

Adding an Element into OpenSees

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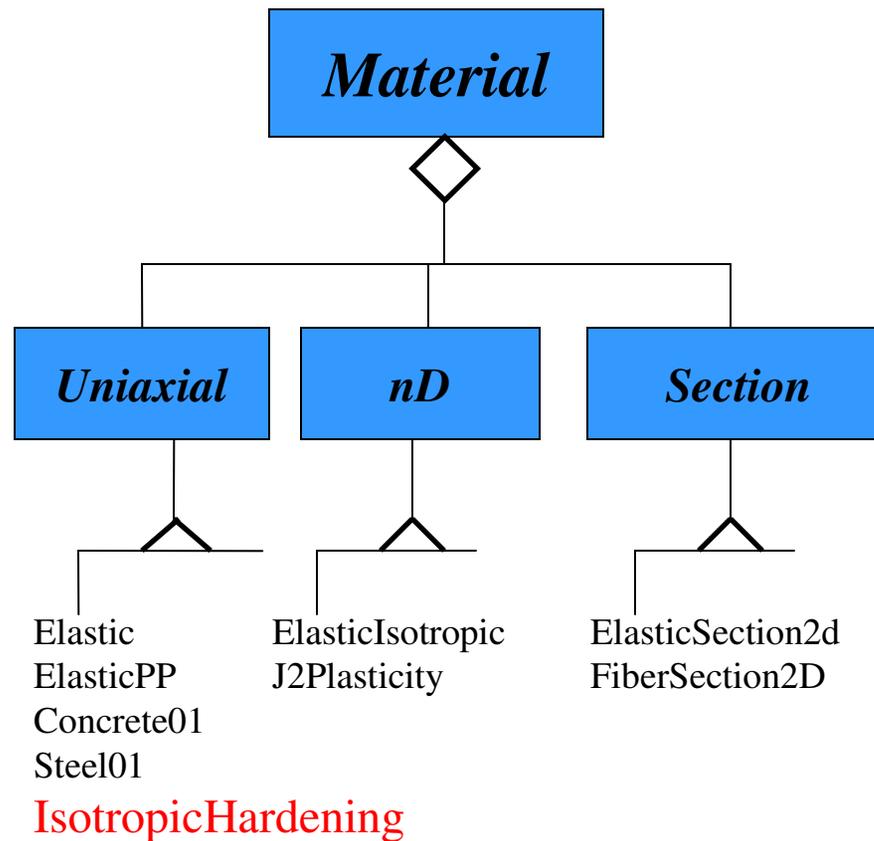
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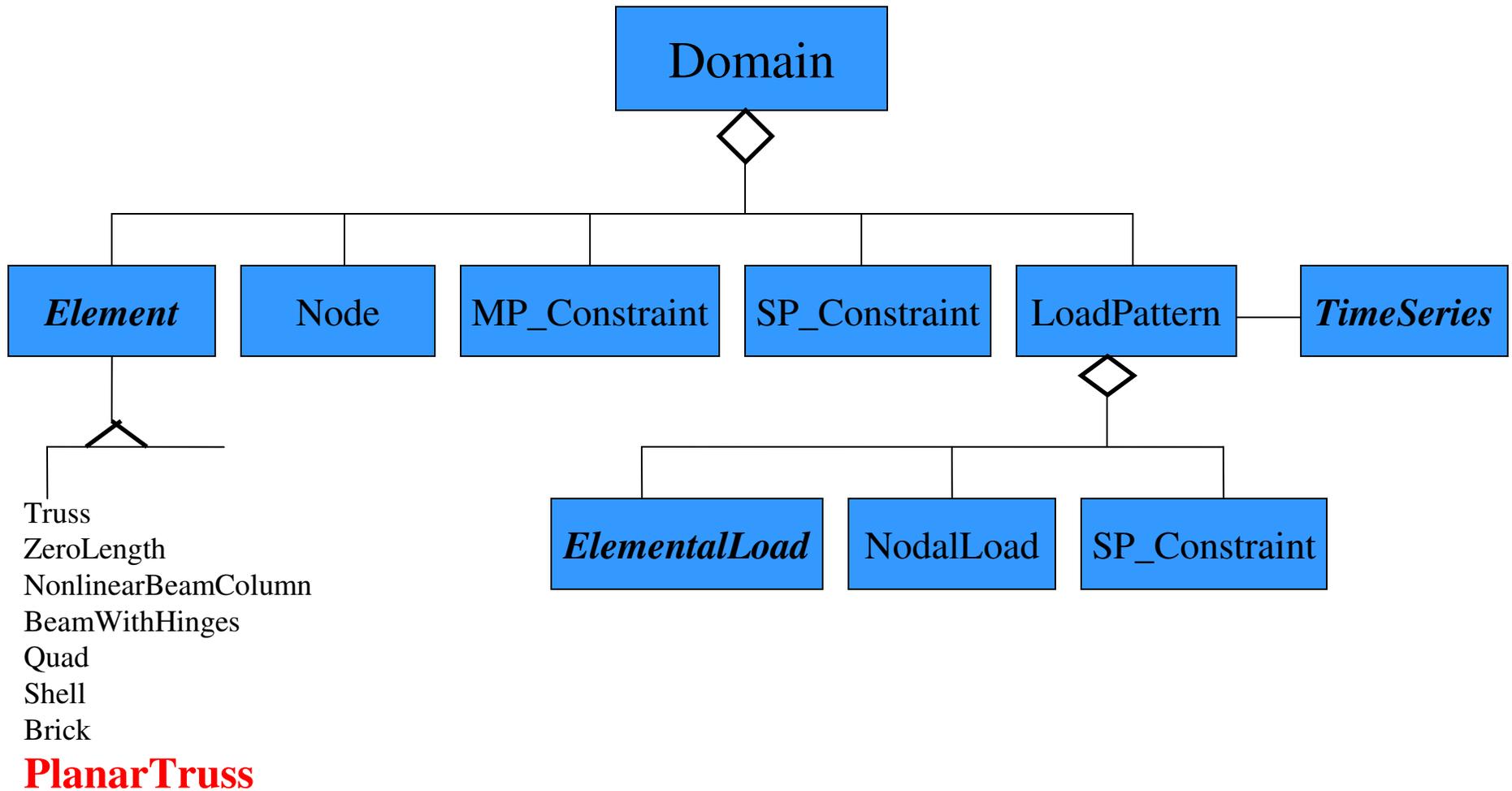


This Morning:

1. Added IsotropicHardening Material to OpenSees Framework



This Afternoon!

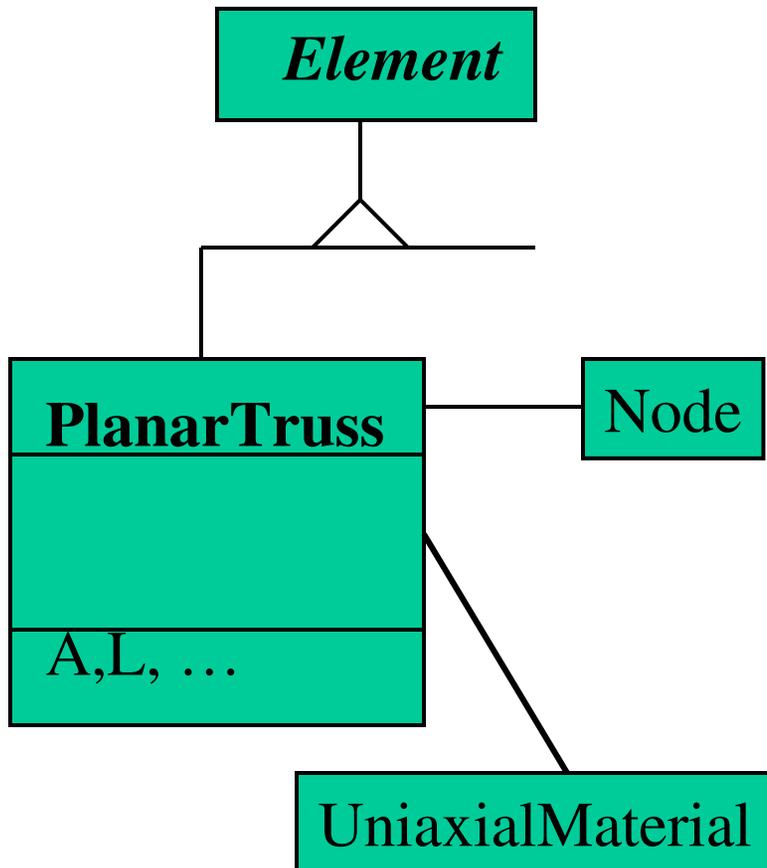


We are going to add a 2d truss to OpenSees!

Element Interface

```
class Element : public DomainComponent {
public:
    Element(int tag, int classTag);
    virtual ~Element();
    virtual int getNumExternalNodes();
    virtual const ID &getExternalNodes()
    virtual Node **getNodePtrs;
    virtual int getNumDOF(void);
    virtual setDomain(Domain *theDomain);
    virtual int commitState(void);
    virtual int revertToStart();
    virtual int revertToLastCommit(void);
    virtual int update(void);
    virtual const Matrix &getTangentStiff(void);
    virtual const Matrix &getInitialStiff(void);
    virtual void zeroLoad(void);
    virtual int addLoad(ElementLoad *theLoad, double loadFactor);
    virtual int addInertiaLoadToUnbalance(const Vector &accel);
    virtual const Vector &getResistingForce(void);
    virtual const Vector &getResistingForceIncInertia(void);
    virtual Response *setResponse(const char *argv, int argc, Information &info);
    virtual int getResponse(int responseID, Information &info);
    void Print(OPS_Stream &ops, int flag=0);
};
```

New PlanarTruss Element



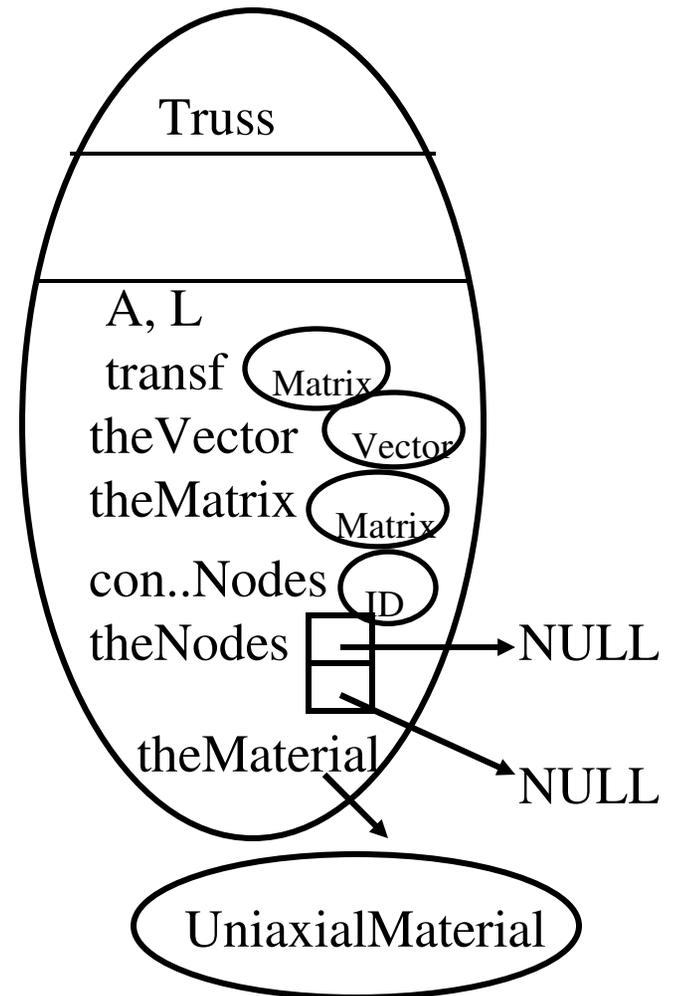
```
class PlanarTruss : public Element {
public:
    PlanarTruss(int tag, int node1, int node2,
                UniaxialMaterial &theMat,
                double A);
    ~PlanarTruss();

    ...

private:
    double A, L;
    Matrix transf;
    Node *theNodes[2];
    UniaxialMaterial *theMaterial;
    ID connectedExternalNodes;
    Vector theVector;
    Matrix theMatrix;
};
```

Constructor

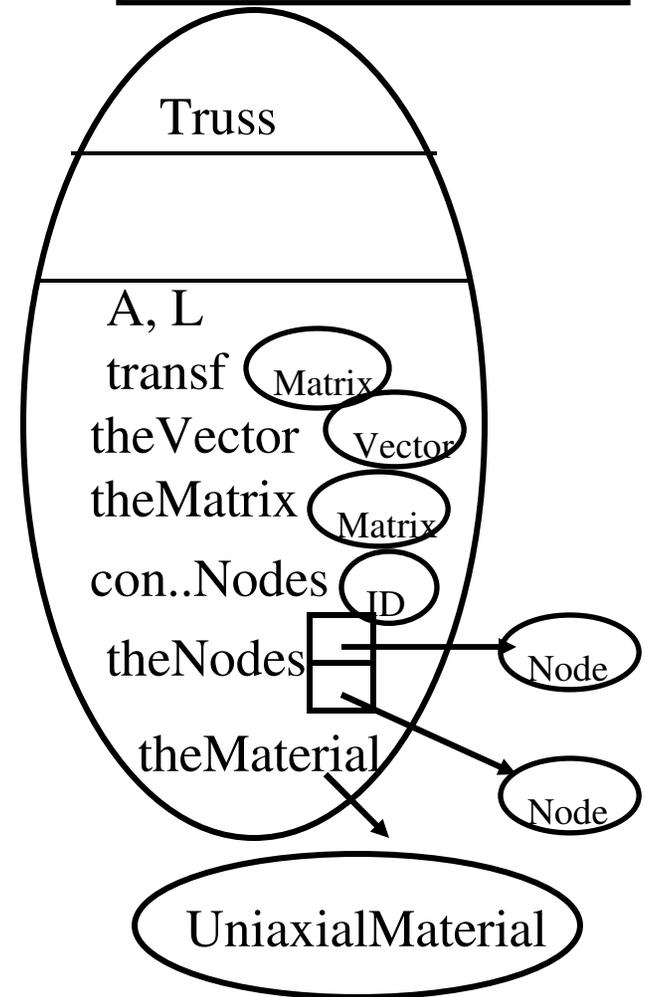
```
#define numNode 2
#define numDOF 4
PlanarTruss::PlanarTruss(int tag, int node1, int node2,
                        UniaxialMaterial &theMat,
                        double a)
:Element(tag, ELE_TAG_PlanarTruss),
  A(a), L(0), transf(1,4),
  connectedExternalNodes(numNode),
  theMatrix(numDOF, numDOF),
  theVector(numDOF)
{
    connectedExternalNodes(0) = node1;
    connectedExternalNodes(1) = node2;
    theMaterial = theMat.getCopy();
    theNodes[0] = 0;
    theNodes[1] = 0;
}
```



Destructor & setDomain

```
Truss::setDomain(Doman *theDomain)
{
    int node1 = connectedExternalNodes(0);
    int node2 = connectedExternalNodes(1);
    theNodes[0] = theDomain->getNode(node1);
    theNodes[1] = theDomain->getNode(node2);
    this->DomainComponent::setDomain(theDomain);
    const Vector &crd1 = end1Ptr->getCrds();
    const Vector &crd2 = end2Ptr->getCrds();
    double dx = crd2(0)-crd1(0);
    double dy = crd2(1)-crd1(1);
    L = sqrt(dx*dx + dy * dy);
    double cs = dx/L; double sn = dy/L;
    trans(0,0)=-cs; trans(0,1)=-sn;
    trans(0,2) = cs; trans(0,3)=sn;
    this->update();
}
```

```
Truss::~Truss()
{
    delete theMaterial;
}
```



Public Methods - some easy ones

```
int PlanarTruss::getNumNodes(void)
{
    return numNode;
}
```

```
int PlanarTruss::commitState(void)
{
    return theMaterial->commitState()
}
```

```
Node **PlanarTruss::getNodes(void)
{
    return theNodes;
} □ □
```

Public Methods - more difficult!

```
const Matrix &PlanarTruss::getTangentStiff(void) {  
    double E = theMaterial->getTangent();  
    theMatrix = transf ^ transf;  
    theMatrix *= A*E/L;  
    return theMatrix;  
}
```

```
const Matrix &PlanarTruss::getInitialStiff(void) {  
    // one line needs to be changed from above  
    // which one???  
}
```

```
const Vector &PlanarTruss::getResistingForce(){  
    double force = A*theMaterial->getStress();  
    for (int I=0; I<4; I++)  
        theVector(I) = transf(0,I)*force;  
    return theVector;  
}
```

Public Methods - most difficult!

```
int PlanarTruss::update(void)
{
    const Vector &disp1 = theNodes[0]->getTrialDisp();
    const Vector &disp2 = theNodes[1]->getTrialDisp();
    double dLength = 0.0;
    for (int i=0; i<2; i++)
        dLength -= (disp2(i)-disp1(i)) * trans (0,i);
    double strain = dLength / L;
    return theMaterial->setTrialStrain(strain);
} □ □
```

```
void PlanarTruss::Print(OPS_Stream &out, int flag)
{
    out << "PlanarTruss tag: " << this->getTag() << endl;
    out << "resisting Force: " << this->getResistingForce();
    theMaterial->Print(out, flag);
} □ □
```

Now it's your turn - steps to proceed:

1. In OpenSees/SRC/element there are 2 files: NewElement.h and NewElement.cpp. Make a copy of them and rename them PlanarTruss.h and PlanarTruss.cpp.
2. Open PlanarTruss.h and .cpp and make necessary changes. Hint start by doing a global replace of NewElement!
3. Open the TclElementCommands.cpp file. Search out the string “addTruss” and add the obvious addPlanarTruss additions. (hint: 2 locations)
4. Copy the file OpenSees/SRC/element/TclNewElement.cpp to be TclPlanarTruss.cpp. Make changes. (hint: look at TclTruss.cpp file in SRC/element/truss directory)
5. Add the files to the project, compile & link.
6. Does it Work? .. Test it (hint: use Example1.1.tcl)