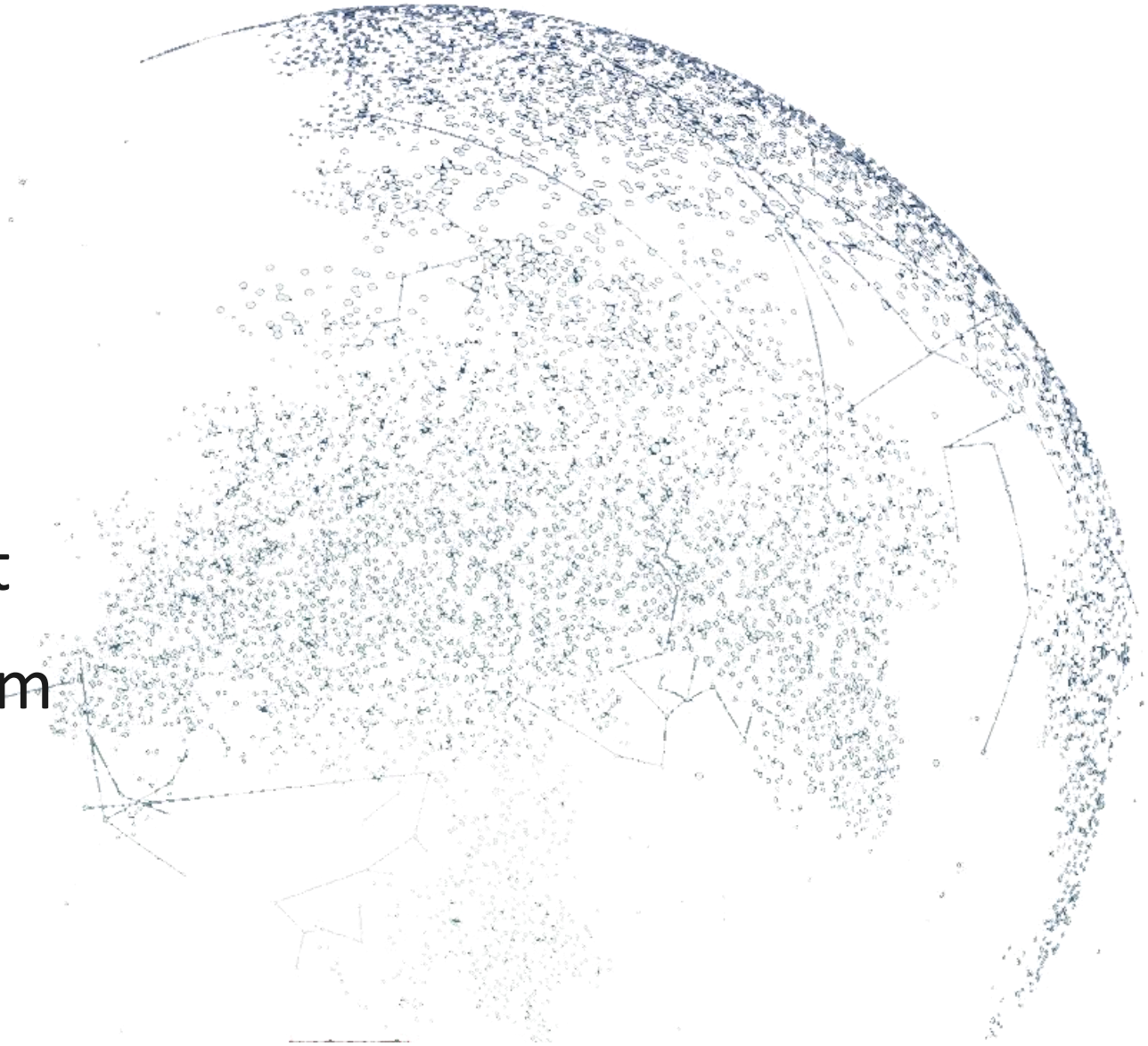
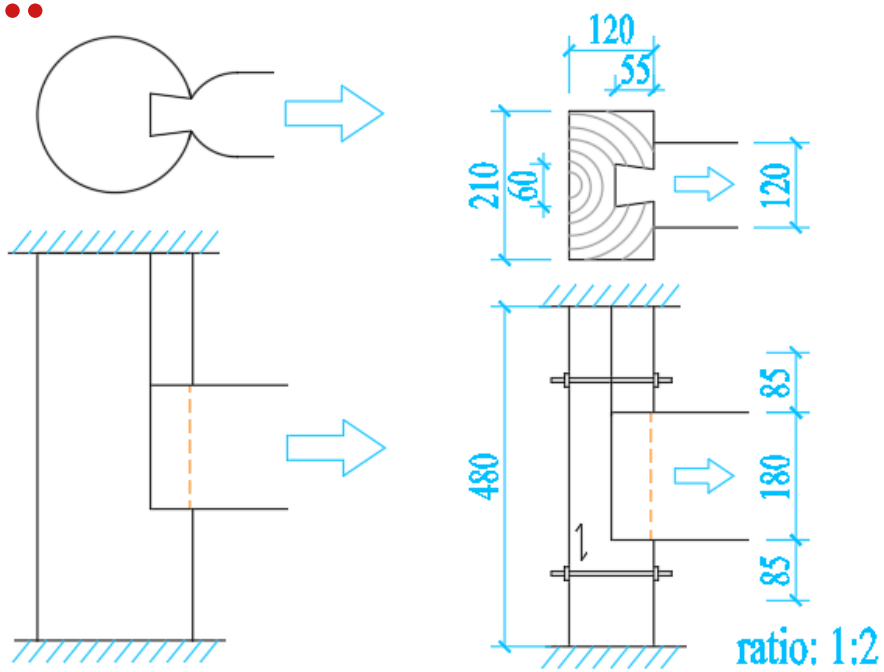
02

Test Plan of the Dovetail Joint Between column and tie-beam

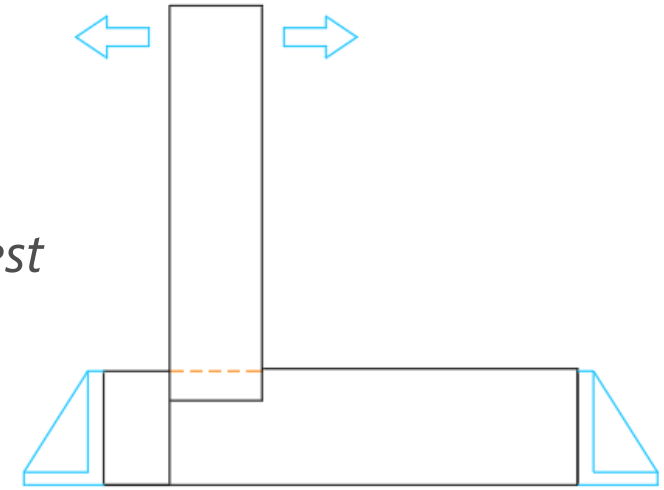


Tensile and Rotational properties of Dovetail joint

Tensile test



Joint rotation
Cyclic loading test



Parameters:

- ✓ Material: カラマツ,アカマツ, Larch (or Larch Glulam), Japanese Cypress
- ✓ Geometric dimension of Dovetail tenon: Inclined angle of both side face;
  Ratio of column diameter and dovetail's size
  The contacting surface of beam shoulders.
- ✓ Location (top connection part)
- ✓ Vertical load

Specimen's material

In North China, the Chinese Larch (*Larix principis-rupprechtii* Mayr) and Chinese Red Pine (*Pinus tabulaeformis* Carr.) are most commonly used for column and beams.

The smaller components, bracket complex and tenons: Elm 榆 (*Ulmaceae macrocarpa* Hance) and Locust 槐 (*Sophora japonica* L.)

Chinese Larch	Air dry density	Basic density	Parallel to the grain						Perpendicular to the grain		
			MOE	MOR	Fc	Ft	Fs (Radial)	Fs (Tangential)	Full-surface Compression (Radial)	Full-surface Compression (Tangential)	MOE (compression)
Unit	g/cm^3	g/cm^3	GPa	MPa	MPa	MPa	MPa	MPa	MPa	MPa	GPa
Ancient	0.56	0.55	11.7	98.4	46.8	65.2	7.6	7.7	2.1	1.6	0.67
Modern	0.64	0.51	14.5	113.3	57.6	129.9	9.0	9.4	4.3	4.7	0.91

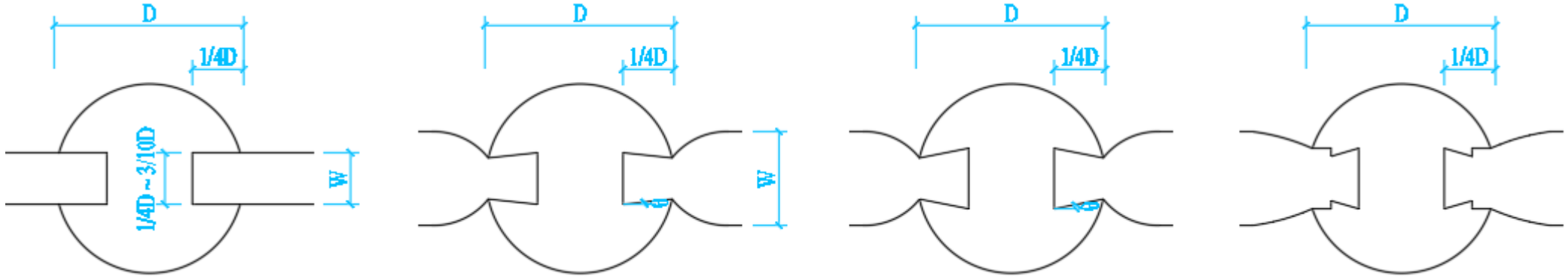
The ancient material was taken from the pagoda in 1056A.D. Modern material was taken from the North East area of China

(In South China, the China fir, Cypress, Chestnut 栗, Nanmu 楠are most commonly used for column and beams.)

[1] 《古建筑木结构维护与加固规范》编制组.古建筑木结构用材的树种调查及其主要材性的实测分析 [J]. 四川建筑科学研究, 1994(1):11-14.

Geometric dimension of Dovetail tenon

Inclined angle of both side face of Dovetail joint (North China):



Tang dynasty: Θ=0°

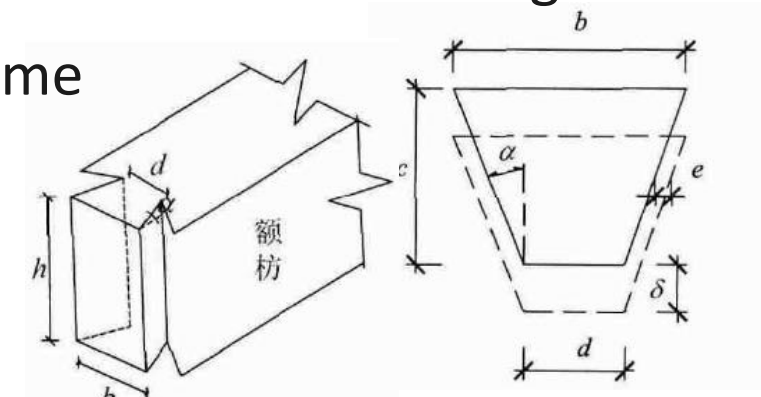
Song-Yuan dynasty: Θ=6-8°
(commonly used in Shanxi province)

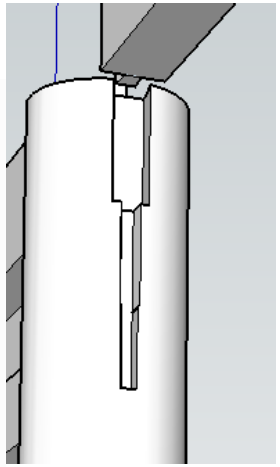
Qing dynasty: Θ=11° or larger (consider shoulders)

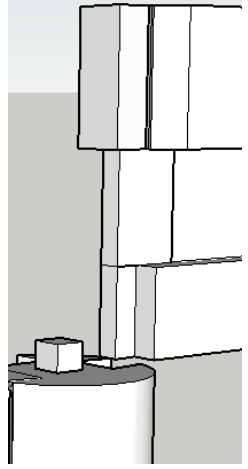
If consider technique in South China: Θ=15-20°

Ratio of column diameter with dovetail's cross section and height:

Change the ratio of h, b(d) and c under same column diameter



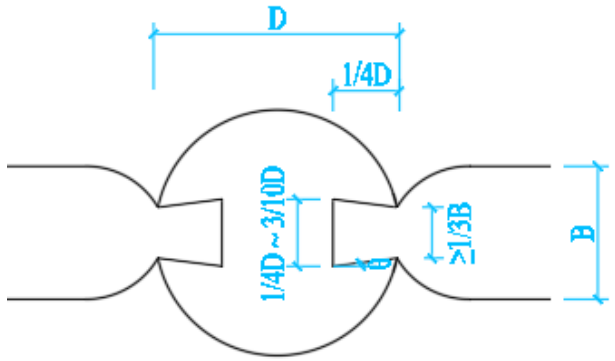




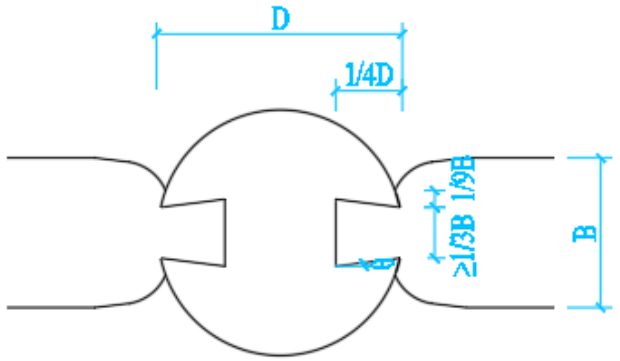
[1] 鲁晨海. 中国古代木构建筑榫卯初探[D]. 同济大学: 1986.

Geometric dimension of Dovetail tenon

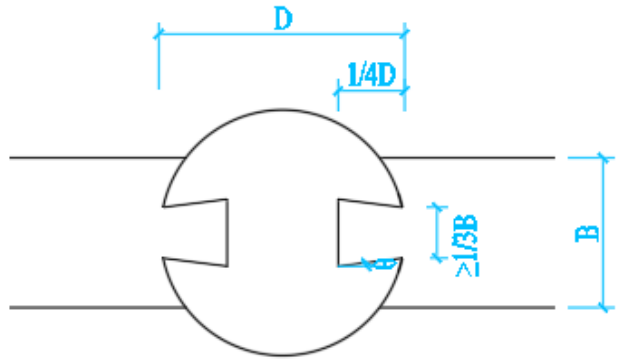
The contacting surface of beam shoulders:



Contacting width: 0



Contacting width: 1/9B



Contacting width: 1/3B

If possible this perimeter considered in the frame test or from joint rotation test?

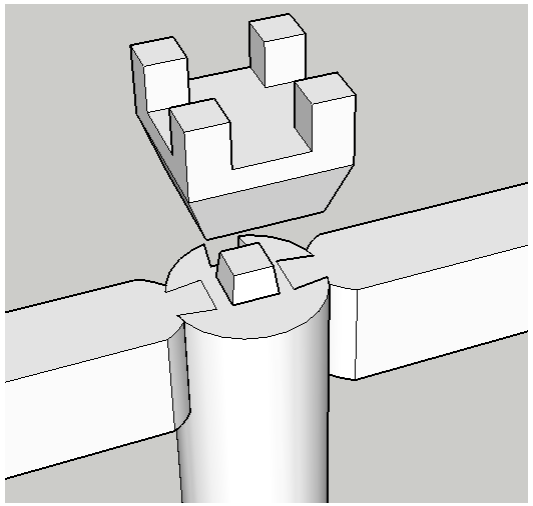
Joint rotation test

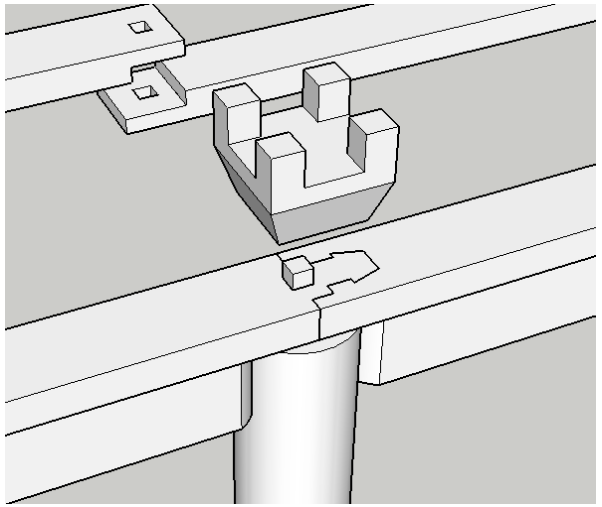
Frame test

[1] 鲁晨海. 中国古代木构建筑榫卯初探[D]. 同济大学: 1986.

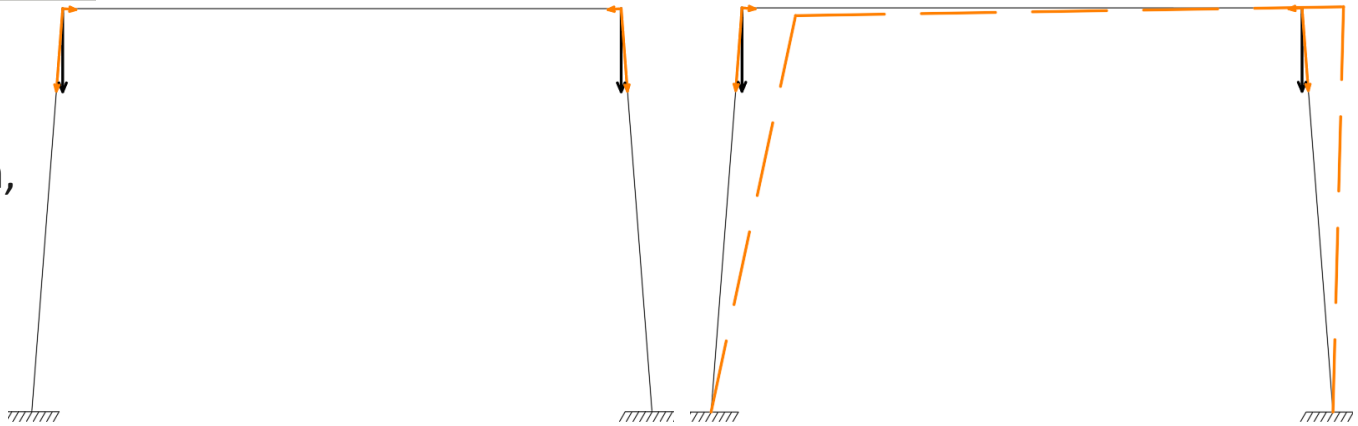
Further frame test of the column and head tie beams

2> lateral performance of the frame of two columns and head tie beam with dovetail and straight tenon connection, in consideration with the tension from the flat beam on top of column;





Lateral performance of the frame with two columns and the head tie beam with straight tenon connection, in consideration with the inclined angle of column;



Lateral movement of column foot: 0.01H

Further frame test of the column and head tie beams

3> the conbination of head tie beams, in consideration of two commonly used techniques:

1) inserting with timber plate only in center;

2) connect top and bottom tie beam with short columns and insert with timber plates and short columns (ladder beam).