湖南大學

HUNAN UNIVERSITY

# 研究生期末大作业

课程名称：有限元方法及应用

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# 目录

# 悬臂梁 abaqus 有限元建模方法分析

## 一. 问题重述

### 1.1 问题描述

悬臂梁静力分析，某悬臂轻质梁，截面尺寸为 200mmX400mm，长度为 2500mm，弹性模量取 30GPa，泊松比为 0.2，悬臂梁顶部受 0.5MPa 均布载荷作用，端部受 10kN 的集中载荷，求结构整体位移云图、应力云图。。

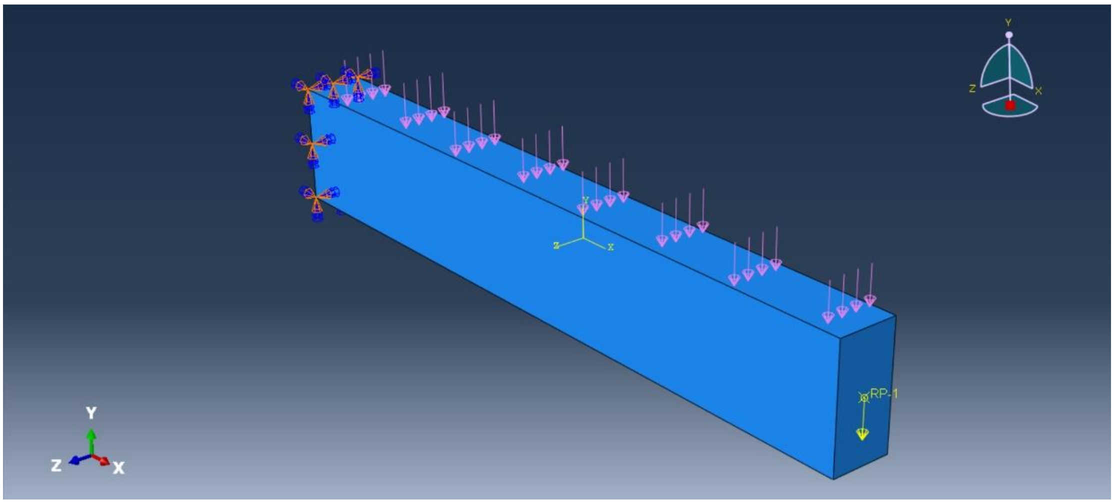


图 1. 悬臂梁的结构模型

### 1.2 理论分析

于 abaqus 中建立悬臂梁模型，建立采取模型空间为三维，类型为可变形采用实体模型，计算最终结果，确定建模方式的可行性。

## 二. 悬臂梁有限元分析的过程

### 2.1 实体类型模型分析

#### 2.1.1 前处理

几何模型的构建：采用模型空间为三维，类型为可变性，形状为实体的部件类型，得到一根长度为2500mm，边长为200mm × 400mm的梁。

材料参数的定义：杨氏模量为 30GPa，泊松比为 0.2。

网络系统的构建：采用 C3D8R 八结点线性六面体单元，10000 个单元节点。

### 2.1.2 求解

求解器的设定：设置一个静力学通用的分析步，设置保持默认。

边界条件的设定：模型左端设置为完全固定，右端首先在面中心设置一个参考点，然后将整个面耦合到参考点，最后再参考点施加一个延 y 方向负方向大小为 100N 的集中荷载，如图 4 所示。

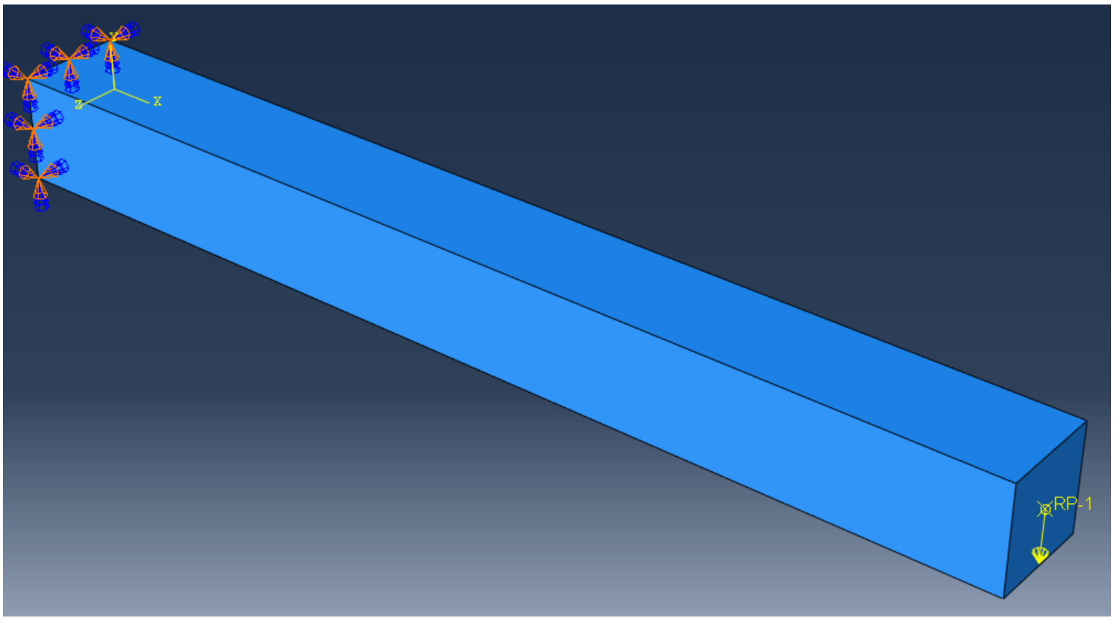
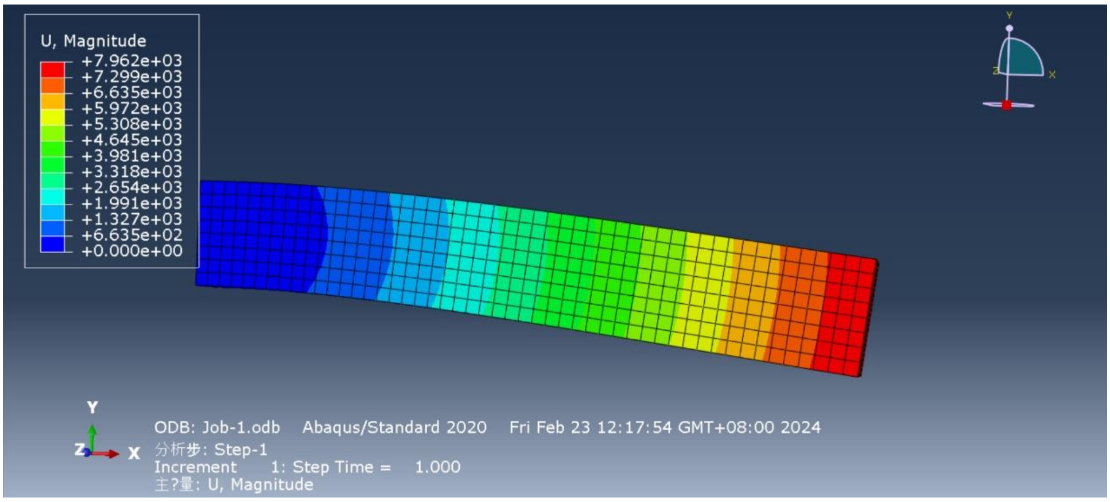


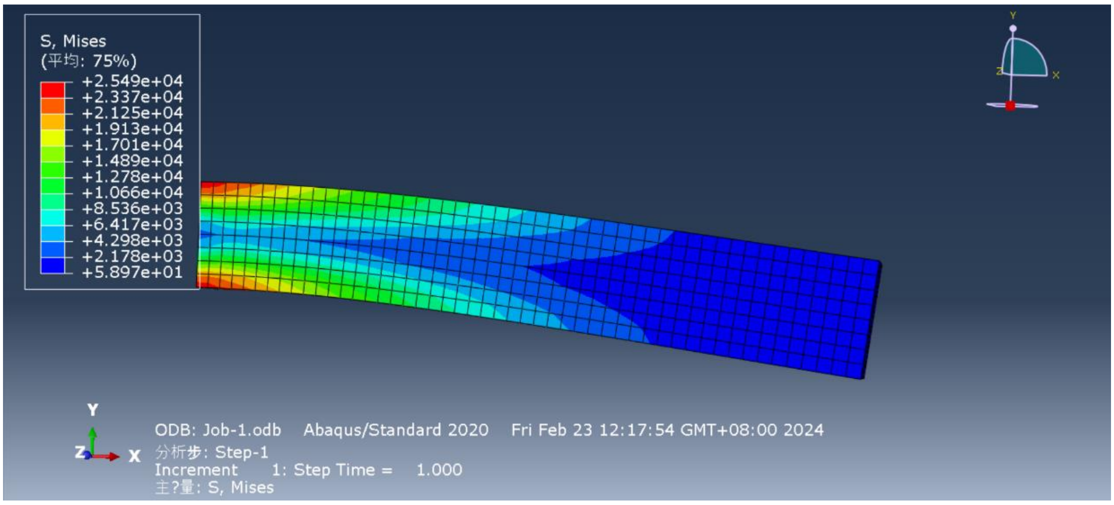
图 2.实体模型构建

### 2.1.3 后处理

创建作业文件 shiti，提交计算，得到图 3。



```
ODB: Job-1.odb    Abaqus/Standard 2020    Fri Feb 23 12:17:54 GMT+08:00 2024
分析步: Step-1
Increment      1: Step Time =     1.000
主?量: U, Magnitude
```



```
ODB: Job-1.odb    Abaqus/Standard 2020    Fri Feb 23 12:17:54 GMT+08:00 2024
分析步: Step-1
Increment     1: Step Time =    1.000
主?量: S, Mises
```

图 3.实体模型后处理整体应力云图、位移云图

# 三．附录代码

## 3.1 代码解释

代码是由 abaqus 软件附带的宏录制功能自动生成的 abaqusMacros.py 文件稍加更改后所得，将代码写入 py 文件后于 abaqus 中运行即可。

## 3.2 代码

### 3.2.1 实体模型代码

```
# -*- coding: mbcs -*-
# Do not delete the following import lines
from abaqus import *
from abaqusConstants import *
import __main__


import section
import regionToolset
import displayGroupMdbToolset as dgm
import part
import material
import assembly
import step
import interaction
import load
import mesh
import optimization
import job
import sketch
import visualization
import xyPlot
import displayGroupOdbToolset as dgo
import connectorBehavior
s = mdb.models['Model-1'].ConstrainedSketch(name='__profile__',
    sheetSize=2500.0)
g, v, d, c = s.geometry, s.vertices, s.dimensions, s.constraints
s.setPrimaryObject(option=STANDALONE)
s.rectangle(point1=(-1250.0, -200.0), point2=(1250.0, 200.0))
session.viewports['Viewport: 1'].view.setValues(nearPlane=1908.76,
    farPlane=2805.29, width=3628.61, height=1624.54, cameraPosition=(
    424.962, 180.943, 2357.02), cameraTarget=(424.962, 180.943, 0))
p = mdb.models['Model-1'].Part(name='Part-1', dimensionality=THREE_D,
    type=DEFORMABLE_BODY)
p = mdb.models['Model-1'].parts['Part-1']
p.BaseSolidExtrude(sketch=s, depth=200.0)
s.unsetPrimaryObject()
p = mdb.models['Model-1'].parts['Part-1']
session.viewports['Viewport: 1'].setValues(displayedObject=p)
del mdb.models['Model-1'].sketches['__profile__']
session.viewports['Viewport: 1'].partDisplay.setValues(sectionAssignments=ON,
    engineeringFeatures=ON)
session.viewports['Viewport: 1'].partDisplay.geometryOptions.setValues(
    referenceRepresentation=OFF)
mdb.models['Model-1'].Material(name='Material1')
mdb.models['Model-1'].materials['Material1'].Elastic(table=((30000.0, 0.2), ))
mdb.models['Model-1'].HomogeneousSolidSection(name='Section-1',
    material='Material1', thickness=None)
p = mdb.models['Model-1'].parts['Part-1']
c = p.cells
cells = c.getSequenceFromMask(mask=('[#1 ]', ), )
region = regionToolset.Region(cells=cells)
p = mdb.models['Model-1'].parts['Part-1']
p.SectionAssignment(region=region, sectionName='Section-1', offset=0.0,
    offsetType=MIDDLE_SURFACE, offsetField='',
    thicknessAssignment=FROM_SECTION)
session.viewports['Viewport: 1'].partDisplay.setValues(sectionAssignments=OFF,
    engineeringFeatures=OFF, mesh=ON)
session.viewports['Viewport: 1'].partDisplay.meshOptions.setValues(
    meshTechnique=ON)
p = mdb.models['Model-1'].parts['Part-1']
p.seedPart(size=10.0, deviationFactor=0.1, minSizeFactor=0.1)
p = mdb.models['Model-1'].parts['Part-1']
p.seedPart(size=50.0, deviationFactor=0.1, minSizeFactor=0.1)
p = mdb.models['Model-1'].parts['Part-1']
p.generateMesh()
a = mdb.models['Model-1'].rootAssembly
session.viewports['Viewport: 1'].setValues(displayedObject=a)
session.viewports['Viewport: 1'].assemblyDisplay.setValues(
    optimizationTasks=OFF, geometricRestrictions=OFF, stopConditions=OFF)
a = mdb.models['Model-1'].rootAssembly
a.DatumCsysByDefault(CARTESIAN)
p = mdb.models['Model-1'].parts['Part-1']
a.Instance(name='Part-1-1', part=p, dependent=ON)
```

```
session.viewports['Viewport: 1'].assemblyDisplay.setValues(
    adaptiveMeshConstraints=ON)
mdb.models['Model-1'].StaticStep(name='Step-1', previous='Initial')
session.viewports['Viewport: 1'].assemblyDisplay.setValues(step='Step-1')
session.viewports['Viewport: 1'].assemblyDisplay.setValues(interactions=ON,
    constraints=ON, connectors=ON, engineeringFeatures=ON,
    adaptiveMeshConstraints=OFF)
a = mdb.models['Model-1'].rootAssembly
v11 = a.instances['Part-1-1'].vertices
a.DatumPointByMidPoint(point1=v11[6], point2=v11[5])
a = mdb.models['Model-1'].rootAssembly
d11 = a.datums
a.ReferencePoint(point=d11[4])
a = mdb.models['Model-1'].rootAssembly
r1 = a.referencePoints
refPoints1=(r1[5], )
region1=regionToolset.Region(referencePoints=refPoints1)
a = mdb.models['Model-1'].rootAssembly
s1 = a.instances['Part-1-1'].faces
side1Faces1 = s1.getSequenceFromMask(mask=('[#4 ]', ), )
region2=regionToolset.Region(side1Faces=side1Faces1)
mdb.models['Model-1'].Coupling(name='Constraint-1', controlPoint=region1,
    surface=region2,                    influenceRadius=WHOLE_SURFACE,
couplingType=KINEMATIC,
    localCsys=None, u1=ON, u2=ON, u3=ON, ur1=ON, ur2=ON, ur3=ON)
session.viewports['Viewport: 1'].assemblyDisplay.setValues(loads=ON, bcs=ON,
    predefinedFields=ON, interactions=OFF, constraints=OFF,
    engineeringFeatures=OFF)
session.viewports['Viewport: 1'].view.setValues(nearPlane=4814.48,
    farPlane=6156.66, width=2900.06, height=1298.36, cameraPosition=(
    -393.666, 3245.26, 4506.34), cameraUpVector=(0.162729, 0.558215,
    -0.813581), cameraTarget=(109.45, -63.9089, 54.4588))
session.viewports['Viewport: 1'].view.setValues(nearPlane=4261.04,
    farPlane=6627.6, width=2566.69, height=1149.11, cameraPosition=(
    -2791.68, 1804.49, 4412.8), cameraUpVector=(0.228558, 0.768483,
    -0.597658), cameraTarget=(146.283, -41.7787, 55.8956))
a = mdb.models['Model-1'].rootAssembly
f1 = a.instances['Part-1-1'].faces
faces1 = f1.getSequenceFromMask(mask=('[#1 ]', ), )
region = regionToolset.Region(faces=faces1)
mdb.models['Model-1'].EncastreBC(name='BC-1', createStepName='Step-1',
    region=region, localCsys=None)
session.viewports['Viewport: 1'].view.setValues(nearPlane=4078.95,
    farPlane=6999.7, width=2457, height=1100.01, cameraPosition=(4566.42,
    978.421, 3079.08), cameraUpVector=(-0.359605, 0.862, -0.357267),
    cameraTarget=(-23.3453, -22.7351, 86.6422))
a = mdb.models['Model-1'].rootAssembly
r1 = a.referencePoints
refPoints1=(r1[5], )
region = regionToolset.Region(referencePoints=refPoints1)
mdb.models['Model-1'].ConcentratedForce(name='Load-1', createStepName='Step-1',
    region=region, cf2=-10000.0, distributionType=UNIFORM, field='',
    localCsys=None)
session.viewports['Viewport: 1'].view.setValues(nearPlane=4170.21,
    farPlane=6900.48, width=2511.98, height=1124.62, cameraPosition=(
    4007.9, 2220.5, 3205.87), cameraUpVector=(-0.531313, 0.727643,
    -0.433869), cameraTarget=(-20.2701, -29.5741, 85.9441))
a = mdb.models['Model-1'].rootAssembly
s1 = a.instances['Part-1-1'].faces
side1Faces1 = s1.getSequenceFromMask(mask=('[#2 ]', ), )
region = regionToolset.Region(side1Faces=side1Faces1)
mdb.models['Model-1'].Pressure(name='Load-2', createStepName='Step-1',
    region=region, distributionType=UNIFORM, field='', magnitude=250.0,
    amplitude=UNSET)
session.viewports['Viewport: 1'].assemblyDisplay.setValues(loads=OFF, bcs=OFF,
    predefinedFields=OFF, connectors=OFF)
mdb.Job(name='Job-1', model='Model-1', description='', type=ANALYSIS,
    atTime=None, waitMinutes=0, waitHours=0, queue=None, memory=90,
    memoryUnits=PERCENTAGE, getMemoryFromAnalysis=True,
    explicitPrecision=SINGLE, nodalOutputPrecision=SINGLE, echoPrint=OFF,
    modelPrint=OFF, contactPrint=OFF, historyPrint=OFF, userSubroutine='',
    scratch='', resultsFormat=ODB, multiprocessingMode=DEFAULT, numCpus=1,
    numGPUs=0)
mdb.jobs['Job-1'].submit(consistencyChecking=OFF)
session.mdbData.summary()
o3 = session.openOdb(name='D:/abaqus/exerciese/fem_final_work/cao/Job-1.odb')
session.viewports['Viewport: 1'].setValues(displayedObject=o3)
session.viewports['Viewport: 1'].makeCurrent()
session.viewports['Viewport: 1'].odbDisplay.display.setValues(plotState=(
    CONTOURS_ON_DEF, ))
session.viewports['Viewport: 1'].view.setValues(nearPlane=4394.76,
    farPlane=6817.96, width=2647.23, height=1185.17, cameraPosition=(
    3173.9, 1243.98, 4524.53), cameraUpVector=(-0.300529, 0.835879,
    -0.459336), cameraTarget=(107.715, -85.7877, 68.8434))
session.viewports['Viewport: 1'].view.setValues(nearPlane=4625.9,
    farPlane=6537.49, width=2786.46, height=1247.5, cameraPosition=(
    2348.99, 1.42957, 5168.76), cameraUpVector=(-0.143635, 0.936962,
    -0.318545), cameraTarget=(102.34, -93.8843, 73.0413))
```

```
session.viewports['Viewport: 1'].odbDisplay.setPrimaryVariable(
    variableLabel='U', outputPosition=NODAL, refinement=(INVARIANT,
    'Magnitude'), )
```

# 四.致谢

研一的第一个学期已经圆满结束，我要由衷地感谢王琥老师在有限元方法课程中给予我的悉心教导。在这段时间里，不仅提升了运用 Abaqus 等软件的技巧，更重要的是，老师深入浅出地讲解了有限元方法的理论和应用，使我对这一领域有了更深入的认识和理解。通过课堂上的案例分析和实践操作，我不仅掌握了软件的使用技巧，还学到了如何将理论知识应用到实际工程问题中去解决。王老师耐心细致的讲解和悉心指导让我受益匪浅，老师的教诲将成为我在未来科研和工作中的宝贵财富。