PEER

Adding an Element into OpenSees

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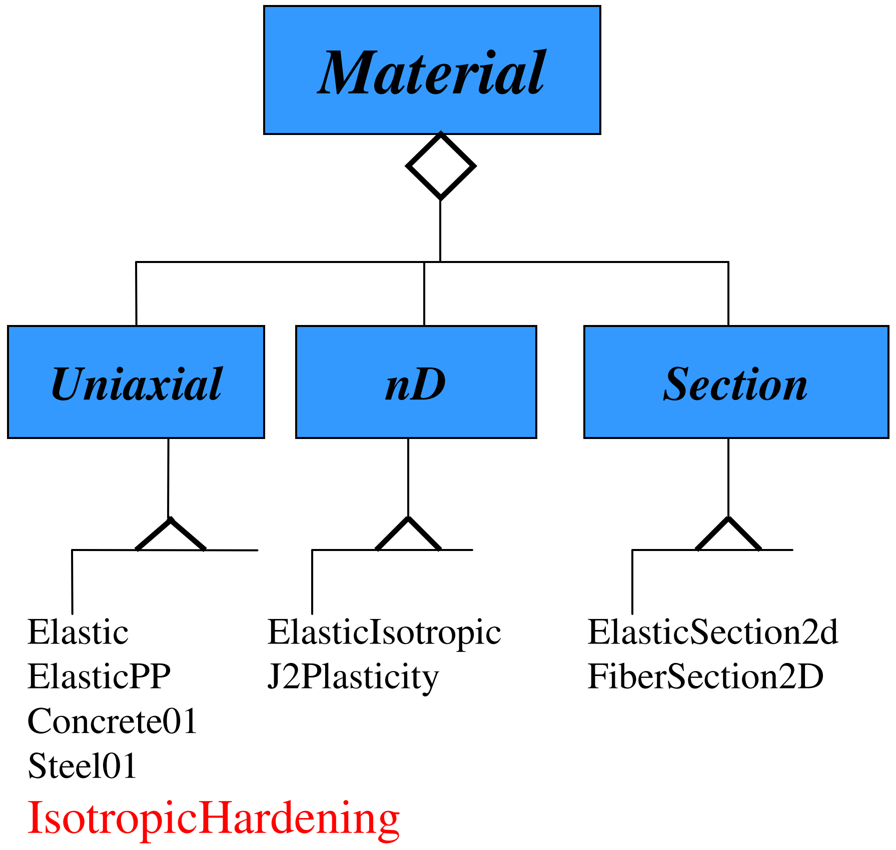
OpenSees Developers Workshop
Berkeley, CA
August 15, 2006

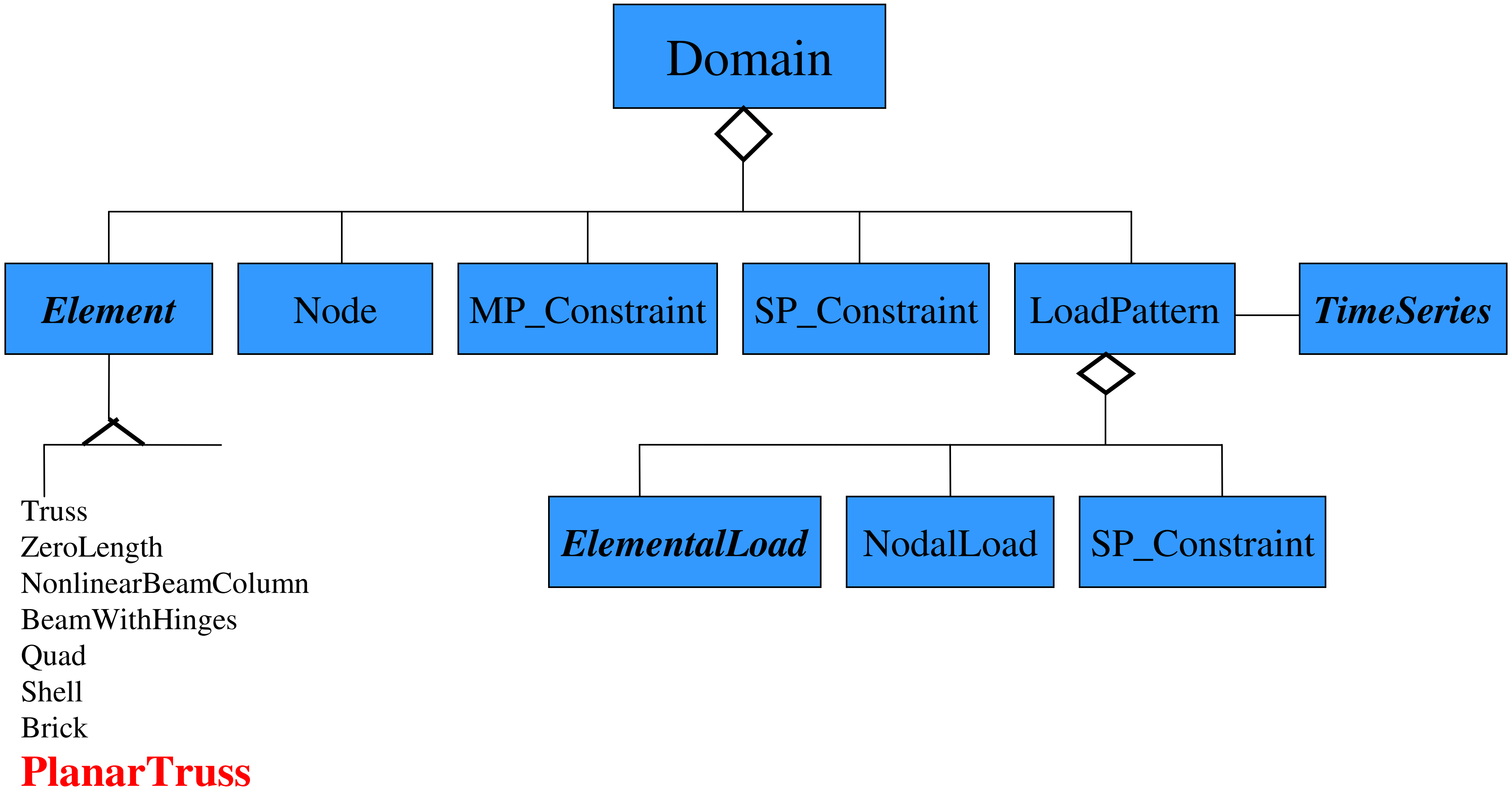
Sponsored by the National Science Foundation
through the Pacific Earthquake Engineering Research Center
and through NEESit

This Morning:

1. Added KinematicHardening Material to OpenSees Framework



This Afternoon!

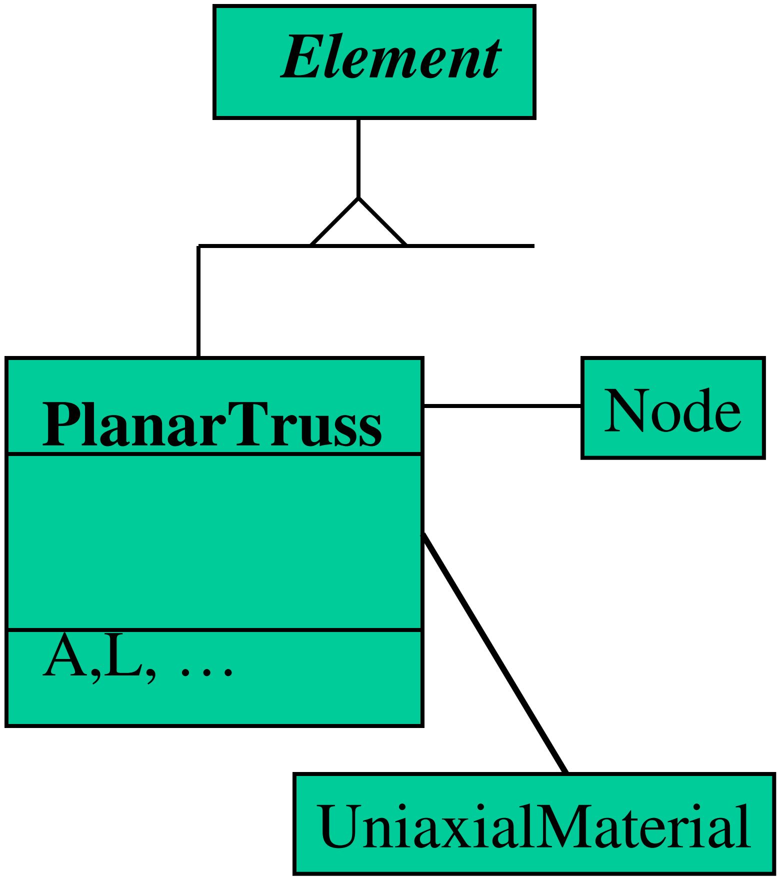


We are going to add a 2d truss to OpenSees!

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

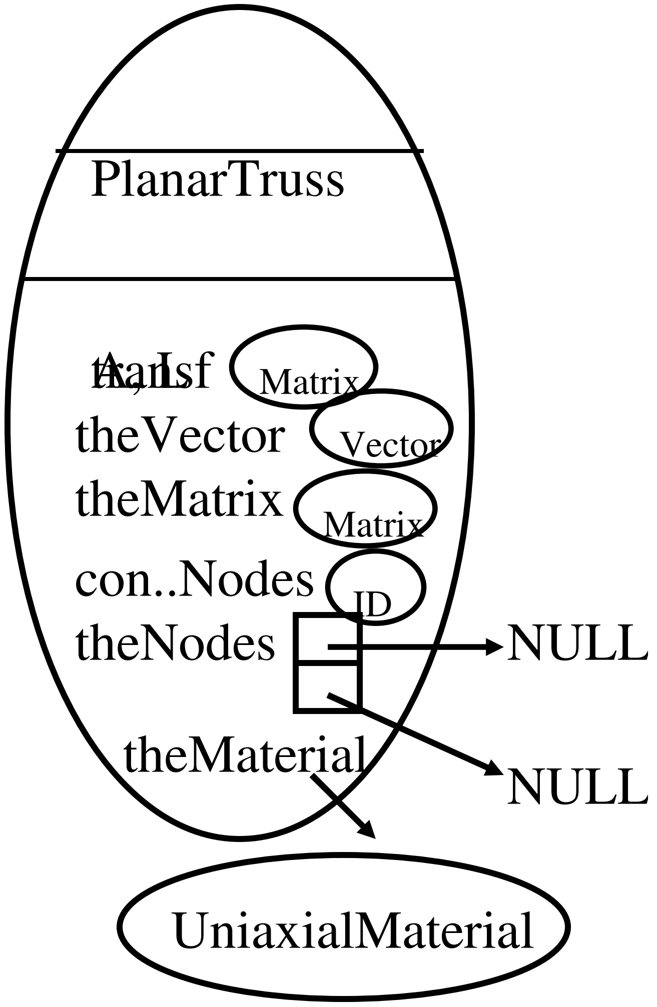


```
class PlanarTruss : public Element {
    public:
            PlanarTruss(int tag, int node1, int node2,
                   UniaxialMaterial &theMat,
                  double A);
            ~PlanarTruss();

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

Constructor

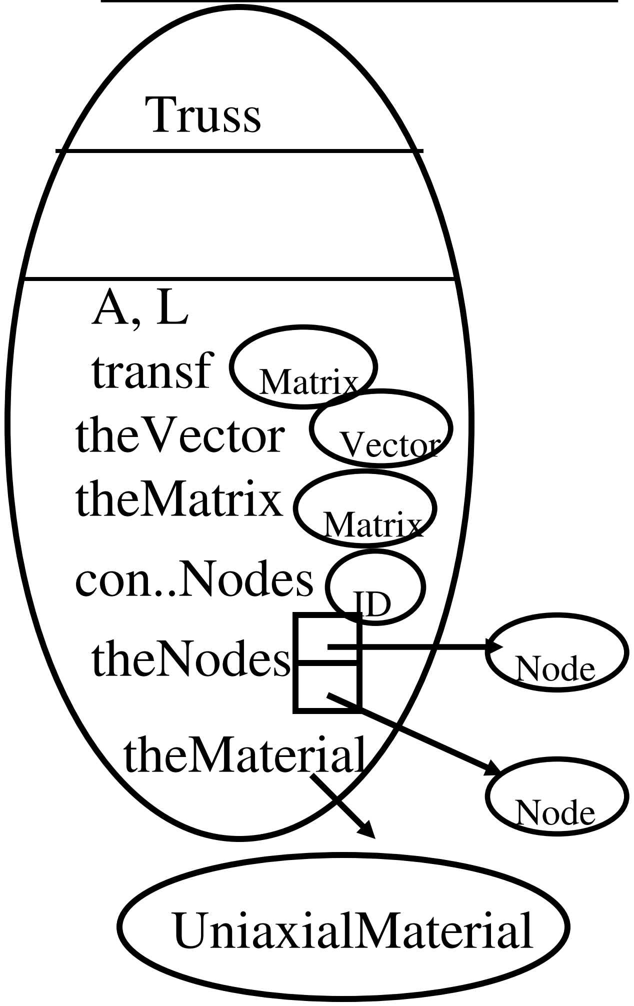
```
#define numNode 2
#define numDOF 4
PlanarTruss::PlanarTruss(int tag, int node1, int node2,
                    UniaxialMaterial &theMat,
                    double a)
:Element(tag, ELE_TAG_PlanarTruss),
 A(a), L(0), transf(1,4),
 connectedExternalNodes(numNode),
 theMatrix(numDOF,  numDOF),
theVector(numDOF)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



Destructor & setDomain

```
PlanarTruss::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() << endln;
   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)