Area

```
double CBarMaterial::Area
```

Sectional area of a bar element.

The documentation for this class was generated from the following files:

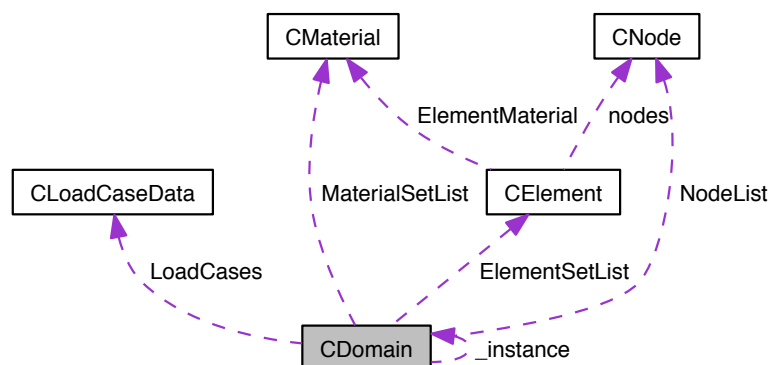
- [/Users/xzhang/GitHub/stapp/src/h/Material.h](#)
- [/Users/xzhang/GitHub/stapp/src/cpp/Material.cpp](#)

## 4.3 CDomain Class Reference

Domain class : Define the problem domain.

```
#include <Domain.h>
```

Collaboration diagram for CDomain:



## Public Member Functions

- [CDomain](#) ()  
*Constructor.*
- [~CDomain](#) ()  
*Desconstructor.*
- bool [ReadData](#) (string FileName, string OutFile)  
*Read domain data from the input data file.*
- bool [ReadNodalPoints](#) ()  
*Read nodal point data.*
- bool [ReadLoadCases](#) ()  
*Read load case data.*
- bool [ReadElements](#) ()  
*Read element data.*
- bool [ReadBarElementData](#) (int EleGrp)  
*Read bar element data from the input data file.*
- void [CalculateEquationNumber](#) ()  
*Calculate global equation numbers corresponding to every degree of freedom of each node.*
- void [CalculateColumnHeights](#) ()  
*Calculate column heights.*
- void [CalculateDiagnoalAddress](#) ()  
*Calculate address of diagonal elements in banded matrix.*
- void [AllocateMatrices](#) ()  
*Allocate storage for matrices.*
- void [AssembleStiffnessMatrix](#) ()  
*Assemble the banded gloabl stiffness matrix.*
- bool [AssembleForce](#) (unsigned int LoadCase)  
*Assemble the global nodal force vector for load case LoadCase.*
- int [GetMODEX](#) ()  
*Return solution mode.*
- string [GetTitle](#) ()  
*Return the title of problem.*
- unsigned int [GetNEQ](#) ()  
*Return the total number of equations.*
- unsigned int [GetNUMNP](#) ()  
*Return the total number of nodal points.*
- unsigned int [GetNWK](#) ()  
*Return the number of banded global stiffness matrix elements.*
- unsigned int [GetMK](#) ()  
*Return the maximum half bandwith.*
- [CNode](#) \* [GetNodeList](#) ()  
*Return the node list.*
- unsigned int \* [GetNUME](#) ()  
*Return the number of elements in each element group.*
- unsigned int [GetNUMEG](#) ()  
*Return total number of element groups.*
- unsigned int \* [GetElementTypes](#) ()  
*Element type of each group.*
- [CElement](#) \*\* [GetElementSetList](#) ()  
*Return element Set List.*
- unsigned int \* [GetNUMMAT](#) ()

- Return number of different sets of material/section properties in each element group.*

  - `CMaterial ** GetMaterialSetList ()`

*Return material set list.*
- `double * GetForce ()`

*Return pointer to the global nodal force vector.*
- `double * GetDisplacement ()`

*Return pointer to the global nodal displacement vector.*
- `unsigned int GetNLCASE ()`

*Return the total number of load cases.*
- `unsigned int * GetNLOAD ()`

*Return the number of concentrated loads applied in each load case.*
- `CLoadCaseData * GetLoadCases ()`

*Return the list of load cases.*
- `unsigned int * GetColumnHeights ()`

*Return column heights.*
- `double * GetStiffnessMatrix ()`

*Return pointer to the banded stiffness matrix.*
- `unsigned int * GetDiagonalAddress ()`

*Return pointer to the array storing the address of diagonal elements.*

## Static Public Member Functions

- `static CDomain * Instance ()`

*Return pointer to the instance of the Domain class.*

## Private Attributes

- `ifstream Input`

*Input file stream for reading data from input data file.*
- `char Title [256]`

*Heading information for use in labeling the output.*
- `int MODEX`

*Solution MODEX.*
- `unsigned int NUMNP`

*Total number of nodal points.*
- `CNode * NodeList`

*List of all nodes in the domain.*
- `unsigned int NUMEG`

*Total number of element groups.*
- `unsigned int * ElementTypes`

*Element type of each group.*
- `unsigned int * NUME`

*Number of elements in each element group.*
- `CElement ** ElementSetList`

*Element Set List.*
- `unsigned int * NUMMAT`

*Number of different sets of material/section properties in each element group.*
- `CMaterial ** MaterialSetList`

*Material set list.*



- unsigned int [NLCASE](#)  
*Number of load cases.*
- [CLoadCaseData](#) \* [LoadCases](#)  
*List of all load cases.*
- unsigned int \* [NLOAD](#)  
*Number of concentrated loads applied in each load case.*
- unsigned int [NEQ](#)  
*Total number of equations in the system.*
- unsigned int [NWK](#)  
*Number of elements in banded global stiffness matrix.*
- unsigned int [MK](#)  
*Maximum half bandwidth.*
- double \* [StiffnessMatrix](#)  
*Banded stiffness matrix.*
- unsigned int \* [ColumnHeights](#)  
*Column heights.*
- unsigned int \* [DiagonalAddress](#)  
*Address of diagonal elements in banded stiffness matrix.*
- double \* [Force](#)  
*Global nodal force/displacement vector.*

### Static Private Attributes

- static [CDomain](#) \* [\\_instance](#) = NULL  
*The instance of the Domain class.*

#### 4.3.1 Detailed Description

Domain class : Define the problem domain.

Only a single instance of Domain class can be created

#### 4.3.2 Constructor & Destructor Documentation

##### 4.3.2.1 CDomain()

```
CDomain::CDomain ( )
```

Constructor.

#### 4.3.2.2 ~CDomain()

```
CDomain::~~CDomain ( )
```

Destructor.

### 4.3.3 Member Function Documentation

#### 4.3.3.1 AllocateMatrices()

```
void CDomain::AllocateMatrices ( )
```

Allocate storage for matrices.

Allocate Force, ColumnHeights, DiagonalAddress and StiffnessMatrix and calculate the column heights and address of diagonal elements

#### 4.3.3.2 AssembleForce()

```
bool CDomain::AssembleForce (
    unsigned int LoadCase )
```

Assemble the global nodal force vector for load case LoadCase.

#### 4.3.3.3 AssembleStiffnessMatrix()

```
void CDomain::AssembleStiffnessMatrix ( )
```

Assemble the banded global stiffness matrix.

#### 4.3.3.4 CalculateColumnHeights()

```
void CDomain::CalculateColumnHeights ( )
```

Calculate column heights.

#### 4.3.3.5 CalculateDiagnoalAddress()

```
void CDomain::CalculateDiagnoalAddress ( )
```

Calculate address of diagonal elements in banded matrix.

#### 4.3.3.6 CalculateEquationNumber()

```
void CDomain::CalculateEquationNumber ( )
```

Calculate global equation numbers corresponding to every degree of freedom of each node.

#### 4.3.3.7 GetColumnHeights()

```
unsigned int* CDomain::GetColumnHeights ( ) [inline]
```

Return column heights.

#### 4.3.3.8 GetDiagonalAddress()

```
unsigned int* CDomain::GetDiagonalAddress ( ) [inline]
```

Return pointer to the array storing the address of diagonal elements.

#### 4.3.3.9 GetDisplacement()

```
double* CDomain::GetDisplacement ( ) [inline]
```

Return pointer to the global nodal displacement vector.

#### 4.3.3.10 GetElementSetList()

```
CElement** CDomain::GetElementSetList ( ) [inline]
```

Return element Set List.

#### 4.3.3.11 GetElementTypes()

```
unsigned int* CDomain::GetElementTypes ( ) [inline]
```

Element type of each group.

#### 4.3.3.12 GetForce()

```
double* CDomain::GetForce ( ) [inline]
```

Return pointer to the global nodal force vector.

#### 4.3.3.13 GetLoadCases()

```
CLoadCaseData* CDomain::GetLoadCases ( ) [inline]
```

Return the list of load cases.

#### 4.3.3.14 GetMaterialSetList()

```
CMaterial** CDomain::GetMaterialSetList ( ) [inline]
```

Return material set list.

#### 4.3.3.15 GetMK()

```
unsigned int CDomain::GetMK ( ) [inline]
```

Return the maximum half bandwidth.

#### 4.3.3.16 GetMODEX()

```
int CDomain::GetMODEX ( ) [inline]
```

Return solution mode.

#### 4.3.3.17 GetNEQ()

```
unsigned int CDomain::GetNEQ ( ) [inline]
```

Return the total number of equations.

#### 4.3.3.18 GetNLCASE()

```
unsigned int CDomain::GetNLCASE ( ) [inline]
```

Return the total number of load cases.

#### 4.3.3.19 GetNLOAD()

```
unsigned int* CDomain::GetNLOAD ( ) [inline]
```

Return the number of concentrated loads applied in each load case.

#### 4.3.3.20 GetNodeList()

```
CNode* CDomain::GetNodeList ( ) [inline]
```

Return the node list.

#### 4.3.3.21 GetNUME()

```
unsigned int* CDomain::GetNUME ( ) [inline]
```

Return the number of elements in each element group.

#### 4.3.3.22 GetNUMEG()

```
unsigned int CDomain::GetNUMEG ( ) [inline]
```

Return total number of element groups.

#### 4.3.3.23 GetNUMMAT()

```
unsigned int* CDomain::GetNUMMAT ( ) [inline]
```

Return number of different sets of material/section properties in each element group.

#### 4.3.3.24 GetNUMNP()

```
unsigned int CDomain::GetNUMNP ( ) [inline]
```

Return the total number of nodal points.

#### 4.3.3.25 GetNWK()

```
unsigned int CDomain::GetNWK ( ) [inline]
```

Return the number of banded global stiffness matrix elements.

#### 4.3.3.26 GetStiffnessMatrix()

```
double* CDomain::GetStiffnessMatrix ( ) [inline]
```

Return pointer to the banded stiffness matrix.

#### 4.3.3.27 GetTitle()

```
string CDomain::GetTitle ( ) [inline]
```

Return the title of problem.

#### 4.3.3.28 Instance()

```
CDomain * CDomain::Instance ( ) [static]
```

Return pointer to the instance of the Domain class.

#### 4.3.3.29 ReadBarElementData()

```
bool CDomain::ReadBarElementData (
    int EleGrp )
```

Read bar element data from the input data file.

#### 4.3.3.30 ReadData()

```
bool CDomain::ReadData (
    string FileName,
    string OutFile )
```

Read domain data from the input data file.

#### 4.3.3.31 ReadElements()

```
bool CDomain::ReadElements ( )
```

Read element data.

#### 4.3.3.32 ReadLoadCases()

```
bool CDomain::ReadLoadCases ( )
```

Read load case data.

#### 4.3.3.33 ReadNodalPoints()

```
bool CDomain::ReadNodalPoints ( )
```

Read nodal point data.

### 4.3.4 Member Data Documentation

#### 4.3.4.1 `_instance`

```
CDomain * CDomain::_instance = NULL [static], [private]
```

The instance of the Domain class.

#### 4.3.4.2 `ColumnHeights`

```
unsigned int* CDomain::ColumnHeights [private]
```

Column heights.

#### 4.3.4.3 `DiagonalAddress`

```
unsigned int* CDomain::DiagonalAddress [private]
```

Address of diagonal elements in banded stiffness matrix.

#### 4.3.4.4 `ElementSetList`

```
CElement** CDomain::ElementSetList [private]
```

Element Set List.

ElementSetList[i] - ith element set

ElementSetList[i][j] - jth element in ith set

#### 4.3.4.5 `ElementTypes`

```
unsigned int* CDomain::ElementTypes [private]
```

Element type of each group.

#### 4.3.4.6 `Force`

```
double* CDomain::Force [private]
```

Global nodal force/displacement vector.



#### 4.3.4.7 Input

```
ifstream CDomain::Input [private]
```

Input file stream for reading data from input data file.

#### 4.3.4.8 LoadCases

```
CLoadCaseData* CDomain::LoadCases [private]
```

List of all load cases.

#### 4.3.4.9 MaterialSetList

```
CMaterial** CDomain::MaterialSetList [private]
```

Material set list.

MaterialSetList[i] - ith material set

MaterialSetList[i][j] - jth material in ith set

#### 4.3.4.10 MK

```
unsigned int CDomain::MK [private]
```

Maximum half bandwidth.

#### 4.3.4.11 MODEX

```
int CDomain::MODEX [private]
```

Solution MODEX.

0 : Data check only; 1 : Execution

#### 4.3.4.12 NEQ

```
unsigned int CDomain::NEQ [private]
```

Total number of equations in the system.

#### 4.3.4.13 NLCASE

```
unsigned int CDomain::NLCASE [private]
```

Number of load cases.

#### 4.3.4.14 NLOAD

```
unsigned int* CDomain::NLOAD [private]
```

Number of concentrated loads applied in each load case.

#### 4.3.4.15 NodeList

```
CNode* CDomain::NodeList [private]
```

List of all nodes in the domain.

#### 4.3.4.16 NUME

```
unsigned int* CDomain::NUME [private]
```

Number of elements in each element group.

#### 4.3.4.17 NUMEG

```
unsigned int CDomain::NUMEG [private]
```

Total number of element groups.

An element group consists of a convenient collection of elements with same type

#### 4.3.4.18 NUMMAT

```
unsigned int* CDomain::NUMMAT [private]
```

Number of different sets of material/section properties in each element group.

#### 4.3.4.19 NUMNP

```
unsigned int CDomain::NUMNP [private]
```

Total number of nodal points.

#### 4.3.4.20 NWK

```
unsigned int CDomain::NWK [private]
```

Number of elements in banded global stiffness matrix.

#### 4.3.4.21 StiffnessMatrix

```
double* CDomain::StiffnessMatrix [private]
```

Banded stiffness matrix.

A one-dimensional array storing only the elements below the skyline of the global stiffness matrix.

#### 4.3.4.22 Title

```
char CDomain::Title[256] [private]
```

Heading information for use in labeling the output.

The documentation for this class was generated from the following files:

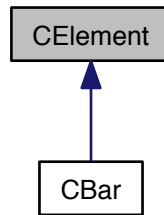
- [/Users/xzhang/GitHub/stapp/src/h/Domain.h](#)
- [/Users/xzhang/GitHub/stapp/src/cpp/Domain.cpp](#)

## 4.4 CElement Class Reference

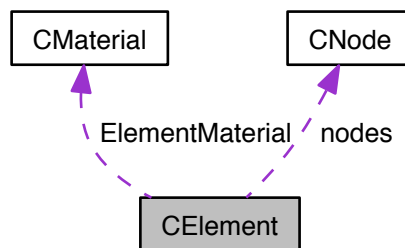
Element base class.

```
#include <Element.h>
```

Inheritance diagram for CElement:



Collaboration diagram for CElement:



### Public Member Functions

- [CElement](#) ()  
*Constructor.*
- virtual bool [Read](#) (ifstream &Input, int Ele, [CMaterial](#) \*MaterialSets, [CNode](#) \*NodeList)=0  
*Read element data from stream Input.*
- virtual void [Write](#) (ofstream &OutputFile, int Ele)=0  
*Write element data to stream OutputFile.*
- void [CalculateColumnHeight](#) (unsigned int \*ColumnHeight)  
*Calculate the column height, used with the skyline storage scheme.*
- void [assembly](#) (double \*Matrix, double \*StiffnessMatrix, unsigned int \*DiagonalAddress)  
*Assemble the element stiffness matrix to the global stiffness matrix.*

- virtual void [ElementStiffness](#) (double \*stiffness)=0  
*Calculate element stiffness matrix (Upper triangular matrix, stored as an array column by column)*
- virtual void [ElementStress](#) (double \*stress, double \*Displacement)=0  
*Calculate element stress.*
- [CNode](#) \*\* [GetNodes](#) ()  
*Return nodes of the element.*
- [CMaterial](#) \* [GetElementMaterial](#) ()  
*Return material of the element.*
- virtual unsigned int [SizeOfStiffnessMatrix](#) ()=0  
*Return the size of the element stiffness matrix (stored as an array column by column)*

### Public Attributes

- friend [CDomain](#)

### Protected Attributes

- int [NEN](#)  
*Number of nodes per element.*
- [CNode](#) \*\* [nodes](#)  
*Nodes of the element.*
- [CMaterial](#) \* [ElementMaterial](#)  
*Material of the element.*

#### 4.4.1 Detailed Description

Element base class.

All type of element classes should be derived from this base class

#### 4.4.2 Constructor & Destructor Documentation

##### 4.4.2.1 CElement()

```
CElement::CElement ( ) [inline]
```

Constructor.

#### 4.4.3 Member Function Documentation

#### 4.4.3.1 assembly()

```
void CElement::assembly (
    double * Matrix,
    double * StiffnessMatrix,
    unsigned int * DiagonalAddress )
```

Assemble the element stiffness matrix to the global stiffness matrix.

#### 4.4.3.2 CalculateColumnHeight()

```
void CElement::CalculateColumnHeight (
    unsigned int * ColumnHeight )
```

Calculate the column height, used with the skyline storage scheme.

#### 4.4.3.3 ElementStiffness()

```
virtual void CElement::ElementStiffness (
    double * stiffness ) [pure virtual]
```

Calculate element stiffness matrix (Upper triangular matrix, stored as an array column by column)

Implemented in [CBar](#).

#### 4.4.3.4 ElementStress()

```
virtual void CElement::ElementStress (
    double * stress,
    double * Displacement ) [pure virtual]
```

Calculate element stress.

Implemented in [CBar](#).

#### 4.4.3.5 GetElementMaterial()

```
CMaterial* CElement::GetElementMaterial ( ) [inline]
```

Return material of the element.

#### 4.4.3.6 GetNodes()

```
CNode** CElement::GetNodes ( ) [inline]
```

Return nodes of the element.

#### 4.4.3.7 Read()

```
virtual bool CElement::Read (
    ifstream & Input,
    int Ele,
    CMaterial * MaterialSets,
    CNode * NodeList ) [pure virtual]
```

Read element data from stream Input.

Implemented in [CBar](#).

#### 4.4.3.8 SizeOfStiffnessMatrix()

```
virtual unsigned int CElement::SizeOfStiffnessMatrix ( ) [pure virtual]
```

Return the size of the element stiffness matrix (stored as an array column by column)

Implemented in [CBar](#).

#### 4.4.3.9 Write()

```
virtual void CElement::Write (
    ofstream & OutputFile,
    int Ele ) [pure virtual]
```

Write element data to stream OutputFile.

Implemented in [CBar](#).

### 4.4.4 Member Data Documentation

#### 4.4.4.1 CDomain

```
friend CElement::CDomain
```

#### 4.4.4.2 ElementMaterial

```
CMaterial* CElement::ElementMaterial [protected]
```

Material of the element.

Pointer to an element of MaterialSetList[[]]

#### 4.4.4.3 NEN

```
int CElement::NEN [protected]
```

Number of nodes per element.

#### 4.4.4.4 nodes

```
CNode** CElement::nodes [protected]
```

Nodes of the element.

The documentation for this class was generated from the following files:

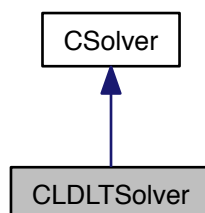
- /Users/xzhang/GitHub/stappp/src/h/[Element.h](#)
- /Users/xzhang/GitHub/stappp/src/cpp/[Element.cpp](#)

## 4.5 CLDLTSolver Class Reference

LDLT solver: A in core solver using skyline storage and column reduction scheme.

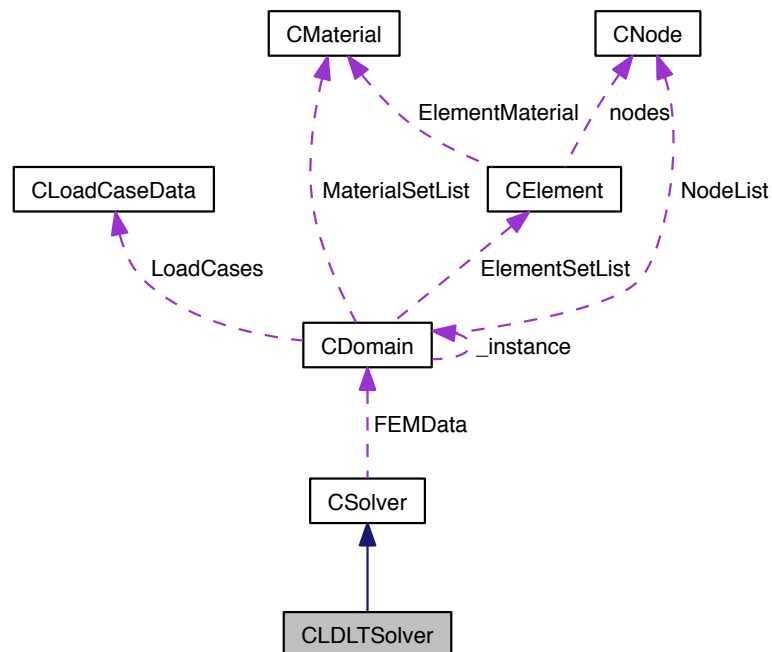
```
#include <Solver.h>
```

Inheritance diagram for CLDLTSolver:





Collaboration diagram for CLDLTSolver:



## Public Member Functions

- [CLDLTSolver](#) ([CDomain](#) \*[FEMData](#))  
*Constructor.*
- void [LDLT](#) ()  
*Perform  $L * D * L(T)$  factorization of the stiffness matrix.*
- void [BackSubstitution](#) ()  
*Reduce right-hand-side load vector and back substitute.*
- virtual void [Solve](#) ()  
*Solve the equilibrium equations.*

## Additional Inherited Members

### 4.5.1 Detailed Description

LDLT solver: A in core solver using skyline storage and column reduction scheme.

### 4.5.2 Constructor & Destructor Documentation

#### 4.5.2.1 CLDLTSolver()

```
CLDLTSolver::CLDLTSolver (
    CDomain * FEMData ) [inline]
```

Constructor.

### 4.5.3 Member Function Documentation

#### 4.5.3.1 BackSubstitution()

```
void CLDLTSolver::BackSubstitution ( )
```

Reduce right-hand-side load vector and back substitute.

#### 4.5.3.2 LDLT()

```
void CLDLTSolver::LDLT ( )
```

Perform  $L \cdot D \cdot L^T$  factorization of the stiffness matrix.

#### 4.5.3.3 Solve()

```
void CLDLTSolver::Solve ( ) [virtual]
```

Solve the equilibrium equations.

Implements [CSolver](#).

The documentation for this class was generated from the following files:

- [/Users/xzhang/GitHub/stappp/src/h/Solver.h](#)
- [/Users/xzhang/GitHub/stappp/src/cpp/Solver.cpp](#)

## 4.6 CLoadCaseData Class Reference

Class LoadData is used to store load data.

```
#include <LoadCaseData.h>
```

## Public Member Functions

- [CLoadCaseData](#) ()
- [~CLoadCaseData](#) ()
- void [Allocate](#) (int num)  
*Set nloads, and new array node, dof and load.*
- bool [Read](#) (ifstream &Input, int lcase)  
*Read load case data from stream Input.*
- void [Write](#) (ofstream &OutputFile, int lcase)  
*Write load case data to stream OutputFile.*

## Public Attributes

- unsigned int [nloads](#)  
*Number of concentrated loads in this load case.*
- unsigned int \* [node](#)  
*Node number to which this load is applied.*
- unsigned int \* [dof](#)  
*Degree of freedom number for this load component.*
- double \* [load](#)  
*Magnitude of load.*

### 4.6.1 Detailed Description

Class LoadData is used to store load data.

### 4.6.2 Constructor & Destructor Documentation

#### 4.6.2.1 CLoadCaseData()

```
CLoadCaseData::CLoadCaseData ( ) [inline]
```

#### 4.6.2.2 ~CLoadCaseData()

```
CLoadCaseData::~~CLoadCaseData ( )
```

### 4.6.3 Member Function Documentation

#### 4.6.3.1 Allocate()

```
void CLoadCaseData::Allocate (
    int num )
```

Set nloads, and new array node, dof and load.

#### 4.6.3.2 Read()

```
bool CLoadCaseData::Read (
    ifstream & Input,
    int lcase )
```

Read load case data from stream Input.

#### 4.6.3.3 Write()

```
void CLoadCaseData::Write (
    ofstream & OutputFile,
    int lcase )
```

Write load case data to stream OutputFile.

### 4.6.4 Member Data Documentation

#### 4.6.4.1 dof

```
unsigned int* CLoadCaseData::dof
```

Degree of freedom number for this load component.

#### 4.6.4.2 load

```
double* CLoadCaseData::load
```

Magnitude of load.

#### 4.6.4.3 nloads

```
unsigned int CLoadCaseData::nloads
```

Number of concentrated loads in this load case.

#### 4.6.4.4 node

```
unsigned int* CLoadCaseData::node
```

Node number to which this load is applied.

The documentation for this class was generated from the following files:

- [/Users/xzhang/GitHub/stapp/src/h/LoadCaseData.h](#)
- [/Users/xzhang/GitHub/stapp/src/cpp/LoadCaseData.cpp](#)

## 4.7 Clock Class Reference

[Clock](#) class for timing.

```
#include <Clock.h>
```

### Public Member Functions

- [Clock](#) ()  
*Constructor.*
- void [Start](#) ()  
*Start the clock.*
- void [Stop](#) ()  
*Stop the clock.*
- void [Resume](#) ()  
*Resume the stoped clock.*
- void [Clear](#) ()  
*Clear the clock.*
- double [ElapsedTime](#) ()  
*Return the elapsed time since the clock started.*

### Private Attributes

- clock\_t [t0\\_](#)
- clock\_t [t1\\_](#)
- double [ct\\_](#)
- bool [st0\\_](#)  
*Flag for Start method.*
- bool [st1\\_](#)  
*Flag for Stop method.*

### 4.7.1 Detailed Description

[Clock](#) class for timing.

### 4.7.2 Constructor & Destructor Documentation

#### 4.7.2.1 Clock()

```
Clock::Clock ( )
```

Constructor.

### 4.7.3 Member Function Documentation

#### 4.7.3.1 Clear()

```
void Clock::Clear ( )
```

Clear the clock.

#### 4.7.3.2 ElapsedTime()

```
double Clock::ElapsedTime ( )
```

Return the elapsed time since the clock started.

#### 4.7.3.3 Resume()

```
void Clock::Resume ( )
```

Resume the stoped clock.

#### 4.7.3.4 Start()

```
void Clock::Start ( )
```

Start the clock.

#### 4.7.3.5 Stop()

```
void Clock::Stop ( )
```

Stop the clock.

### 4.7.4 Member Data Documentation

#### 4.7.4.1 ct\_

```
double Clock::ct_ [private]
```

#### 4.7.4.2 st0\_

```
bool Clock::st0_ [private]
```

Flag for Start method.

#### 4.7.4.3 st1\_

```
bool Clock::st1_ [private]
```

Flag for Stop method.

#### 4.7.4.4 t0\_

```
clock_t Clock::t0_ [private]
```

#### 4.7.4.5 t1\_

```
clock_t Clock::t1_ [private]
```

The documentation for this class was generated from the following files:

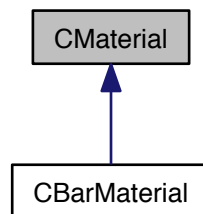
- /Users/xzhang/GitHub/stapp/src/h/[Clock.h](#)
- /Users/xzhang/GitHub/stapp/src/cpp/[Clock.cpp](#)

## 4.8 CMaterial Class Reference

Material base class which only define one data member.

```
#include <Material.h>
```

Inheritance diagram for CMaterial:



### Public Member Functions

- virtual bool [Read](#) (ifstream &Input, int mset)=0  
*Read material data from stream Input.*
- virtual void [Write](#) (ofstream &OutputFile, int mset)=0  
*Write material data to Stream OutputFile.*

### Public Attributes

- unsigned int [nset](#)  
*Number of set.*
- double [E](#)  
*Young's modulus.*

#### 4.8.1 Detailed Description

Material base class which only define one data member.

All type of material classes should be derived from this base class



## 4.8.2 Member Function Documentation

### 4.8.2.1 Read()

```
virtual bool CMaterial::Read (  
    ifstream & Input,  
    int mset ) [pure virtual]
```

Read material data from stream *Input*.

Implemented in [CBarMaterial](#).

### 4.8.2.2 Write()

```
virtual void CMaterial::Write (  
    ofstream & OutputFile,  
    int mset ) [pure virtual]
```

Write material data to Stream *OutputFile*.

Implemented in [CBarMaterial](#).

## 4.8.3 Member Data Documentation

### 4.8.3.1 E

```
double CMaterial::E
```

Young's modulus.

### 4.8.3.2 nset

```
unsigned int CMaterial::nset
```

Number of set.

The documentation for this class was generated from the following file:

- [/Users/xzhang/GitHub/stappp/src/h/Material.h](#)

## 4.9 CNode Class Reference

Node class.

```
#include <Node.h>
```

### Public Member Functions

- [CNode](#) (double X=0, double Y=0, double Z=0)  
*Constructor.*
- bool [Read](#) (ifstream &Input, int np)  
*Read nodal point data from stream Input.*
- void [Write](#) (ofstream &OutputFile, int np)  
*Output nodal point data to stream OutputFile.*
- void [WriteEquationNo](#) (ofstream &OutputFile, int np)  
*Output equation numbers of nodal point to stream OutputFile.*
- void [WriteNodalDisplacement](#) (ofstream &OutputFile, int np, double \*Displacement)  
*Write nodal displacement.*

### Public Attributes

- unsigned int [NodeNumber](#)  
*Node numer.*
- double [XYZ](#) [[NDF](#)]  
*x, y and z coordinates of the node*
- int [bcode](#) [[NDF](#)]  
*Boundary code of each degree of freedom of the node.*

### Static Public Attributes

- static const unsigned int [NDF](#) = 3  
*Maximum number of degrees of freedom per node.*

#### 4.9.1 Detailed Description

Node class.

#### 4.9.2 Constructor & Destructor Documentation

##### 4.9.2.1 CNode()

```
CNode::CNode (
    double X = 0,
    double Y = 0,
    double Z = 0 )
```

Constructor.

### 4.9.3 Member Function Documentation

#### 4.9.3.1 Read()

```
bool CNode::Read (
    ifstream & Input,
    int np )
```

Read nodal point data from stream Input.

#### 4.9.3.2 Write()

```
void CNode::Write (
    ofstream & OutputFile,
    int np )
```

Output nodal point data to stream OutputFile.

#### 4.9.3.3 WriteEquationNo()

```
void CNode::WriteEquationNo (
    ofstream & OutputFile,
    int np )
```

Output equation numbers of nodal point to stream OutputFile.

#### 4.9.3.4 WriteNodalDisplacement()

```
void CNode::WriteNodalDisplacement (
    ofstream & OutputFile,
    int np,
    double * Displacement )
```

Write nodal displacement.

### 4.9.4 Member Data Documentation

#### 4.9.4.1 bcode

```
int CNode::bcode[NDF]
```

Boundary code of each degree of freedom of the node.

0: The corresponding degree of freedom is active (defined in the global system)

1: The corresponding degree of freedom is nonactive (not defined)

After call `Domain::CalculateEquationNumber()`, `bcode` stores the global equation number corresponding to each degree of freedom of the node

#### 4.9.4.2 NDF

```
const unsigned int CNode::NDF = 3 [static]
```

Maximum number of degrees of freedom per node.

For 3D bar and solid elements, `NDF = 3`. For 3D beam or shell elements, `NDF = 5` or `6`

#### 4.9.4.3 NodeNumber

```
unsigned int CNode::NodeNumber
```

Node number.

#### 4.9.4.4 XYZ

```
double CNode::XYZ[NDF]
```

x, y and z coordinates of the node

The documentation for this class was generated from the following files:

- [/Users/xzhang/GitHub/stapp/src/h/Node.h](#)
- [/Users/xzhang/GitHub/stapp/src/cpp/Node.cpp](#)

## 4.10 COutputter Class Reference

Outputter class is used to output results.

```
#include <Outputter.h>
```

Collaboration diagram for COutputter:



## Public Member Functions

- `ofstream * GetOutputFile ()`  
*Return pointer to the output file stream.*
- `void PrintTime (const struct tm *ptm, ostream &output)`  
*Output current time and date.*
- `void OutputHeading ()`  
*Output logo and heading.*
- `void OutputNodeInfo ()`  
*Output nodal point data.*
- `void OutputEquationNumber ()`  
*Output equation numbers.*
- `void OutputElementInfo ()`  
*Output element data.*
- `void PrintBarElementData (int EleGrp)`  
*Output bar element data.*
- `void OutputLoadInfo ()`  
*Output load data.*
- `void OutputNodalDisplacement (int Icase)`  
*Output displacement data.*
- `void OutputElementStress ()`  
*Output element stresses.*
- `void OutputTotalSystemData ()`  
*Print total system data.*

## Static Public Member Functions

- `static COutputter * Instance (string FileName=" ")`  
*Return the single instance of the class.*

## Protected Member Functions

- `COutputter (string FileName)`  
*Constructor.*

## Static Protected Attributes

- `static COutputter * _instance = NULL`  
*Designed as a single instance class.*

## Private Attributes

- `ofstream OutputFile`  
*File stream for output.*

### 4.10.1 Detailed Description

Outputter class is used to output results.

## 4.10.2 Constructor & Destructor Documentation

### 4.10.2.1 COutputter()

```
COutputter::COutputter (
    string FileName ) [protected]
```

Constructor.

## 4.10.3 Member Function Documentation

### 4.10.3.1 GetOutputFile()

```
ofstream* COutputter::GetOutputFile ( ) [inline]
```

Return pointer to the output file stream.

### 4.10.3.2 Instance()

```
COutputter * COutputter::Instance (
    string FileName = " " ) [static]
```

Return the single instance of the class.

### 4.10.3.3 OutputElementInfo()

```
void COutputter::OutputElementInfo ( )
```

Output element data.

### 4.10.3.4 OutputElementStress()

```
void COutputter::OutputElementStress ( )
```

Output element stresses.

#### 4.10.3.5 OutputEquationNumber()

```
void COutputter::OutputEquationNumber ( )
```

Output equation numbers.

#### 4.10.3.6 OutputHeading()

```
void COutputter::OutputHeading ( )
```

Output logo and heading.

#### 4.10.3.7 OutputLoadInfo()

```
void COutputter::OutputLoadInfo ( )
```

Output load data.

#### 4.10.3.8 OutputNodalDisplacement()

```
void COutputter::OutputNodalDisplacement (
    int lcase )
```

Output displacement data.

#### 4.10.3.9 OutputNodeInfo()

```
void COutputter::OutputNodeInfo ( )
```

Output nodal point data.

#### 4.10.3.10 OutputTotalSystemData()

```
void COutputter::OutputTotalSystemData ( )
```

Print total system data.

#### 4.10.3.11 PrintBarElementData()

```
void COutputter::PrintBarElementData (
    int EleGrp )
```

Output bar element data.

#### 4.10.3.12 PrintTime()

```
void COutputter::PrintTime (
    const struct tm * ptm,
    ostream & output )
```

Output current time and date.

### 4.10.4 Member Data Documentation

#### 4.10.4.1 \_instance

```
COutputter * COutputter::_instance = NULL [static], [protected]
```

Designed as a single instance class.

#### 4.10.4.2 OutputFile

```
ofstream COutputter::OutputFile [private]
```

File stream for output.

The documentation for this class was generated from the following files:

- [/Users/xzhang/GitHub/stappp/src/h/Outputter.h](#)
- [/Users/xzhang/GitHub/stappp/src/cpp/Outputter.cpp](#)

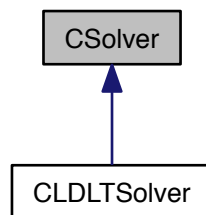


## 4.11 CSolver Class Reference

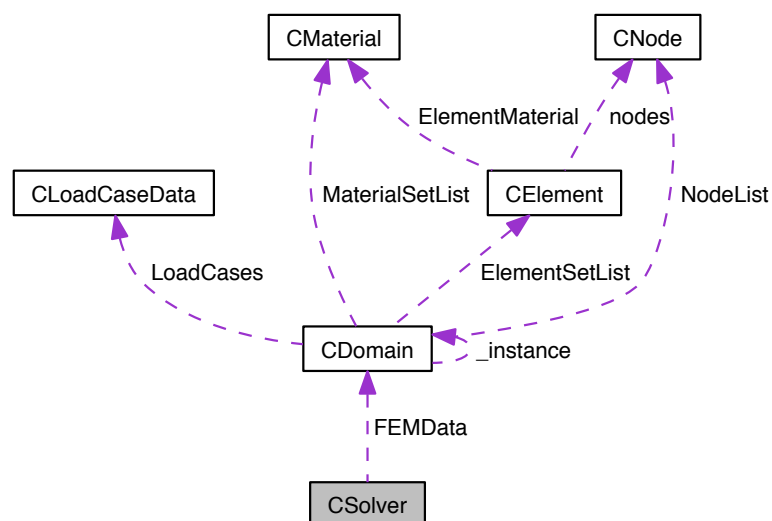
Base class for a solver.

```
#include <Solver.h>
```

Inheritance diagram for CSolver:



Collaboration diagram for CSolver:



### Public Member Functions

- [CSolver](#) ([CDomain](#) \*[FEMData](#))
- virtual void [Solve](#) ()=0

## Protected Attributes

- [CDomain](#) \* [FEMData](#)

### 4.11.1 Detailed Description

Base class for a solver.

### 4.11.2 Constructor & Destructor Documentation

#### 4.11.2.1 CSolver()

```
CSolver::CSolver (
    CDomain * FEMData )
```

### 4.11.3 Member Function Documentation

#### 4.11.3.1 Solve()

```
virtual void CSolver::Solve ( ) [pure virtual]
```

Implemented in [CLDLTSolver](#).

### 4.11.4 Member Data Documentation

#### 4.11.4.1 FEMData

```
CDomain* CSolver::FEMData [protected]
```

The documentation for this class was generated from the following files:

- /Users/xzhang/GitHub/stapp/src/h/[Solver.h](#)
- /Users/xzhang/GitHub/stapp/src/cpp/[Solver.cpp](#)

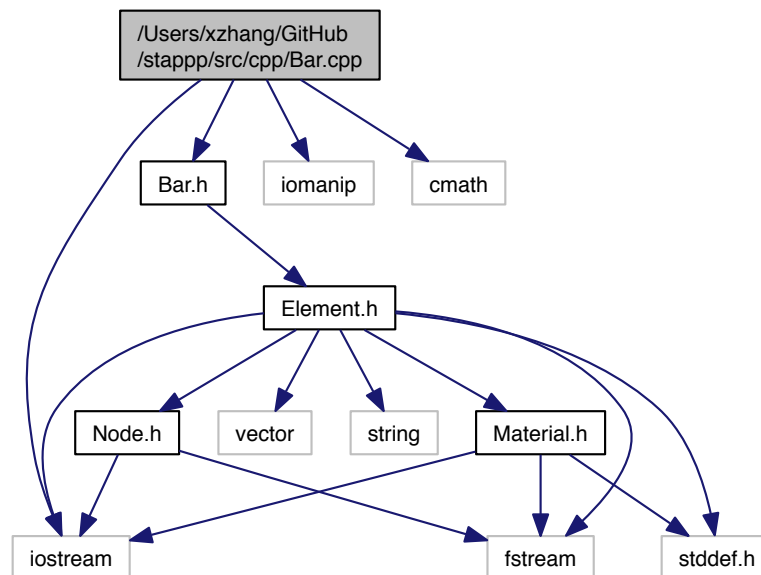
## Chapter 5

# File Documentation

### 5.1 /Users/xzhang/GitHub/stappp/src/cpp/Bar.cpp File Reference

```
#include "Bar.h"  
#include <iostream>  
#include <iomanip>  
#include <cmath>
```

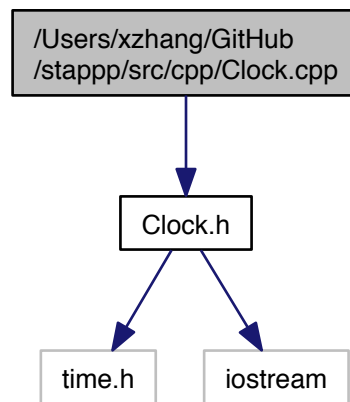
Include dependency graph for Bar.cpp:



### 5.2 /Users/xzhang/GitHub/stappp/src/cpp/Clock.cpp File Reference

```
#include "Clock.h"
```

Include dependency graph for Clock.cpp:



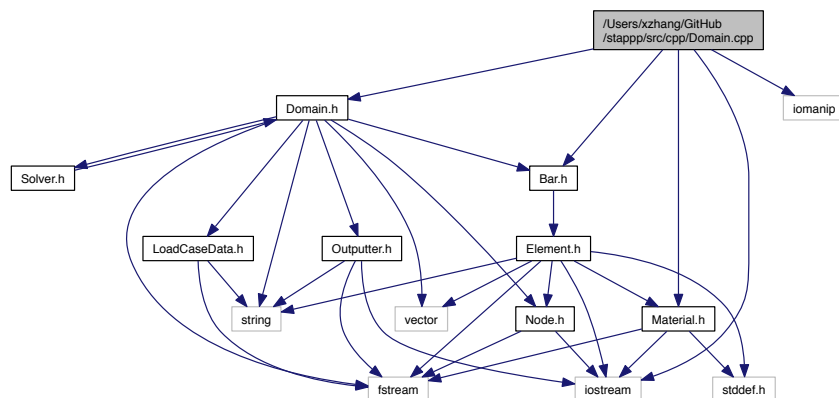
### 5.3 /Users/xzhang/GitHub/stapp/src/cpp/Domain.cpp File Reference

```

#include "Domain.h"
#include "Bar.h"
#include "Material.h"
#include <iomanip>
#include <iostream>

```

Include dependency graph for Domain.cpp:



## Functions

- `template<class type >`  
`void clear (type *a, int N)`  
*Clear an array.*

### 5.3.1 Function Documentation

#### 5.3.1.1 clear()

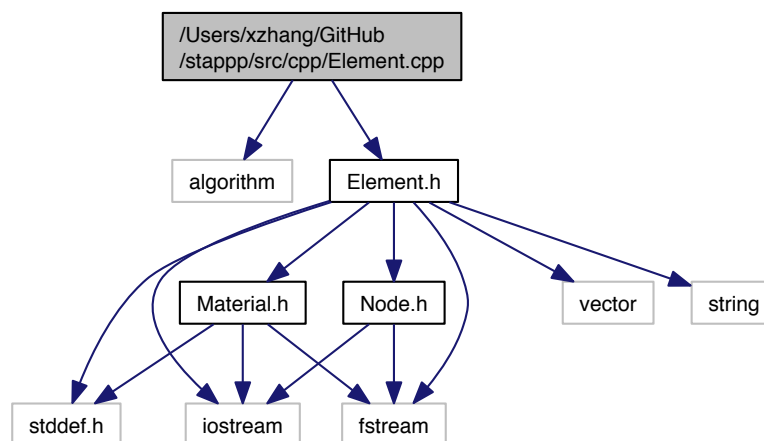
```
template<class type >
void clear (
    type * a,
    int N )
```

Clear an array.

## 5.4 /Users/xzhang/GitHub/stapp/src/cpp/Element.cpp File Reference

```
#include <algorithm>
#include "Element.h"
```

Include dependency graph for Element.cpp:

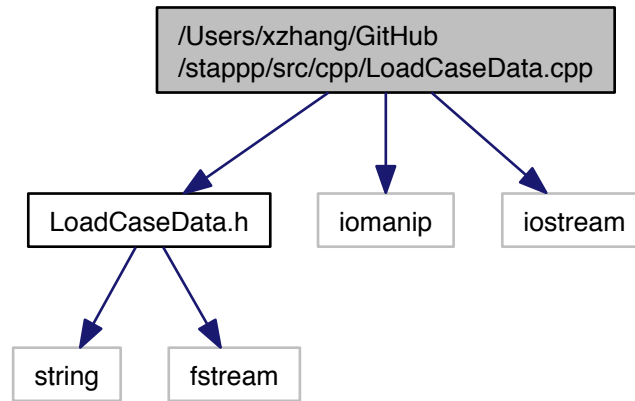


## 5.5 /Users/xzhang/GitHub/stapp/src/cpp/LoadCaseData.cpp File Reference

```
#include "LoadCaseData.h"
#include <iomanip>
```

```
#include <iostream>
```

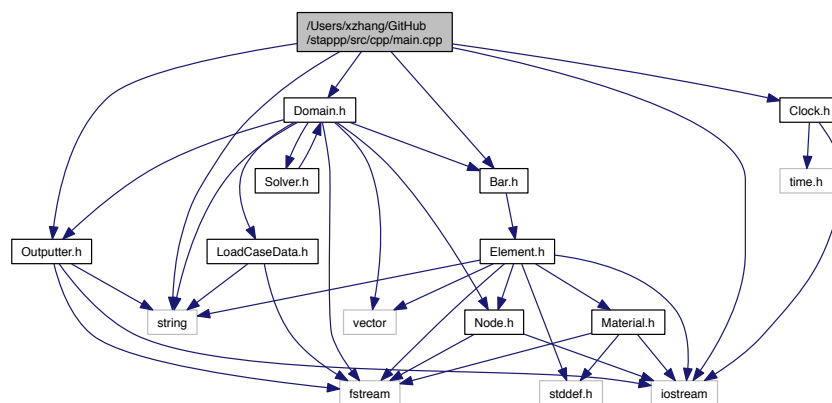
Include dependency graph for LoadCaseData.cpp:



## 5.6 /Users/xzhang/GitHub/stapp/src/cpp/main.cpp File Reference

```
#include <string>
#include <iostream>
#include "Domain.h"
#include "Bar.h"
#include "Outputter.h"
#include "Clock.h"
```

Include dependency graph for main.cpp:



## Functions

- int `main` (int argc, char \*argv[ ])

### 5.6.1 Function Documentation

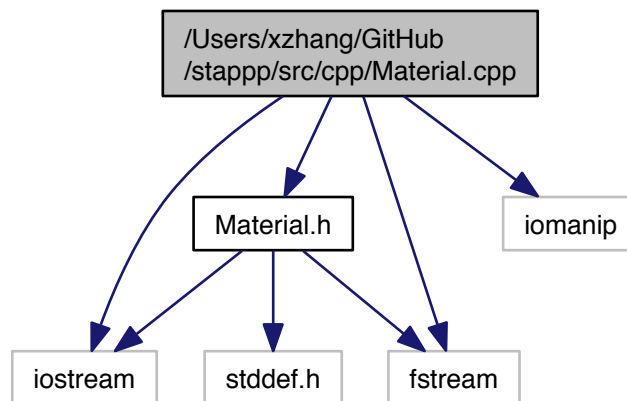
#### 5.6.1.1 main()

```
int main (  
    int argc,  
    char * argv[] )
```

## 5.7 /Users/xzhang/GitHub/stappp/src/cpp/Material.cpp File Reference

```
#include "Material.h"  
#include <iostream>  
#include <fstream>  
#include <iomanip>
```

Include dependency graph for Material.cpp:

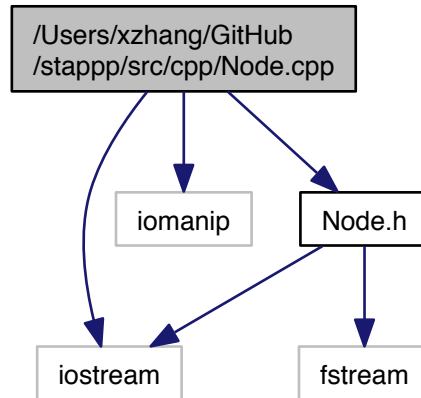


## 5.8 /Users/xzhang/GitHub/stappp/src/cpp/Node.cpp File Reference

```
#include <iostream>  
#include <iomanip>
```

```
#include "Node.h"
```

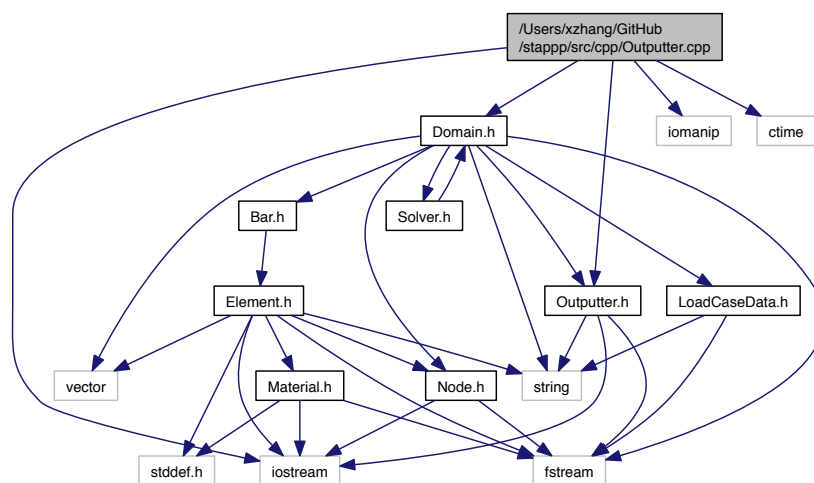
Include dependency graph for Node.cpp:



## 5.9 /Users/xzhang/GitHub/stapp/src/cpp/Outputter.cpp File Reference

```
#include "Domain.h"
#include "Outputter.h"
#include <iostream>
#include <iomanip>
#include <ctime>
```

Include dependency graph for Outputter.cpp:

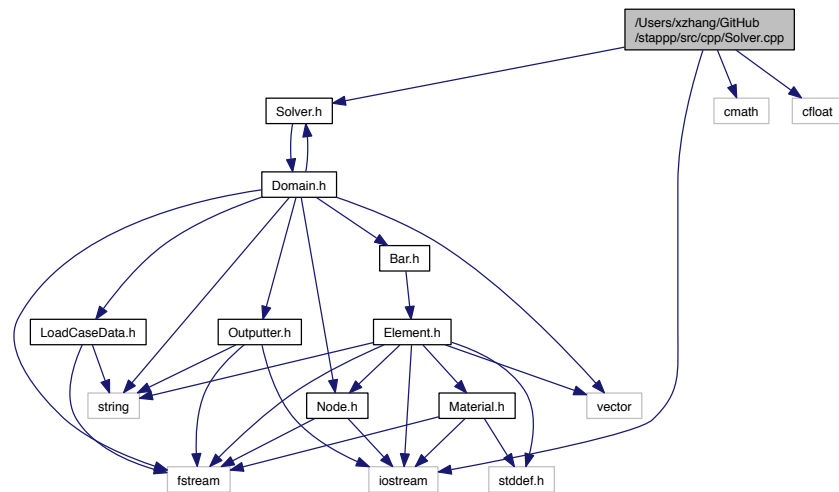




## 5.10 /Users/xzhang/GitHub/stapp/src/cpp/Solver.cpp File Reference

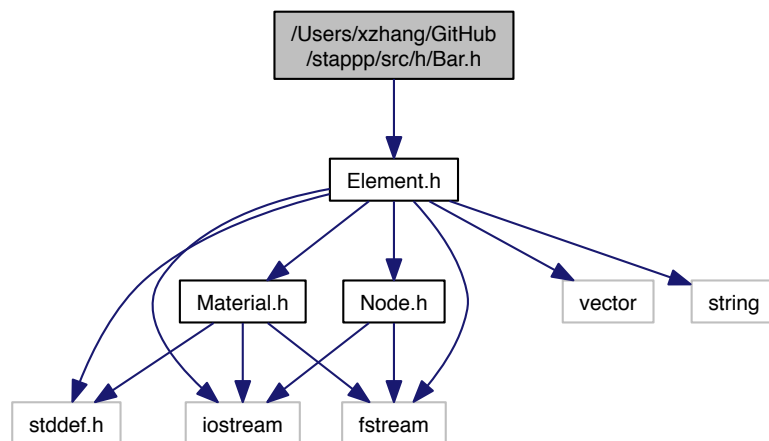
```
#include "Solver.h"
#include <cmath>
#include <cfloat>
#include <iostream>
```

Include dependency graph for Solver.cpp:

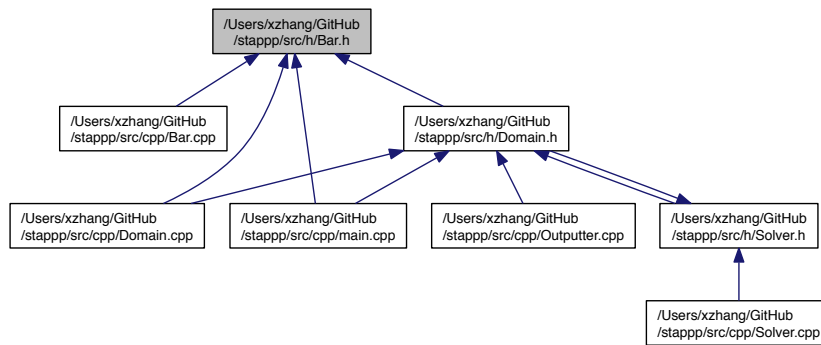


## 5.11 /Users/xzhang/GitHub/stapp/src/h/Bar.h File Reference

```
#include "Element.h"
Include dependency graph for Bar.h:
```



This graph shows which files directly or indirectly include this file:



## Classes

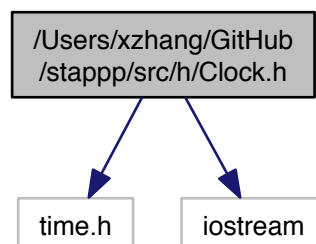
- class [CBar](#)

*Bar element class.*

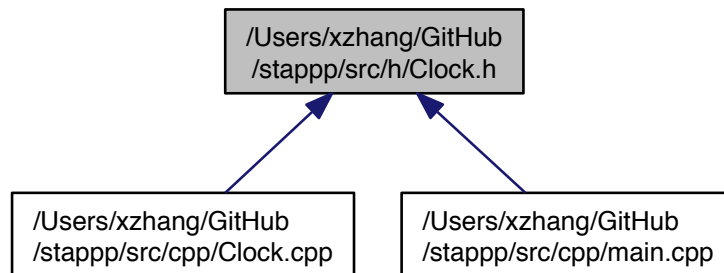
## 5.12 /Users/xzhang/GitHub/stapp/src/h/Clock.h File Reference

```
#include <time.h>
#include <iostream>
```

Include dependency graph for Clock.h:



This graph shows which files directly or indirectly include this file:



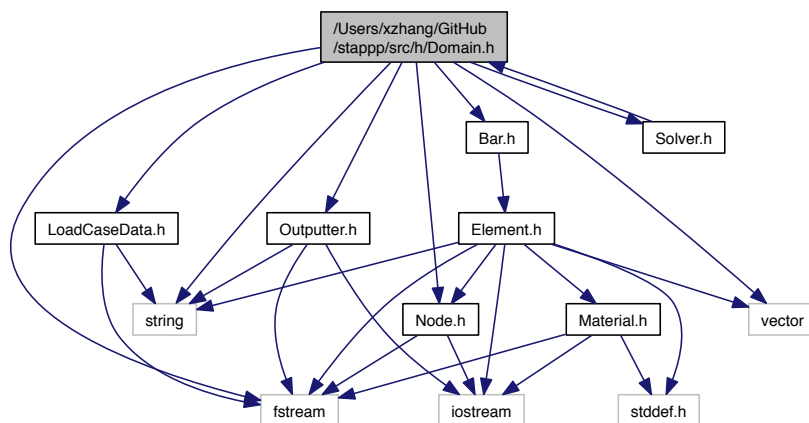
## Classes

- class `Clock`  
*Clock class for timing.*

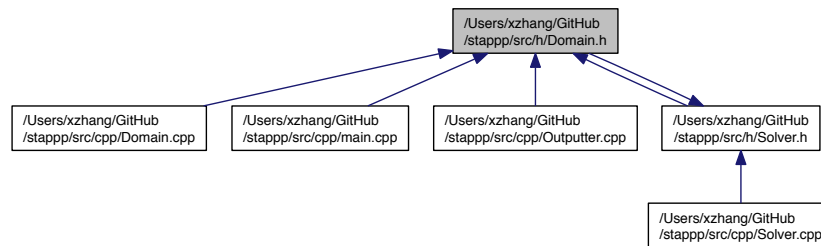
## 5.13 /Users/xzhang/GitHub/stapp/src/h/Domain.h File Reference

```
#include <string>
#include <fstream>
#include <vector>
#include "Node.h"
#include "Bar.h"
#include "Outputter.h"
#include "Solver.h"
#include "LoadCaseData.h"
```

Include dependency graph for Domain.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class [CDomain](#)

*Domain class : Define the problem domain.*

## Functions

- `template<class type >`  
`void clear (type *a, int N)`  
*Clear an array.*

### 5.13.1 Function Documentation

#### 5.13.1.1 `clear()`

```

template<class type >
void clear (
    type * a,
    int N )
  
```

Clear an array.

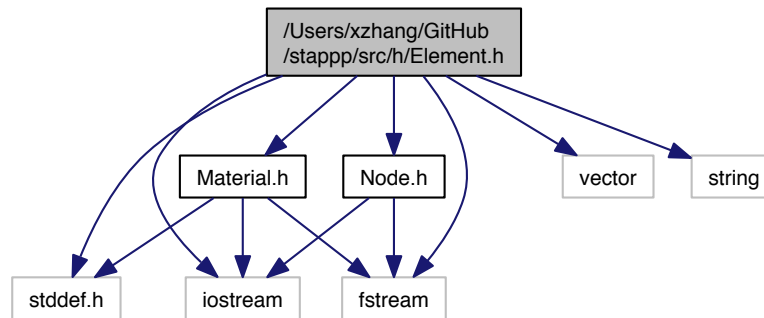
## 5.14 /Users/xzhang/GitHub/stapp/src/h/Element.h File Reference

```

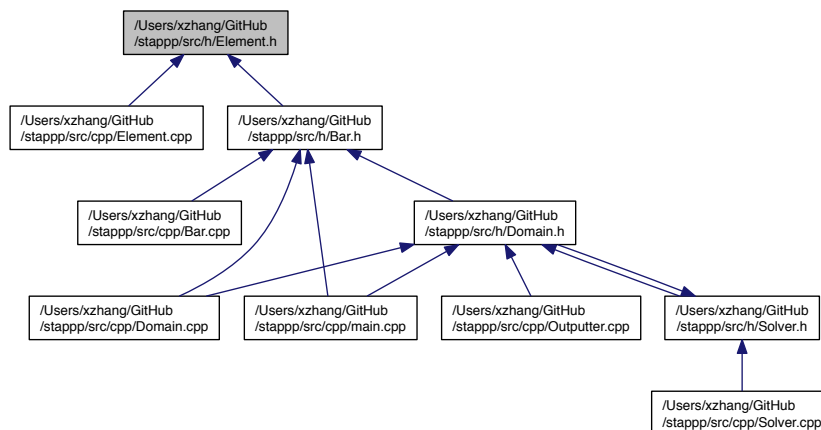
#include <stddef.h>
#include <vector>
#include <string>
#include <iostream>
#include <fstream>
#include "Node.h"
  
```

```
#include "Material.h"
```

Include dependency graph for Element.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class `CElement`  
*Element base class.*

## Functions

- template<class type >  
void `clear` (type \*a, int N)  
*Clear an array.*

### 5.14.1 Function Documentation

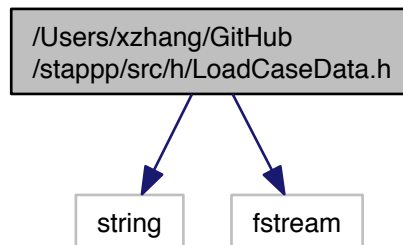
#### 5.14.1.1 clear()

```
template<class type >
void clear (
    type * a,
    int N )
```

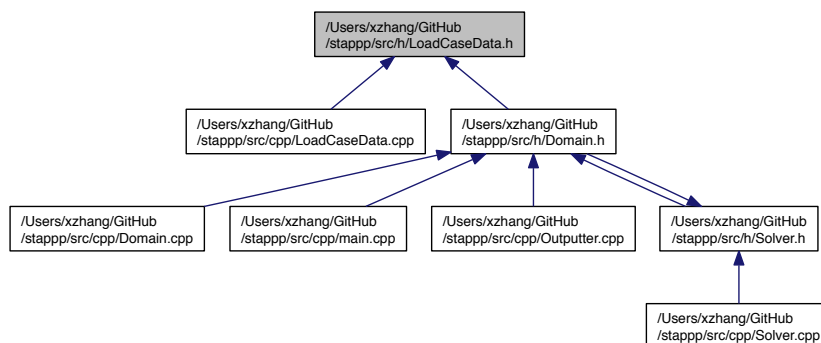
Clear an array.

### 5.15 /Users/xzhang/GitHub/stapp/src/h/LoadCaseData.h File Reference

```
#include <string>
#include <fstream>
Include dependency graph for LoadCaseData.h:
```



This graph shows which files directly or indirectly include this file:



## Classes

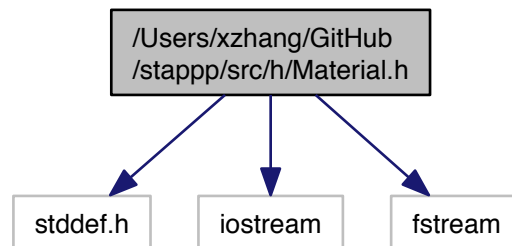
- class [CLoadCaseData](#)

*Class LoadData is used to store load data.*

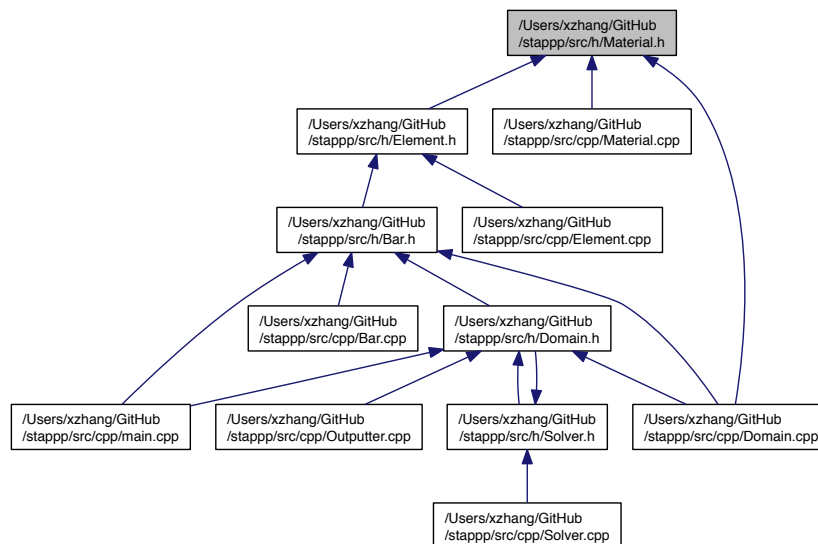
## 5.16 /Users/xzhang/GitHub/stapp/src/h/Material.h File Reference

```
#include <stddef.h>
#include <iostream>
#include <fstream>
```

Include dependency graph for Material.h:



This graph shows which files directly or indirectly include this file:

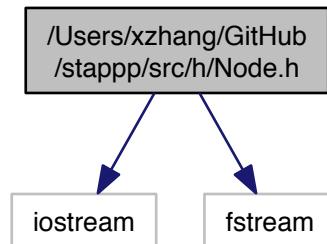


### Classes

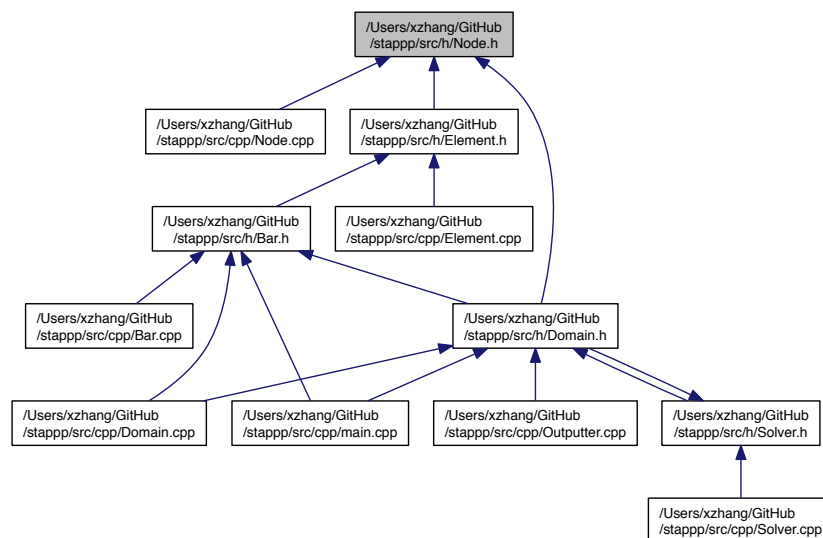
- class [CMaterial](#)  
Material base class which only define one data member.
- class [CBarMaterial](#)  
Material class for bar element.

## 5.17 /Users/xzhang/GitHub/stapp/src/h/Node.h File Reference

```
#include <iostream>
#include <fstream>
Include dependency graph for Node.h:
```



This graph shows which files directly or indirectly include this file:



### Classes

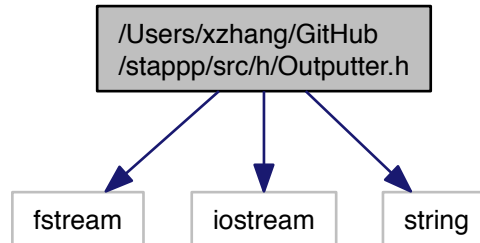
- class [CNode](#)  
*Node class.*



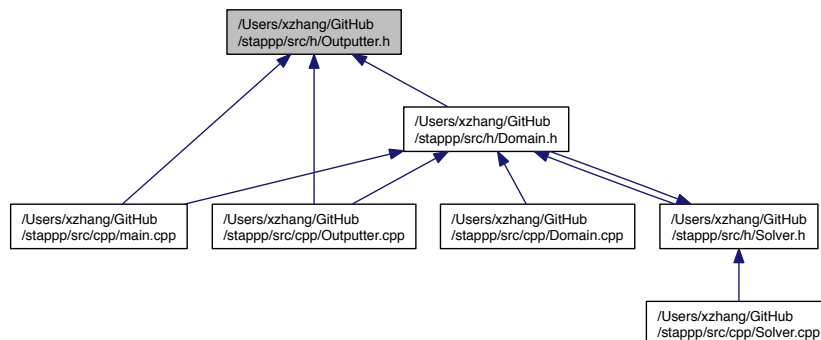
## 5.18 /Users/xzhang/GitHub/stapp/src/h/Outputter.h File Reference

```
#include <fstream>
#include <iostream>
#include <string>
```

Include dependency graph for Outputter.h:



This graph shows which files directly or indirectly include this file:



### Classes

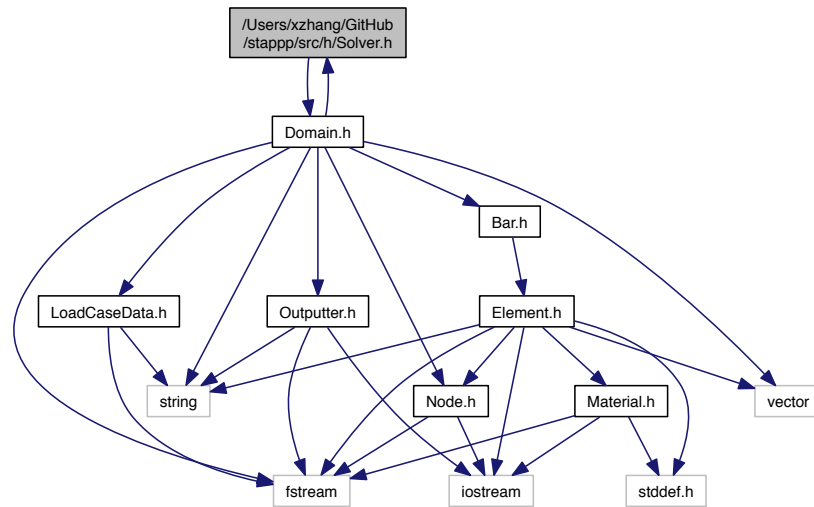
- class [COutputter](#)

*Outputter class is used to output results.*

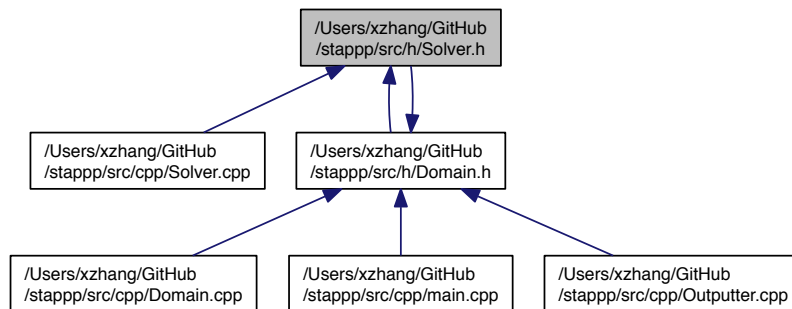
## 5.19 /Users/xzhang/GitHub/stapp/src/h/Solver.h File Reference

```
#include "Domain.h"
```

Include dependency graph for Solver.h:



This graph shows which files directly or indirectly include this file:



## Classes

- class [CSolver](#)  
*Base class for a solver.*
- class [CLDLTSolver](#)  
*LDLT solver: A in core solver using skyline storage and column reduction scheme.*

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