SPT code of tensile test

Kaishu GUAN

Zhiwen WANG

Research Institute of Process Equipment and Pressure Vessels

East China University of Science and Technology

guankaishu@ecust.edu.cn

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Introduction

East China University of Science and Technology (ECUST) is located in Shanghai, a cosmopolitan metropolis where distinguished people, diverse society and exquisite attractions can be found.

It is a key research university in China featuring distinctive disciplines and a balanced curriculum of

science, engineering, materials, computer, economics, management, arts and law.

The university emphasizes the campus motto of "Industry, Pragmatics, Inspiration and Morality", by continuously reviewing our performance and exploring operating models, to attract more and more industrious young students to further their education here. Over the last 50 years, ECUST has provided one group after another of elite graduates to better society.

Introduction

ECUST has three campuses at present, located respectively in

Xuhui District,

Jinshan District

and Fengxian District.

It occupies a total area of over 1.47 square kilometer, and a total construction area of 816,000 square meters. It is home to many standard sports facilities. Its library possesses 2.5 million books, 18,000 periodicals, some 48 large-size databases and web mirror databases like CA & EI.

華東理工大學
EAST CHINA UNIVERSITY OF SCIENCE AND TECHNOLOGY

学校概况

History of School of Mechanical and power engineerning

- School of Mechanical and Power Engineering is one of the three founding departments when East China University of Science and Technology was first established in 1952.
- The School began its first educational major with Chemical Machinery and Process Equipment and has since developed into one of the most well known disciplines in China with three departments in several important fields of modern engineering, technology and automation.
- The School has 176 active faculty members with 27 professors and 66 associate professors.

History of School of Mechanical and power engineerning

- **Research**
- projects in
- Process Equipment and Systems
- Mechanics and Computational Technology
- Materials Processing and Application Technology
- Failure Analysis and Safety Technology
- Fluid Machinery and Engineering
- Pressure Vessels Design
- Manufacturing and Automation, Mechanical Design Fundamentals and Tribology.

History of School of Mechanical and power engineerning

- **Research**
- Those projects are being performed in one of the School's many R&D units:
- Research Institute of Process Equipment and Pressure Vessels,
- SINOPEC (China Petroleum & Chemical Corporation) Failure Analysis & Prevention Center, Sealing Technology Center
- Shanghai Boiler and Pressure Vessel Safety Guarantee Center,
- Key Laboratory of Safety Science of Pressurized System

History of School of Mechanical and power engineerning

- **Research**
- Research Institute of Process Equipment and Pressure Vessels:
- Pressure vessel design
- Defect evaluation-take in charge of drafting standard of defect evaluation for pressure vessels GB/T19624-2004
- Structure integrity
- Failure analysis

History SPT

In China, SPT was first introduced at Tsing Hua university for neutron irradiation material property in the beginning of 1980s.

Then SPT was developed in creep testing by Prof. Zhiwen Wang (ECUST) and Prof.Ling[Najing University of Technology].

Further in tensile property and fracture toughness by Guan et al.

Because Prof. Ling will give an report in this meeting， I mainly introduce the code of SPT in this report.

History of SPT

Now, the code of SPT tesnile properties has been carried out by the China Special Equipment Inspection & Research Institute, East Chna University of Science & technology and the Nanjing university of technology, et al.

SPT code of tensile test

The code is being developed now. The code of "Small Punch Test Method for Metallic Materials" is comprised of two parts

Part A: Metallic material- Small punch testing for in-service pressure equipment -General requirements

Part B:Tensile properties at room temperature.

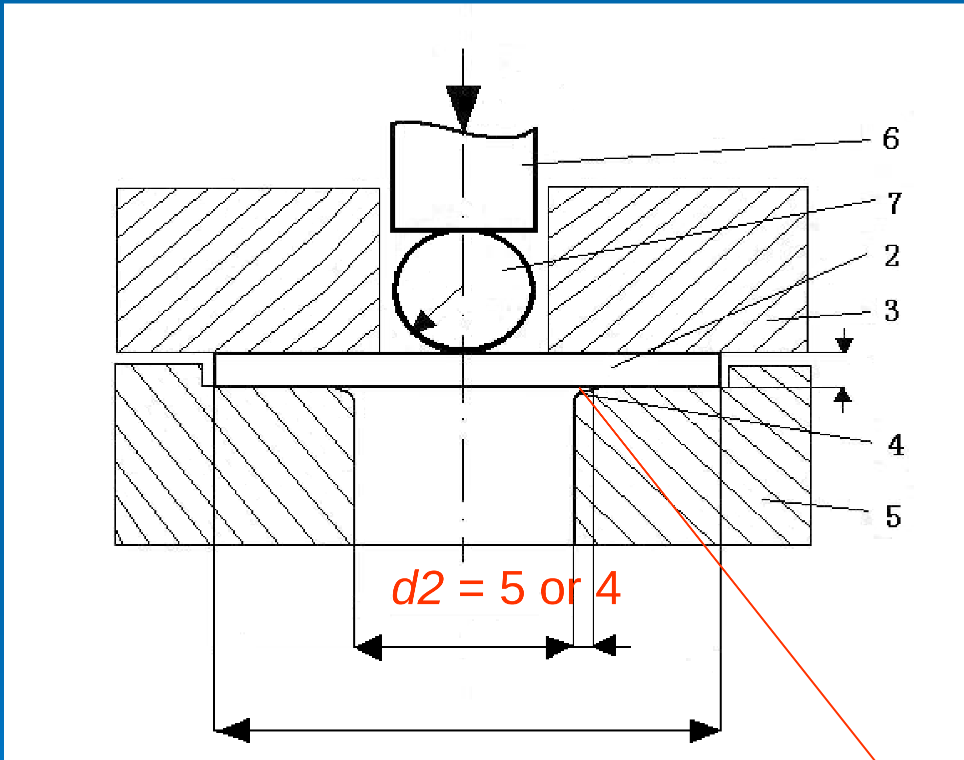
SPT code of tensile test

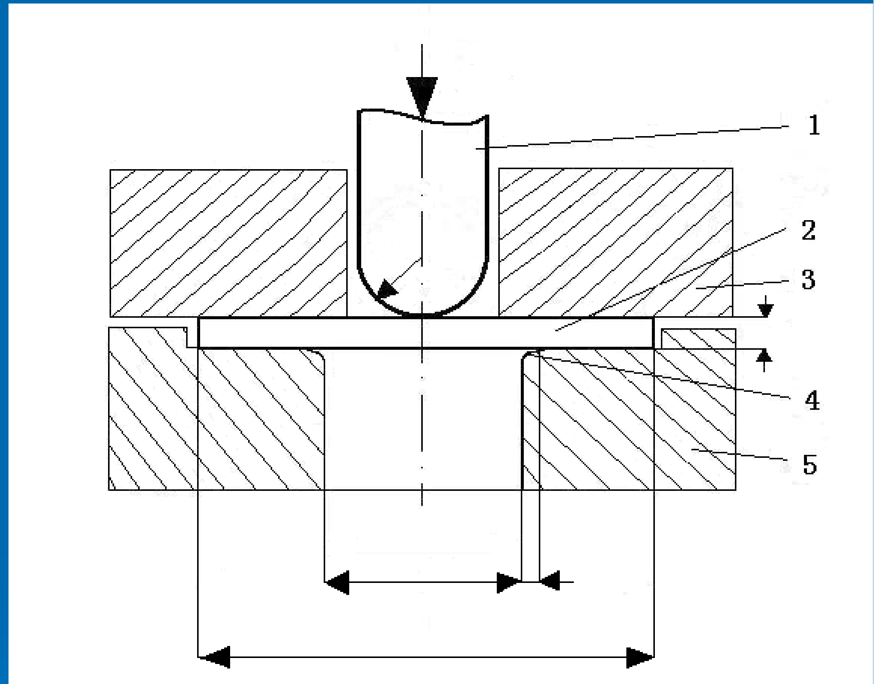
Part A general requirements

INTRODUCTION
Scope
normative references
Definitions
Samples
Appartus
Report

code of SPT

General requirements



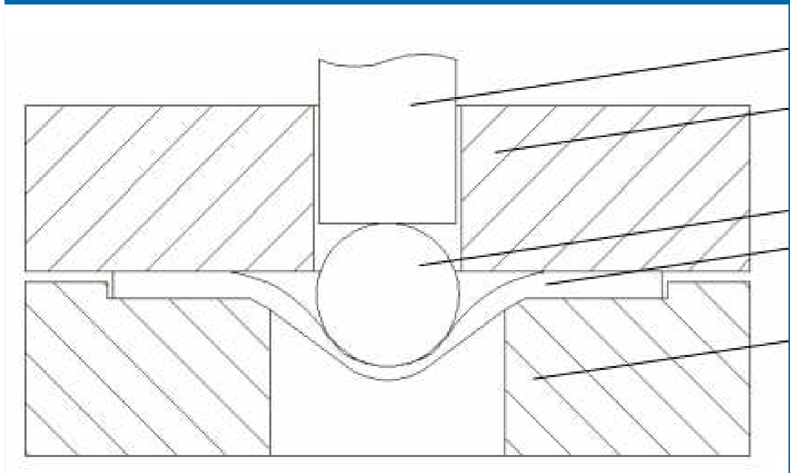


d1 = 8 or 10

Fillet radius *l* = 0.2

code of SPT

General requirements



We recommend ball:

If the ball wear, it is easy to replace

If using punch (withut ball, the punch maybe embeded in the specimen and damage the fracture when pulling the puhch from the specimen code of SPT

General requirements

Sample size：diameter *d1* = 8mm，or *d1* = 10mm；

Thickness *h* =0.5±0.01mm

Surface roughness ≤Ra0.4μm，parallel ≤0.01mm

Receiving hole : diameter; *d2* = 5mm or *d2* = 4 mm

Fillet radius *l* = 0.2mm

Table.1 specific size of specimen and equipment

Reaearch unit	size（ mm ）			
	Specimen diameter	Specimen thickness	Diameter of punch	Diameter of receiving hole
East Chinia University of Science & Technology （ tensile properties ）	10	0.5	2.5	5
East Chinia University of Science & Technolog（ creep property ）	10	0.5	2.4	5
Najing University of Technology	10	0.5	2.4	4

General requirements

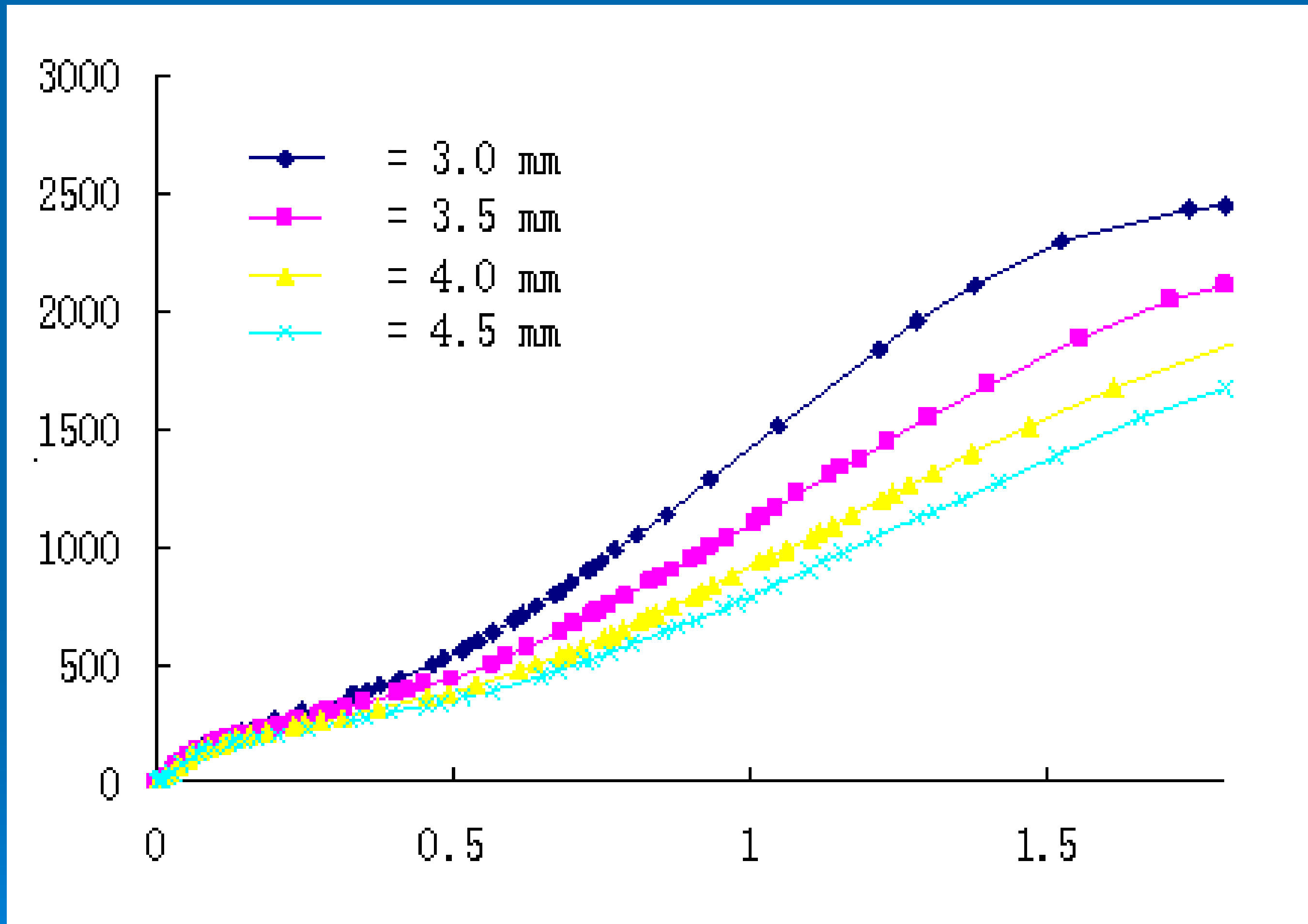
Diameter of receiving hole

the load-displacement curves of different diameter of the receiving die. It can be inferred that peak load remarkably increases with decrease ball diameter. The standard diameter of a receiving hole is defined as 5.0mm or 4.0 mm

General requirements

Diameter of receiving hole

Load/ N

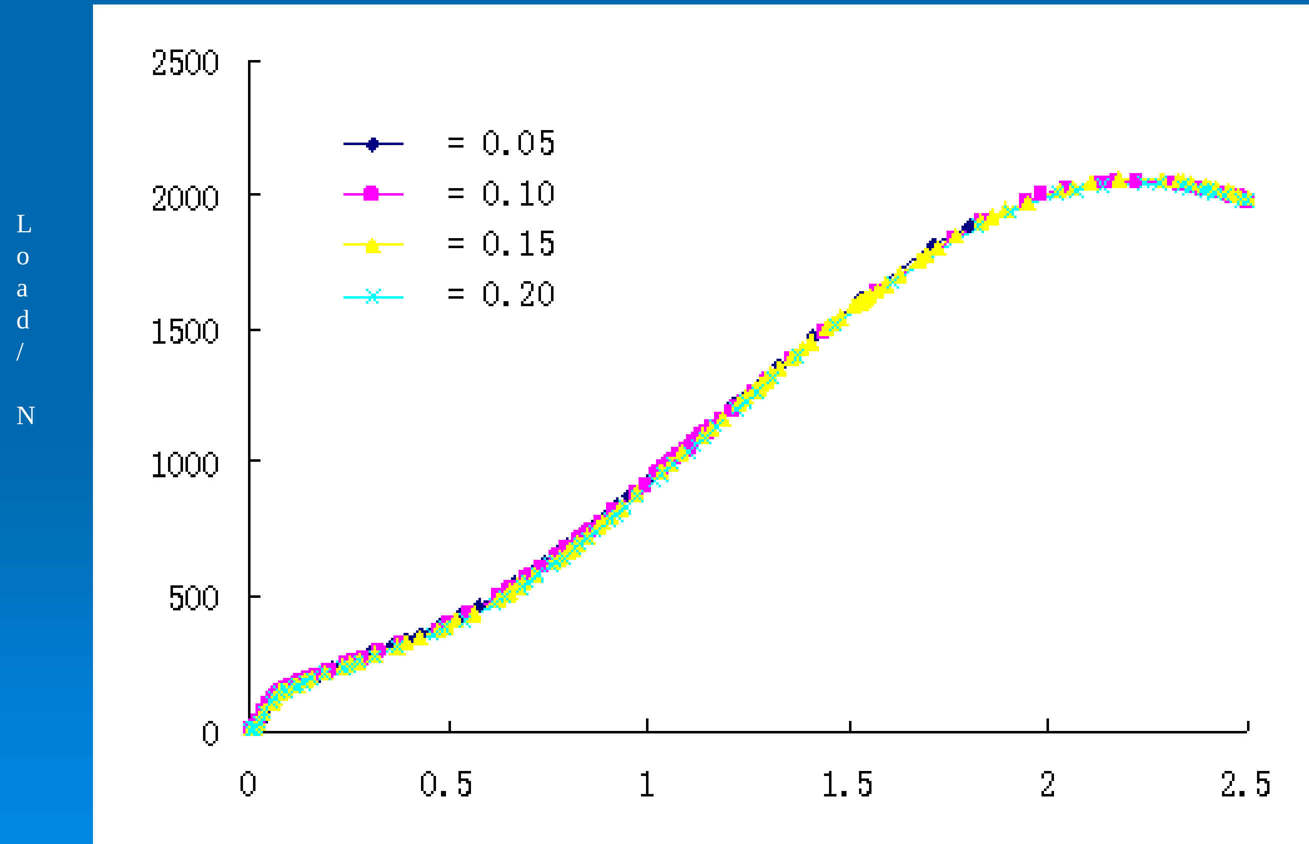


Central deflection/ mm

General requirements

Fillet radius

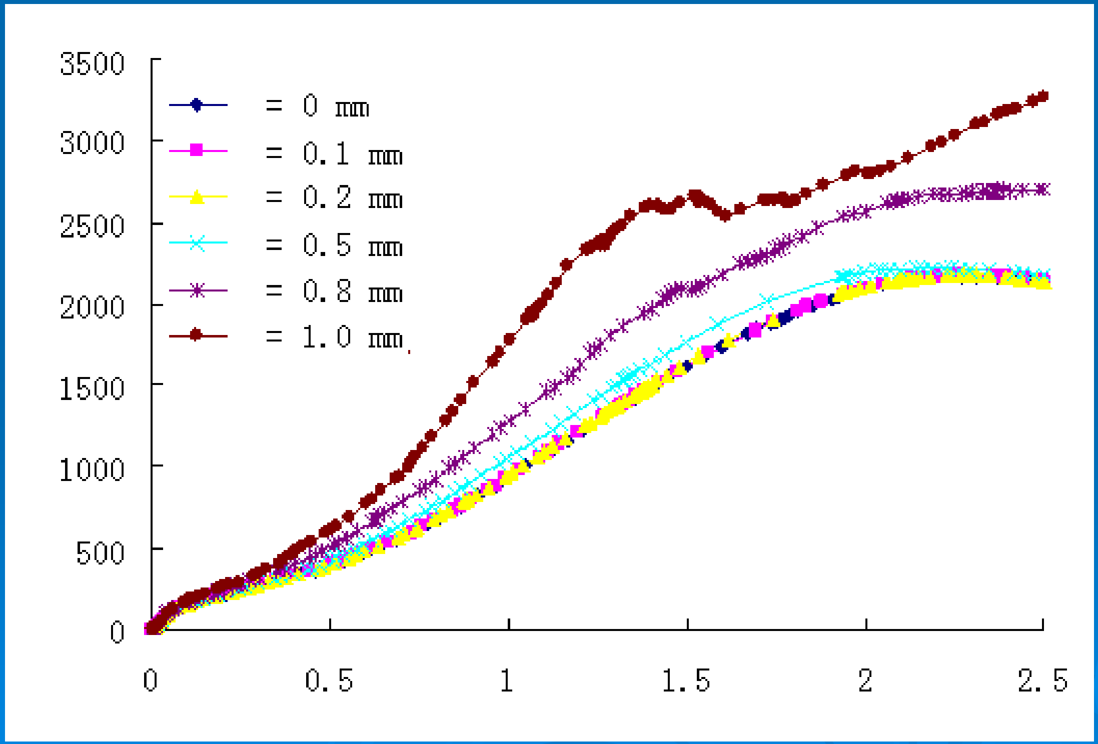
fillet radius has little effect on the SPT when the fillet radius is less than 0.2mm.



General requirements

Offsetting of the punch

Peak loads remain the same when there is varied offsettings of the punch within 0.2mm.

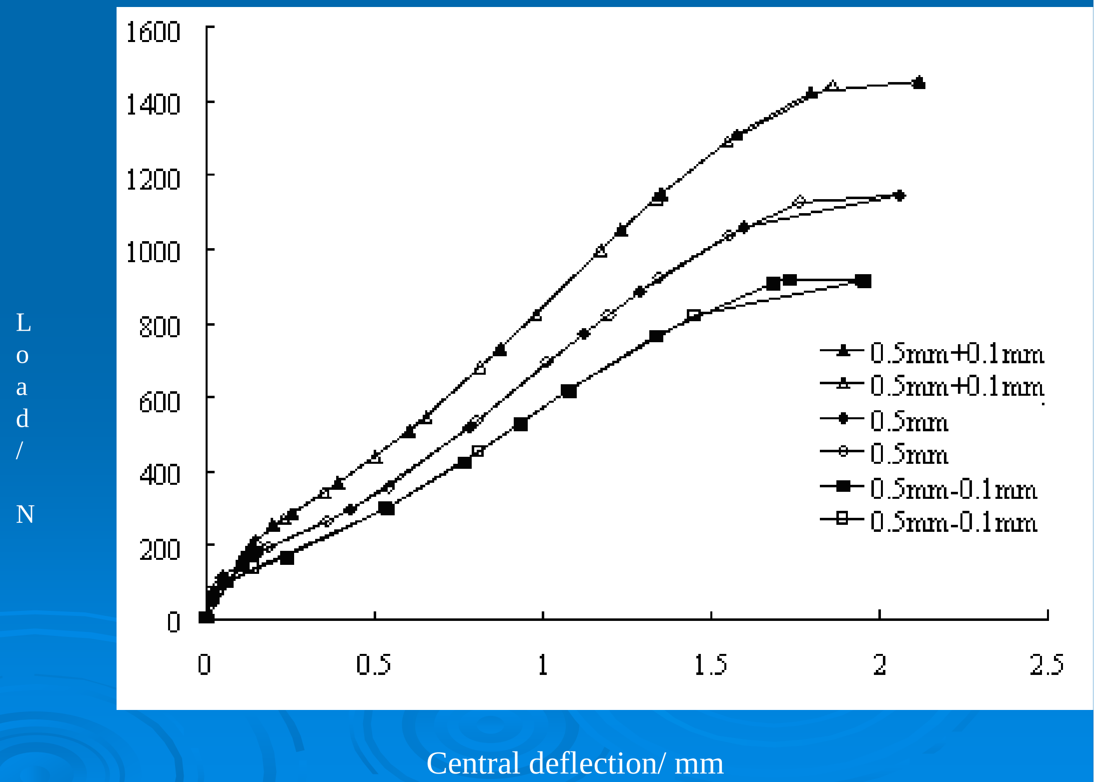


General requirements

Error of thickness of specimen

When δ=±0.01mm, the curves are repeatedly similar. Simulation and test results

The SPT curve of Q345B (yielding strength 345 Megapascal) by the tolerance of thickness at δ=±0.1mm



General requirements

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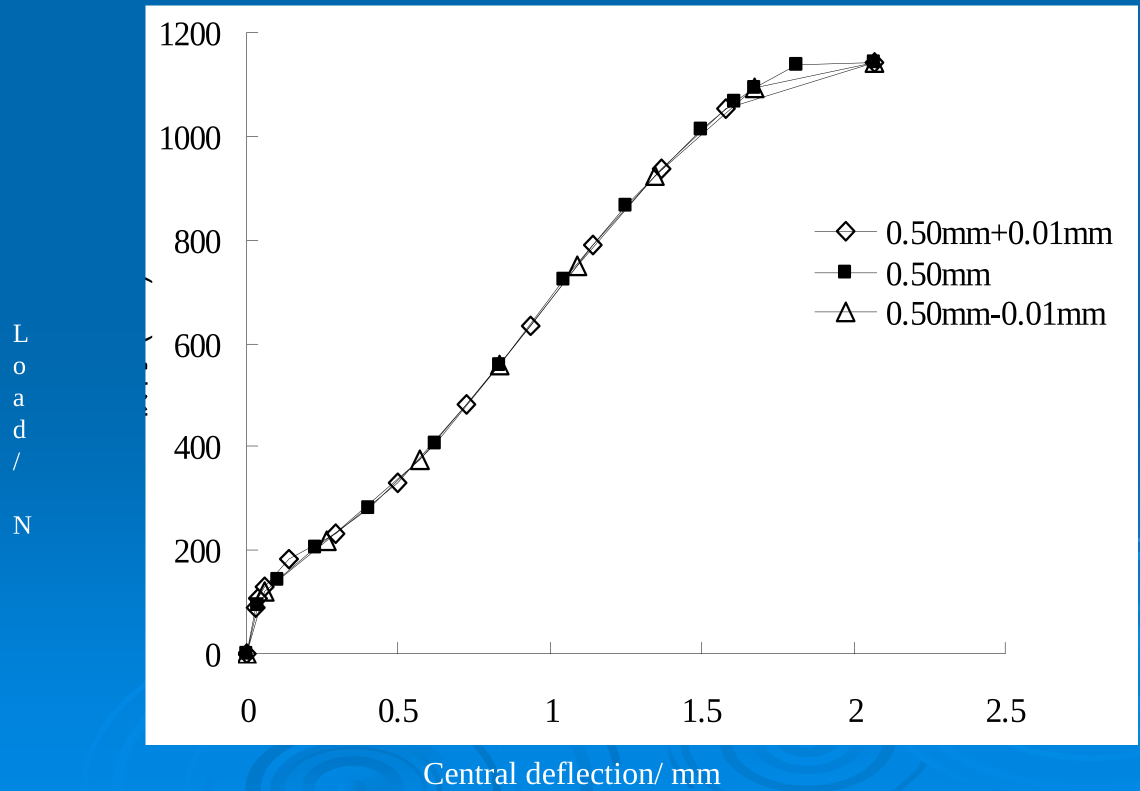
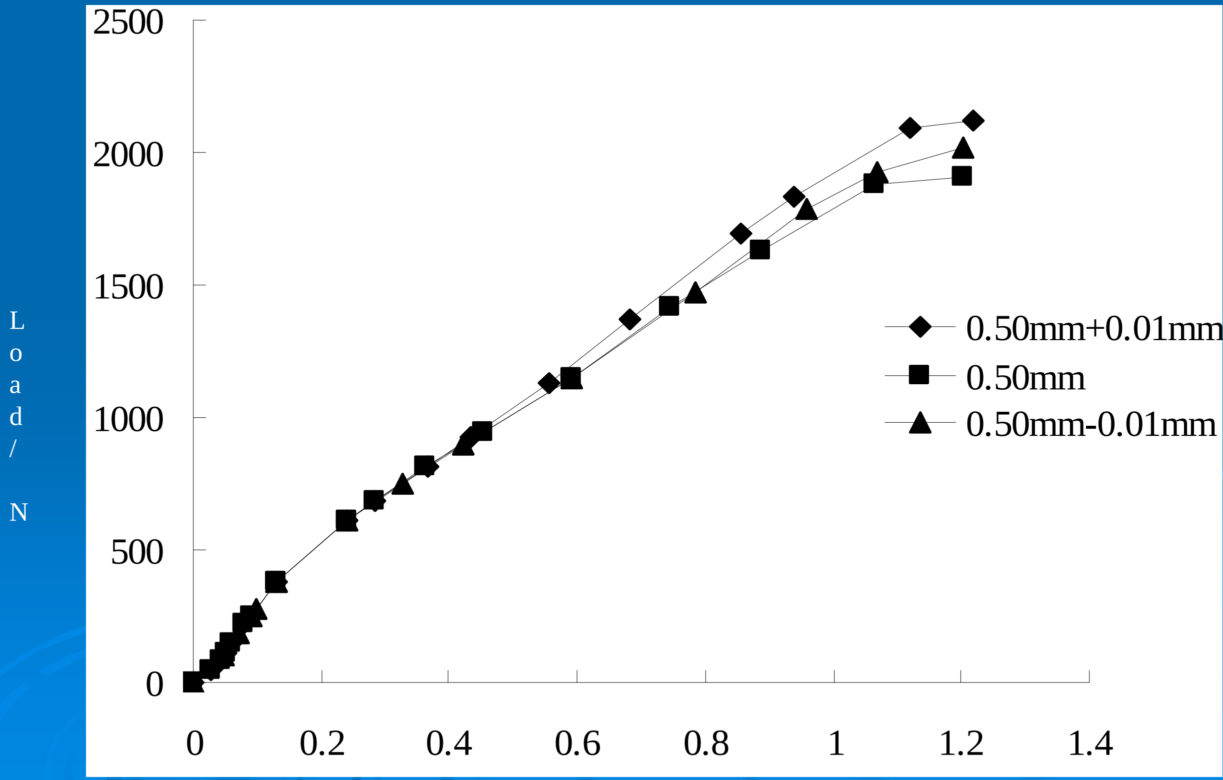


General requirements

Error of thickness of specimen

When δ=±0.01mm, the curves are repeatedly similar. Simulation and test results

The SPT curve of **37SiMnCrNiMoV** by the tolerance of thickness at δ=±0.11mm

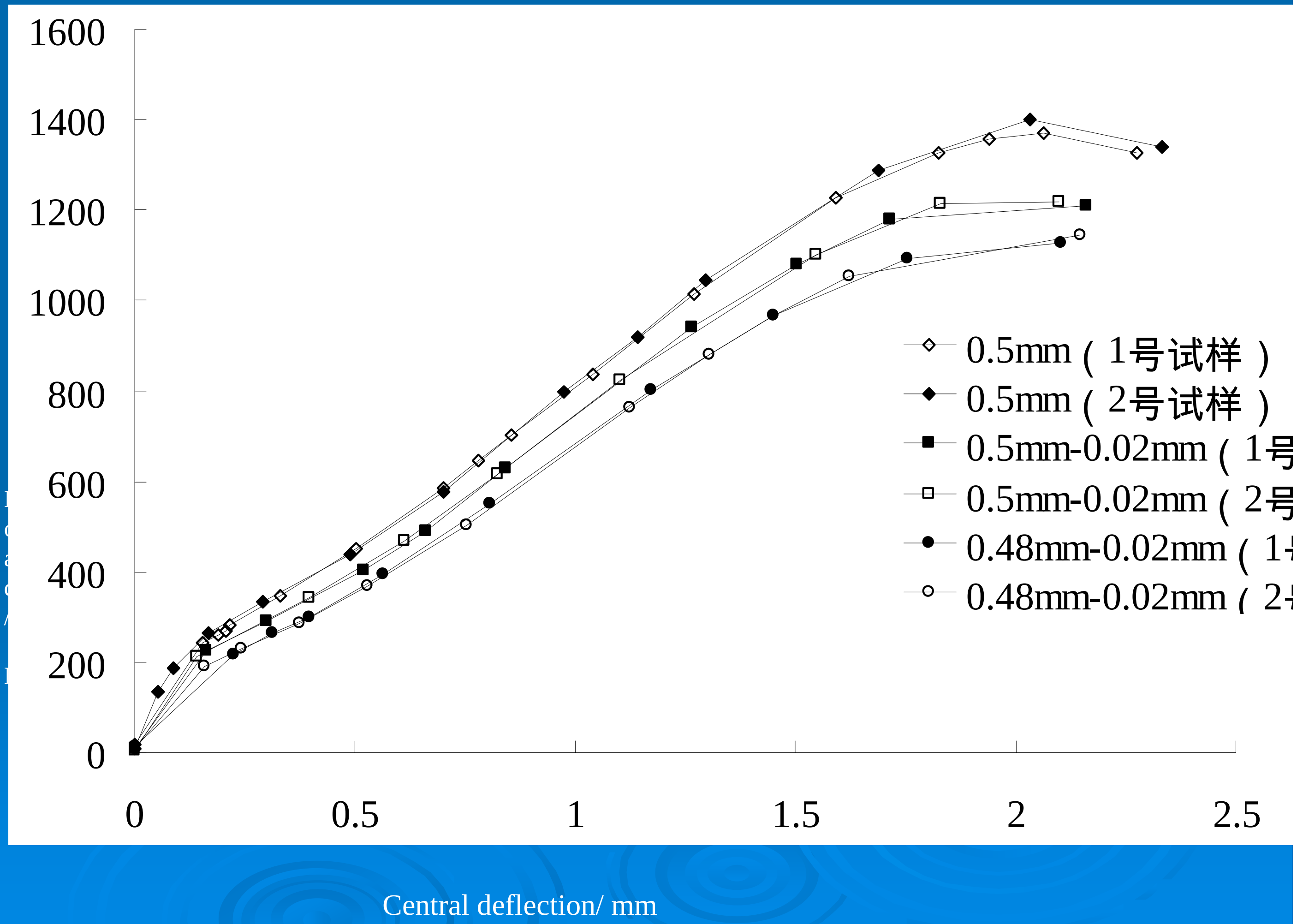


General requirements

Error of thickness of specimen

When δ=±0.01mm, the curves are repeatedly similar. Simulation and test results

The SPT curve of 12Cr1MoV by the tolerance of thickness at δ= -0.02mm



Part B Tensile properties at room temperature

Test Speed

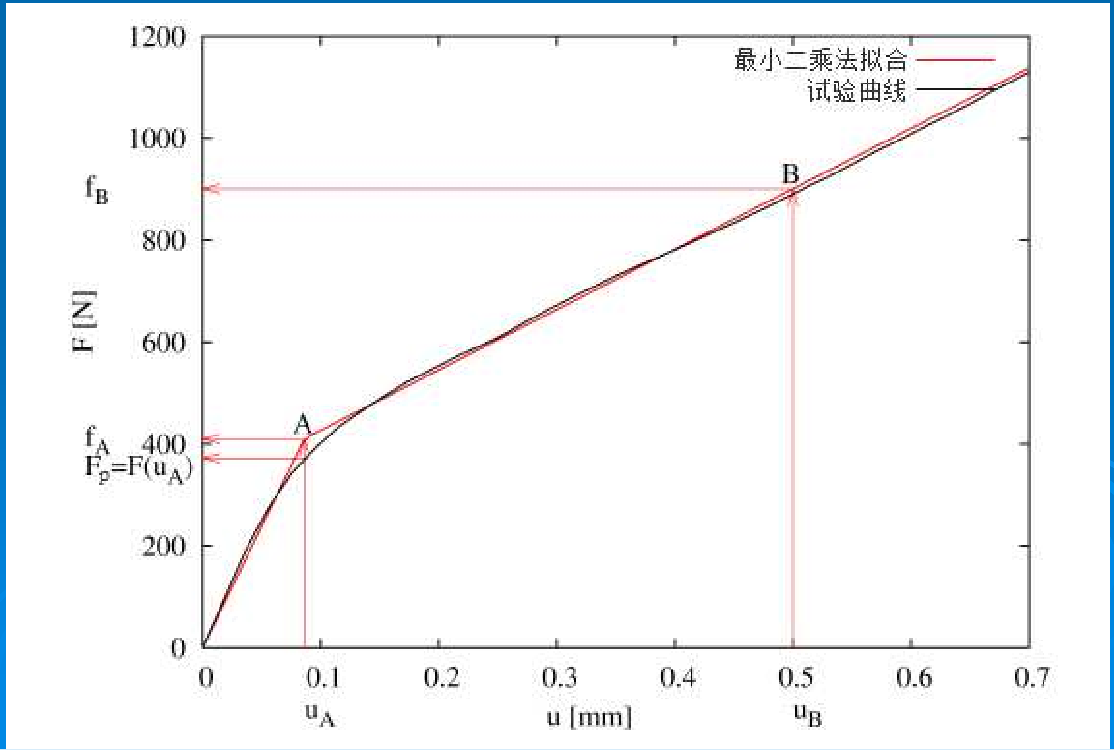
The test speed should be 0.2～0.5mm/min corresponding to standard for tensile testing.

Part B Tensile properties at room temperature

Yielding load Py [N]

Characterizing the transition from linearity to the stage associated with the spread of the yield zone through the specimen thickness.

CWA15627 method was introduced



Part B Tensile properties at room temperature

Yielding strength and ultimate tensile strength

About 60 kinds of materials were used to carry out SPT and uniaxial tensile test.

2.25Cr1Mo and 1.25Cr0.5Mo steels. The 2.25Cr1Mo steel.
2.25Cr1Mo,used for 10 years in a hydrogenation reactor with 343~482℃ and 6.9～28MPa.
1.25Cr0.5Mo , supper-press vapor pipe used for 14 years at 12MPa with 520℃
P91,
Austenitic steel 304,306
High strength steel 37SiMnCrNiMoV , 34NiCrMo16
ASTM A350 et al

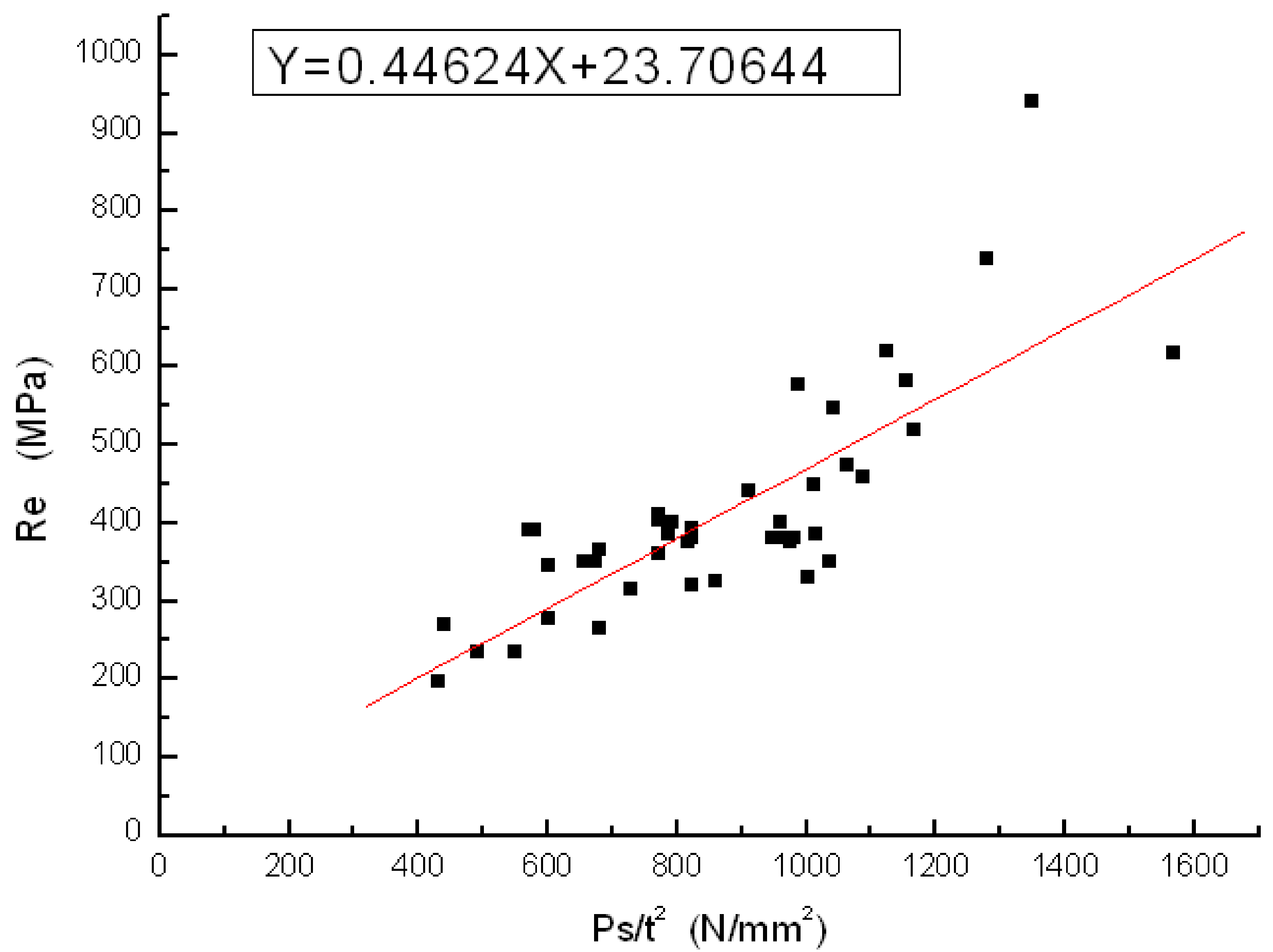
Part B Tensile properties at room temperature

Yielding strength and ultimate tensile strength

About 60 kinds of materials were used to carry out SPT and uniaxial tensile test.

$$R_e = 0.4847 P_y / t^2 + 21.359$$

$$R_m = 0.0666 P_{\max} / t^2 + 146.03$$



Y=0.44624X+23.70644
Re (MPa)
Ps/t2 (N/mm2)
0
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
1200
1400
1600

Part B Tensile properties at room temperature

Elongation

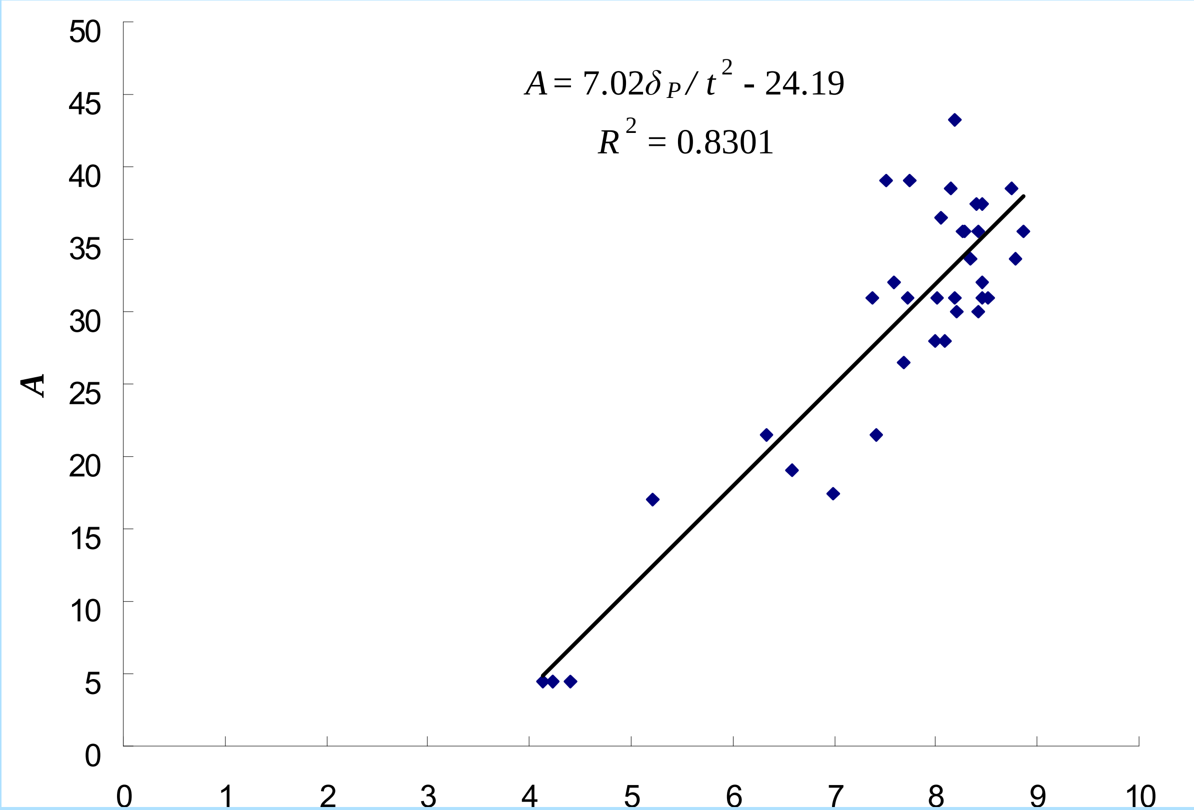
The data is very scatter.

So the materials should be devided into diferent groups.

The maximum deflection displacement of SPT maybe linearly correlated to the elongation after fracture of tensile teseach for each group, respectively.

Part B Tensile properties at room temperature

Elongation



Scatter

Mechanical property test

Mechanical properties, such as tensile, fracture toughness test were carried out since 1997 by Hao Han and Prof. Wang and Guan

图

Creep

Zhen Yang(PhD) with Prof. Zhi-wen Wang carried out creep test with 12Cr1MoV steel since 1998.

Relationship between strain and central deflection in small punch creep specimens.International Journal of Pressure Vessels and Piping 404 80 (2003) 397–404

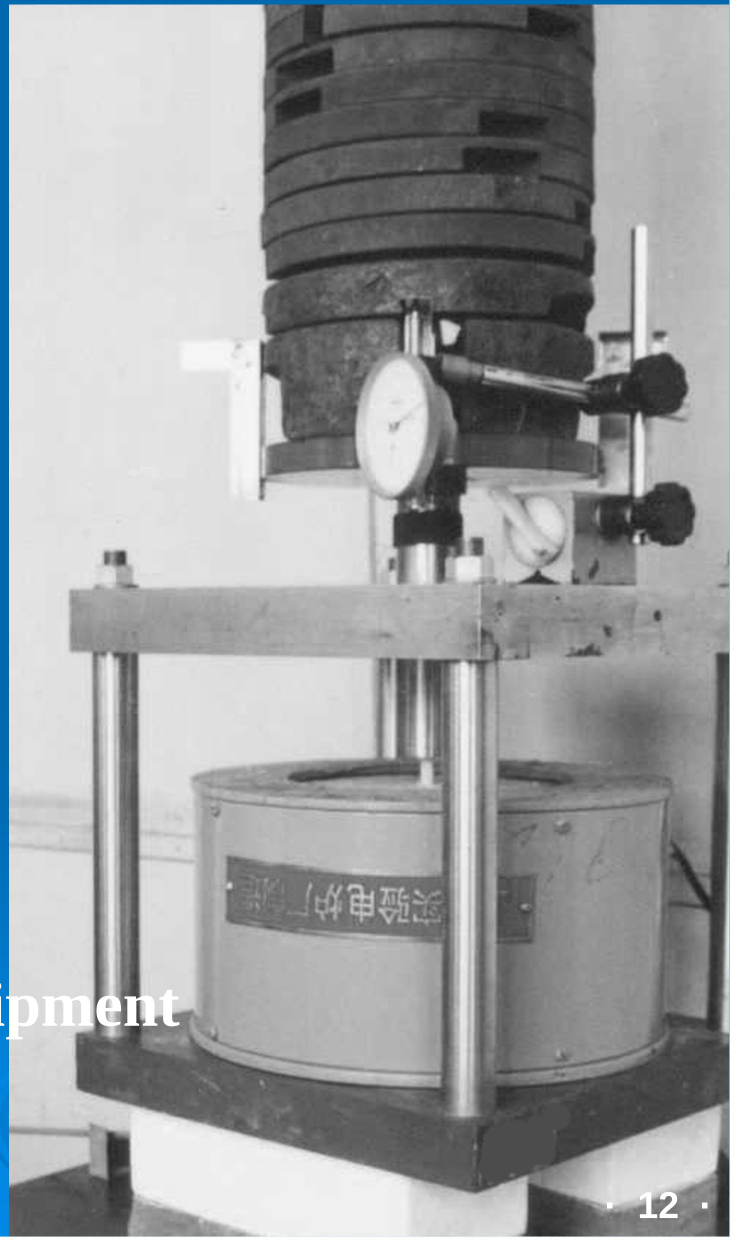
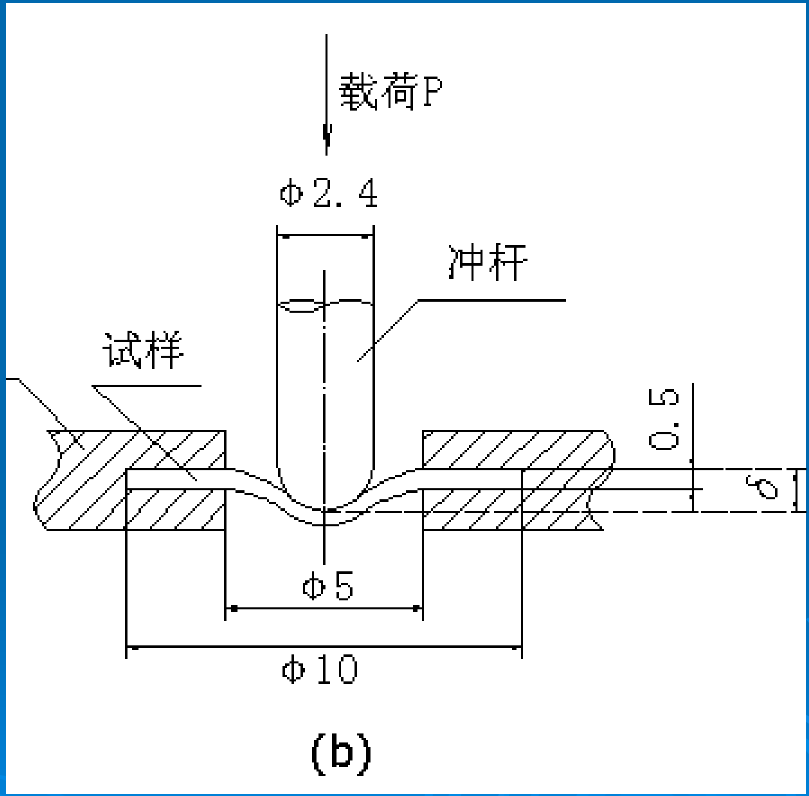


Photo of main element in small punch equipment

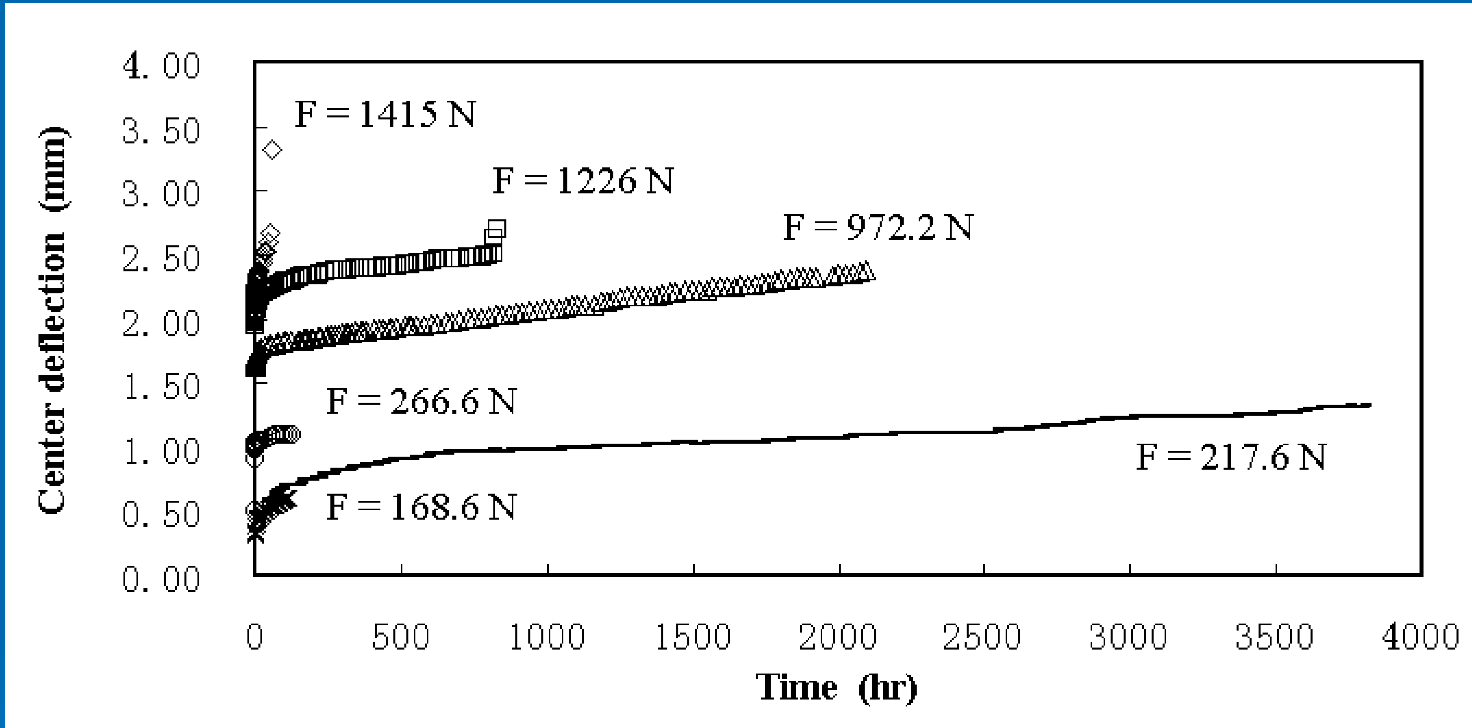
Creep

Zhen Yang(PhD) with Prof. Zhi-wen Wang carried out creep test with 12Cr1MoV steel since 1998.



Deformation of small punch creep specimen (a) before loading (b) after loadin

Creep



Typical displacement (vertical deflection) vs. time curve for a SP creep test under constant load at 540℃ for 12Cr1MoV steel

Creep

The center strain of a specimen of a certain size is deduced from a plastic membrane stretch model. The formula concerned with central deflection δ and characteristic creep strain is deduced, shown as .

$$\varepsilon_{SP} = 0.2111\delta^2 + 0.3299\delta$$

As a result, method of calculating creep strain of small punch specimen from experimental δ - t data is determined.

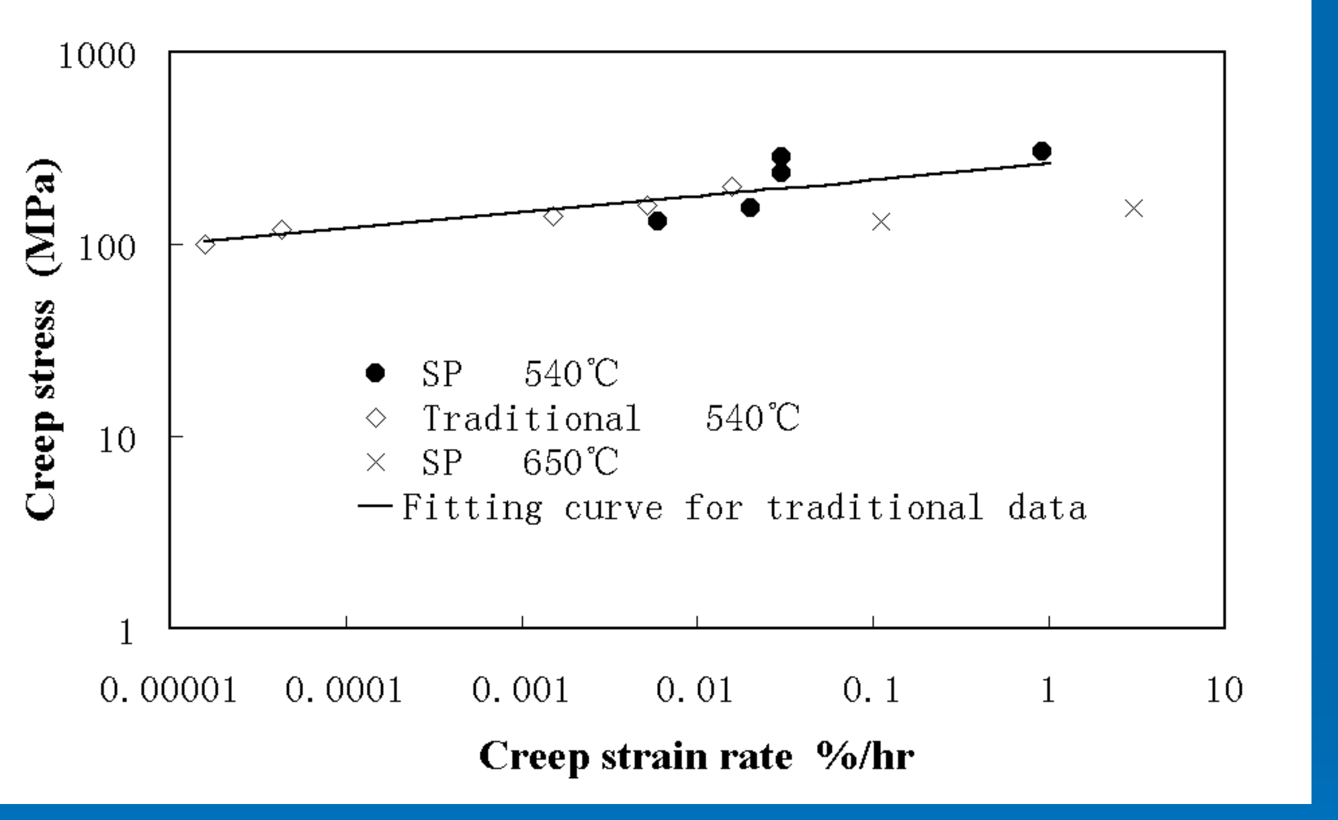
Creep

A model for calculating characteristic creep stress in a small punch specimen of a certain size is set up, with which an formula concerned with central deflection *δ*, applied load *F* and central creep stress is deduced, shown as

$$\sigma_{SP} = 0.6542\delta^{-1.1442}F$$

As a result, the method of calculating creep stress of small punch specimen from experimental *δ* - *t* data and *F* data is determined.

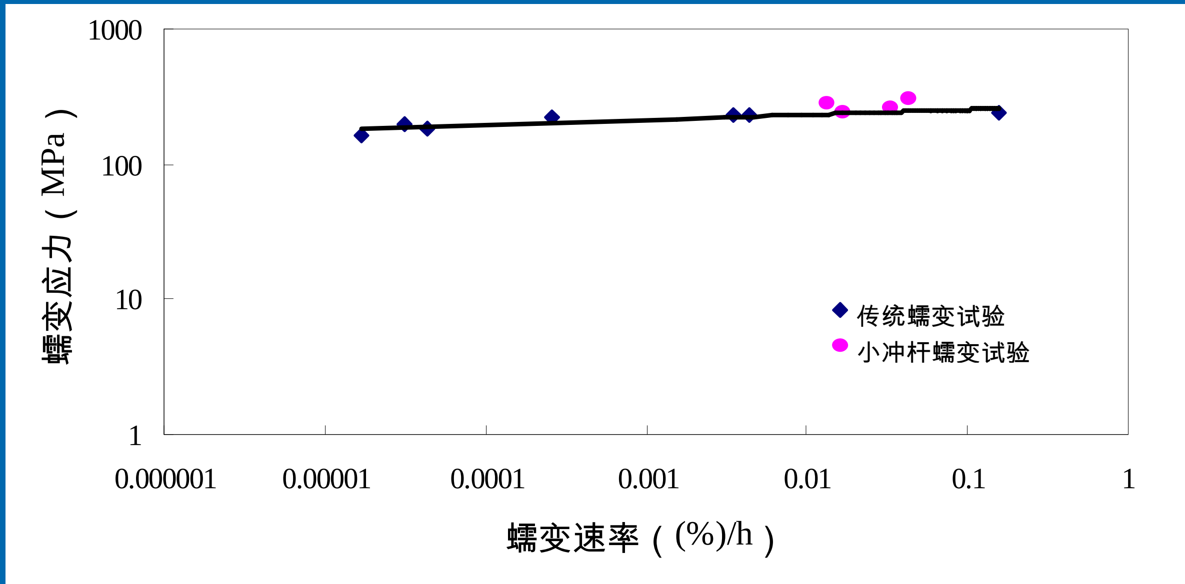
Creep



Curves of creep strain rate vs. stress for 12Cr1MoV steel

Creep

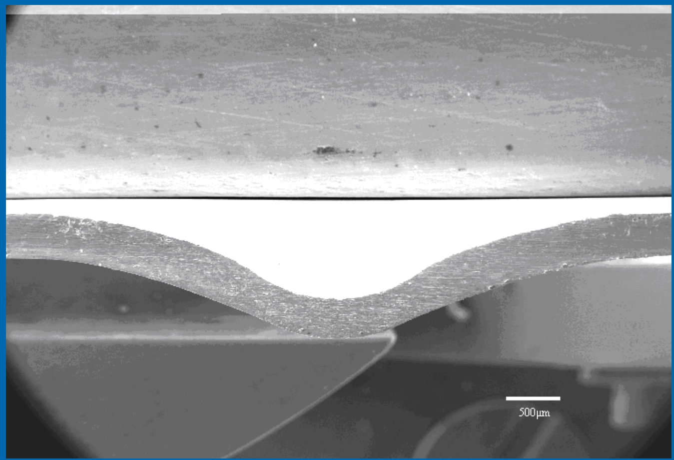
Zhanbin Li (Master) with Prof. Zhi-wen Wang carried out creep test with **commercial purity** titanium.

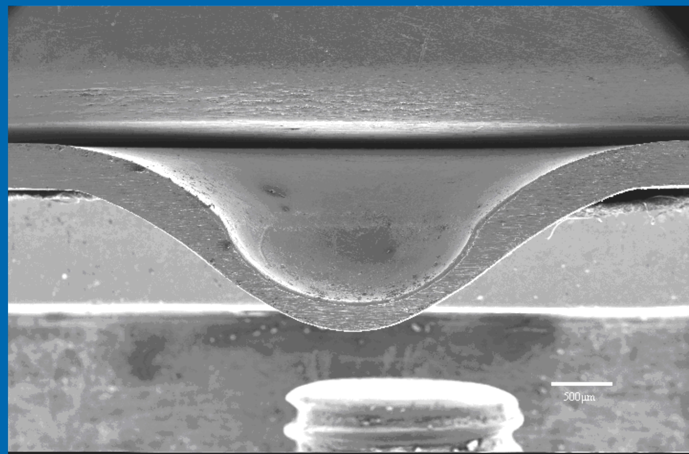


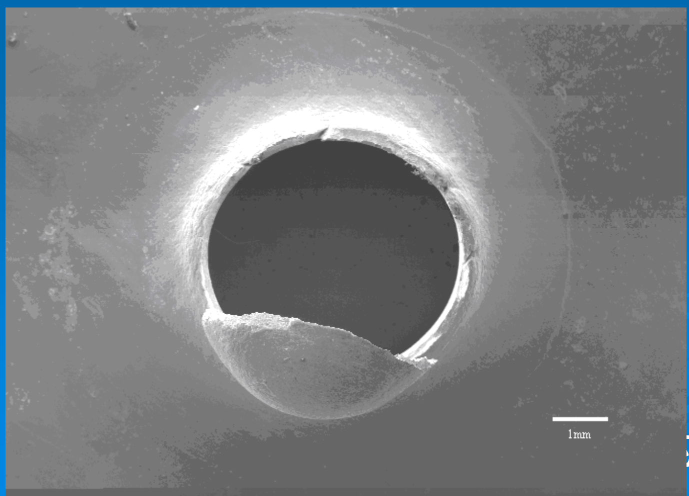
Comparison between creep rate of SP method and uniaxial tensile method of commerically purity titanium at 150℃

Norton equation:

$$\dot{\varepsilon} = 6 \times 10^{-49} \sigma^{18.551}$$







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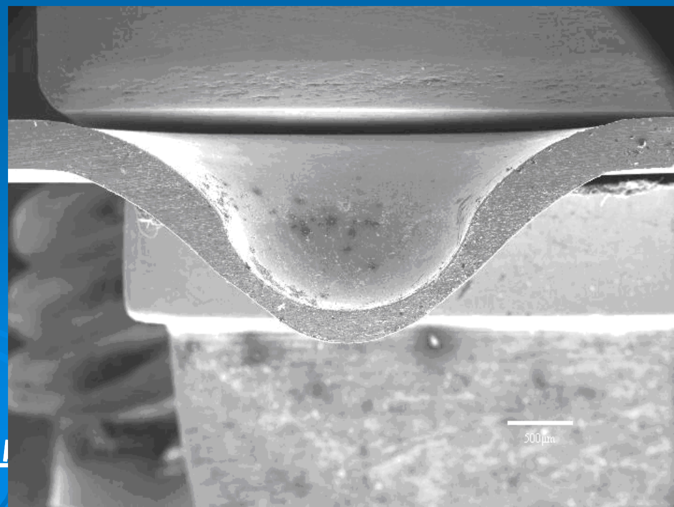

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- K.S. Guan, H.R. Bai, Z.W. Wang and Y.S. Yin . Monte-Carlo Simulation for Atomic Deposition of Amorphous Electroless Ni80P20 Coating. Acta Metallurgica Sinica. 2002, 15(5):479-486
- **Zhen Yang and Zhi-wen Wang.Relationship between strain and central deflection in small punch creep specimens**
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Thanks !