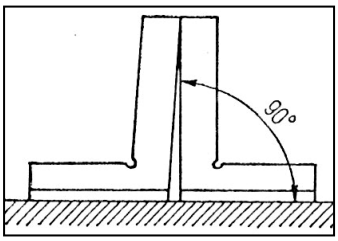
Third School Year

MEASURING - ANGLES, SURFACE QUALITY, MATERIAL DEFECTS

Measuring Angles

Angles are ***measured*** either ***directly*** with ***protractors***, ***set squares***, ***gauges*** or ***water levels*** or ***indirectly*** so that other ***angles*** are ***measured*** and the size of an ***angle*** is calculated. That is why a ***sine bar*** is used for example.

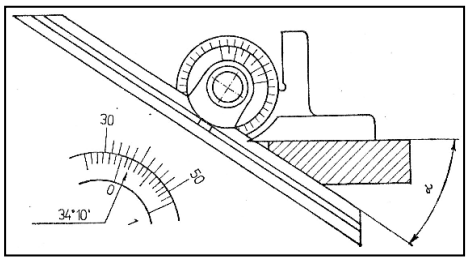


Set squares

They are fixed ***measuring*** instruments for checking various ***angles***, and most often right ***angles***. A ***set square*** is placed on a checked part and the daylight between the checked ***angle*** and the ***measuring*** instrument is ***observed***. The more uniform the daylight is, the more precise the ***rectangularity***.

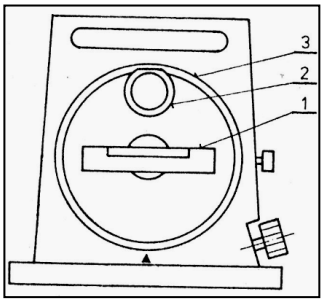
Angle gauges

They are hardened steel plates which are ground and ***lapping*** with precisely produced ***angles***.
We can make an ***arbitrary angle*** with one-minute accuracy from it.



Universal *protractor*

It has two ***perpendicular*** arms together and one changeable ***rule***. Similar to a ***slide gauge*** it has a fixed and a rotating ***scale*** with a nonius. The ***scale*** lines on the rotating ***scale*** show how many times 5´ should be added to the total number of degrees. The accuracy of ***subtraction*** is 5 minutes.



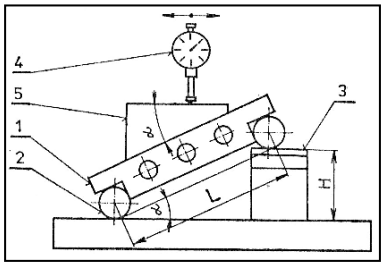
Angle *water level* – optical level

It is used for ***measuring*** a surface ***angle*** in regards to a horizontal level. We determine the horizontal level by a ***water level*** and we ***subtract*** the ***gradient*** (of the ***angle***) on the ***scale*** by a microscope. The accuracy of ***subtraction*** is 1 minute.

1 – ***water level***
2 – ***eyepiece***
3 – ***scale***

Sine bar

It is a small ground plate with fixed ***cylinders*** with the same diameter in the precise ***axial*** distance L. During ***measurement*** the ***sine bar*** is positioned by one ***cylinder*** on a flat plate. Under the other ***cylinder*** a ***slip gauge*** with the dimension H is ***inserted***. The ***angle*** is calculated from the ***relation***: $\sin \alpha = H / L$.



1 – ***bar***
2 – ***cylinder***
3 – ***gauges***
4 – ***dial*** indicator
5 – measured part

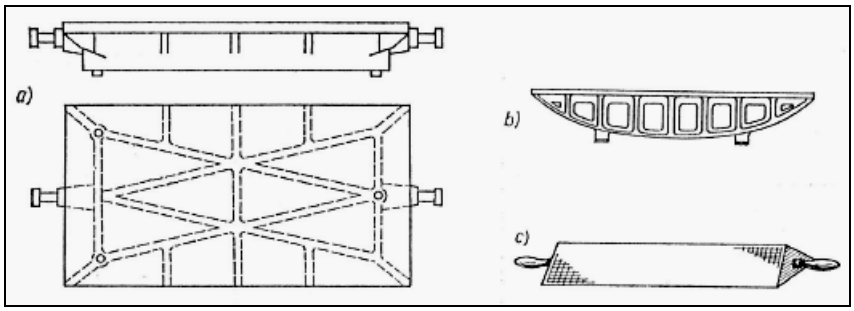
SURFACE QUALITY INSPECTION

When inspecting surface quality we ***measure evenness*** and ***roughness***.
The ***evenness*** or ***waviness*** of a surface is formed by the affects of a machine, tool and workpiece together. According to it, we can ***evaluate*** how the geometrical form of a surface is kept.

Surface ***roughness*** is formed as a tool mark during ***chip*** separation.

Inspection of *evenness*

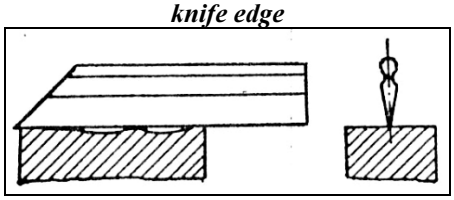
We check surface ***evenness*** be comparing it with another surface. Surface plates, straight edges, straight prisms and ***knife edges*** are used for it. These ***measuring*** tools have very precise edges and surfaces produced by ***grinding*** and ***lapping***.



a) surface plate, b) straight edge, c) straight prism

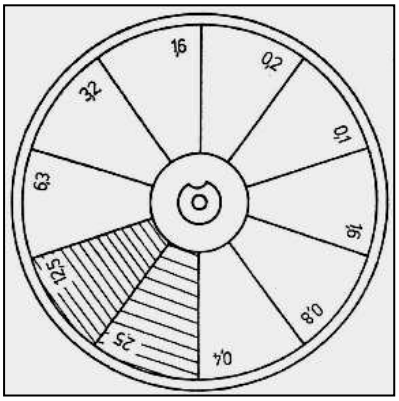
For the checking of narrow long surfaces **straight edges** are used.
We use ***knife edges*** for short precise surfaces. The daylight is checked.

knife edge



Surface plates are produced from grey cast iron or from stone (granite). The plate is painted, a checking surface is placed on it and is moved with it. In raised places ***traces*** of paint are left. According to the size and amount of painted surfaces the quality of checked surfaces is ***evaluated***.

Measuring surface *roughness*



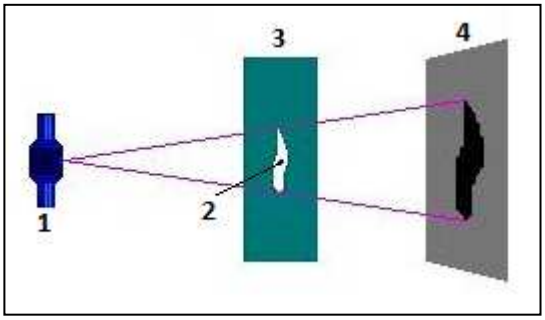
We determine surface ***roughness*** by comparing it with the ***roughness* sample diagram**.
A sample has to be made in the same way as a workpiece.
Roughness can be measured more precisely with ***roughness gauges***.

←***Roughness*** sample diagram

MEASURING EXTERNAL AND INTERNAL MATERIAL DEFECTS

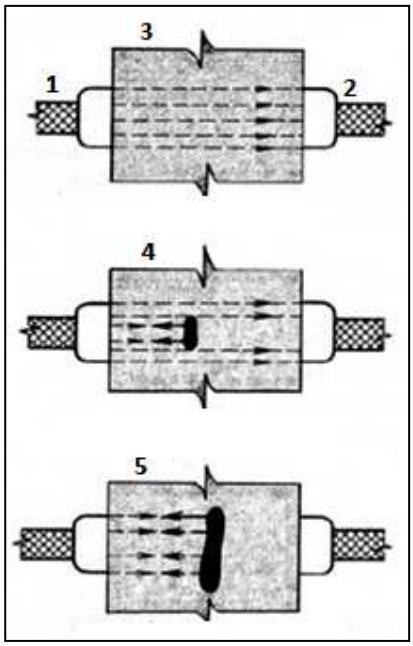
In the production and processing of metals various material ***defects*** can ***occur***. These ***defects*** can be difficult to determine. Among the most common ***defects*** there are ***bubbles*** or external and internal ***cracks***. The branch, which deals with determining these ***defects***, is called defectoscopy.

X-ray radiation inspection



1…source of x-ray radiation
2…defect
3…material being tested
4…film

X-ray radiation inspection is mostly used for inspecting ***welds***.
In the course of testing a material by x-ray radiation this intensity is ***weakened***.
When film cassettes are placed behind testing materials hidden material ***defects*** are shown as a blackening of various intensities in the form of ***defects***. Radiation can cause ***burns*** and can seriously ***endanger*** health.



Inspection using *ultrasound*

Ultrasound waves are short waves ***inaudible*** to the human ear. They expand in a straight line. When transferring from one environment to another they ***reflect*** and break at their boundaries.
An ***ultrasound probe*** (a transmitter) ***transmits*** short term ***ultrasound*** impulses into an object being tested. These impulses ***reflect*** from the hidden ***defects*** and from the opposite surface of the material. After reflection the ***ultrasound*** waves are received by the receiver.
If there is a ***defect*** in a material, a reflected wave appears on its surface and a sound with lower energy comes to the receiving ***probe***, which is shown by a drop of the little hand of the ***measuring*** instrument.
In testing material with ***ultrasound*** it is necessary to properly clean an object being tested.
When sound is transferred from the ***ultrasound probe*** to the material being tested it is necessary to use a connecting (bonding) layer (vaseline, kerosene and similar substances.), or to prevent the transfer of ***ultrasound*** to the object being tested by a layer of air between the object and the ***probe***.

1…***transmitting probe***
2…receiving ***probe***
3…material without ***defects***
4…material with a ***defect*** smaller than the ***bundle*** of ***ultrasound*** waves
5…material with a ***defect*** bigger than the ***bundle*** of ***ultrasound*** waves

Inspection using the magnetic method

By inspecting using the magnetic method we determine ***cracks*** on the surface of materials. Magnetic fields are created in the tested material.

In the places where there are ***cracks*** there are magnetic lines of force pressed to the surface. Oil is ***poured*** on the object being tested, in which particles of light iron powder are ***dispersed*** in it. Iron particles hold onto the surface of parts in places where magnetic lines of force come out of the surface

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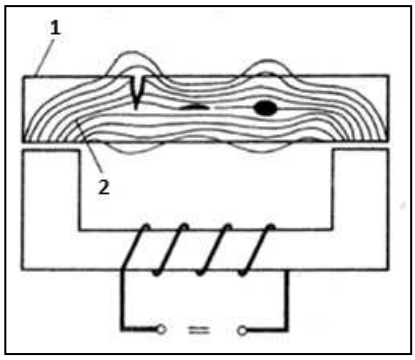
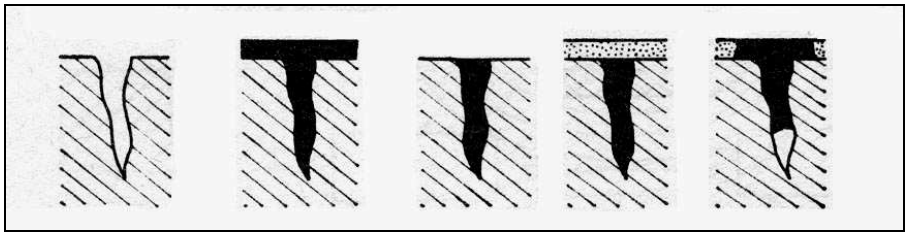


1…material being tested
2…longitudinal magnetic field

Capillary inspection

On the surface of the cleaned material being tested a fluid is applied (paint kerosene, fluorescent liquid), which ***penetrates*** inside of ***cracks***. The object is then rinsed and dried, and a developer is applied on it (mostly in the form of a spray). After several minutes a liquid capillarity comes out of the location of the ***defect*** on the surface of the object and a ***defect*** picture is formed. When we use a fluorescent liquid we observe an object in the dark under ultraviolet light. The drawing of the ***defect*** is sharper.



Literature and sources used:
Jan Šulc a kol., Technologická a strojnická měření, SNTL
Milan Martinák, Kontrola a měření, SNTL

VOCABULARY

angle	úhel	**measurement**	měření
arbitrary	libovolný	**measuring**	měření
axial	osový	**observe**	pozorovat, sledovat
bar	pravítko	**occur**	vyskytovat se
bubble	bublina	**penetrate**	vnikat, pronikat
bundle	svazek	**perpendicular**	kolmý
burn	popálenina	**pour**	nalévat
chip	tříska	**probe**	sonda
crack	trhlina	**protractor**	úhloměr
cylinder	váleček	**rectangularity**	pravoúhlost
defect	vada	**reflect**	odrážet
dial indicator	číselníkový úchylkoměr	**relation**	vztah
		roughness	drsnost
directly	přímo	**rule**	pravítko
disperse	rozptýlit, rozsypat	**scale**	stupnice
endanger	ohrožení	**set square**	úhelník
evaluate	hodnotit	**sine bar**	sinusové pravítko
evenness	rovinnost	**slide gauge**	posuvné měřítko
eyepiece	okulár	**slip gauge**	základní měrka
gauge	úhlová měrka	**subtract**	odčítat
gradient	sklon	**subtraction**	odčítání
grinding	broušení	**trace**	stopa
inaudible	neslyšitelný	**transmit**	přenášet, vysílat
indirectly	nepřímo	**ultrasound**	ultrazvuk
insert	vkládat	**water level**	vodováha
knife edge	nožové pravítko	**waviness**	vlnitost
lap	lapování, lapovat	**weaken**	slábnout, oslabit
measure	měřit	**weld**	svar

COMPREHENSION QUESTIONS

1. How do we measure angles?
2. Can you describe a universal protractor?
3. What do we measure when inspecting surface quality?
4. How do we measure surface roughness?
5. How do we measure external and internal material defects?
6. Can you explain capillary inspection?

EXERCISES

1. Letter tiles - Unscramble the tiles to reveal a message. Then translate in Czech.

E T	E M	S ,	I T H	S Q U	W A	L E S	, S
D W	L E	S .	E A S	A N G	A R E	A R	O R
O T R	U R E	T E R	V E L	O R S	P R	A C T	G E S
G A U							

2. Translate the following phrases into English:

1	*sinusové pravítko*	6	*přímo a nepřímo*
2	*přesnost odčítání*	7	*číselníkový úchylkoměr*
3	*magnetická metoda*	8	*ultrazvukové vlny*
4	*vada materiálu*	9	*broušení a lapování*
5	*vysílací sonda*	10	*podélné magnetické pole*

3. Word search with a hidden message - 12 words were placed into the puzzle. Then find the hidden message and translate.

D	D	I	A	L	I	N	S	D	I	U	E	C	A	T
O	I	R	V	K	P	U	Y	G	L	N	T	L	D	Q
Q	U	M	D	R	R	W	G	T	T	L	A	I	X	A
D	L	U	S	F	W	E	R	P	T	S	U	E	G	K
A	F	K	A	E	F	A	L	P	I	E	L	R	E	L
X	G	C	G	U	S	D	I	G	P	Y	A	U	D	N
C	E	U	T	O	K	K	X	G	N	H	V	S	L	U
T	A	A	U	L	P	W	C	Z	Q	A	E	A	E	C
G	X	N	M	N	J	G	D	A	I	T	Y	E	W	T
B	D	H	P	L	N	E	M	N	P	Q	T	M	C	O
P	L	J	A	U	F	S	P	Q	S	C	A	L	E	P
J	Y	K	C	E	P	I	Z	H	I	R	T	R	O	H
N	Y	B	C	K	L	S	Q	Q	O	I	X	U	K	N
W	N	T	K	K	S	P	I	E	V	A	R	C	H	W
I	D	H	R	M	D	F	F	G	Z	Q	K	J	R	M

ANGLE	AXIAL	DEFECT
EVALUATE	FLUID	GAUGE
MEASURE	POUR	SCALE
SURFACE	ULTRASOUND	WELD

Hidden message

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EXERCISES – KEY FOR TEACHERS

1. Angles are measured with protractors, set squares, gauges or water levels.

2. Translate the following phrases into English:

1	*sine bar*	6	*directly and indirectly*
2	*accuracy of subtraction*	7	*dial indicator*
3	*magnetic method*	8	*ultrasound waves*
4	*material defect*	9	*grinding and lapping*
5	*transmitting probe*	10	*longitudinal magnetic field*

3. Word search with a hidden message – ***dial indicator / číselníkový úchylkoměr***