25. Shifting of the neutral at a v-bending process of AISI 1015 steel plate

by Rendi Reynaldi

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21	**Engagement**	
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Measures average sentence length

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words per sentence

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Shifting of the neutral line at a v-bending process of AISI 1015 steel plate

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Abstract. During a forming process of steel plate microstructural changes occurs in the material. The outside part of the material experiences tension while compression stress takes place in the inner side. Constant uniaxial load, speed and temperature were applied on the V bending of 4 mm thick low carbon steel plate. Microstructural observation and hardness test were carried out on the cross-section area of the plate to assess the changes within the material. It is revealed that an offset of the imaginary neutral line to the inner side has occurred. The elongation of stretched material on the outer side, which is associated with microstructural changes of grain shape, orientation and hardness value does not exceed the proportional plastic area.

Introduction

Deformation in the bending process

V bending is one of the most common forming technologies that is applicable in sheet metal forming. In V bending processes the sheet material was cut in angles of 0°, 45° and 90° throughout the rolling direction. and the obtained spring-back and -go amounts were examined after the bending process [1]. The effect of material thickness on bending processes was reported in previous studies [2].

Stress state

The influence of plate thickness has been observed. Stress state determination numerical analysis during the bending process was applied by using.

SimufactForming v10 program package [3]. It was found that there is no significant difference in values of stress for different sheet thicknesses. Figure 1 shows the stress state of plate for various thickness.

2

Figure 1. Stress state for different thickness [3].

Grain deformation

Microstructural characterization and deformation of X10CrAlSi24 Sheet Material by applying V- Bending process has been carried out [4]. It was observed that at 4 mm thick steel plate the increased bending angle had remarkable effect o, the grain orientation and crack that might be occured. The grain orientation is mostly tangential to the center of the bending radii.

Grain size, orientation and its influence to the mechanical properties

The hardness is mainly governed by the average grain size and is independent of the grain shape or the grain aspect ratio. The ductility (in terms of the reduction in area) is influenced by the grain aspect ratio. In contrast, the ultimate tensile strength is independent of the grain aspect ratio but shows an explicit dependency on the specimen orientation [5]. The change in grain size accompanies a plastic deformation determines the change in strength of a polycrystalline material as shown in Hall and Petch's equation. The equation shows an increase in strength by decreasing the grain diameter. Hardness itself is defined as the ability of a material to resist against the penetration of other harder objects and its measurement is based on plastic deformation experienced by the material.

When a quasi-static deformation occur, the mechanical properties are controlled by processing parameters (strain, strain rate, deformation temperature and cooling rate). The level of grain size modification does not cause any significant deviations in material behavior comparing to coarsegrained microstructures [6].

Design of experiment

Material

For the purposes of this study low carbon steel plates AISI 1015 with the size of 200mm length, 20 mm width and 4 mm thick were used. Table 1 describes the chemical composition of the material.

Table 1. Elemental composition of sample.

Material

Elements in weight %

C

Si

Mn

Cr

Ni

Mo

P

S

other

Low

0.12

0.03

0.56

-

-

-

0.007

0.005

-

Initial microstructure and normalizing condition

The initial material has inhomogenous[70,71] grain shape, grain orientation and[72] grain size, which might cause any distortion. Normalizing is carried out on the material to homogenize the microstructure and eliminating stresses caused by the previous rolling process.[73] The material is heated up to 900°C and followed by air cooling.

Speed and temperature of bending

Since[74] Cracks can evenly be distributed all over the surface of plates and are oriented in the rolling direction and in[75] most cases cracks[76] are fully[77] filled with an iron oxide [7]. Steel[78] plate has therefore[79,80] to be grinded[81] to produce a smooth

surface and minimize the occurance of crack initiating notch. Bending is carried out on samples with V bending tools to form 90° plate. The bending process is done at constant speed of 120 mm.s-1 and ambient temperature of 23°C.

Measuring the strain

Prior to the bending process samples are marked at 4 positions as described in the figure 2. The distance b is equal to one eighth of the inner circumference, which corresponds to 45º of bending. Two lines are marked within b in a similar distance, so that three bands are obtained. The elongation after completion of the bending is determined by calculating the difference between the final distance of strips and the initial distance. The elongation value is then compared and analysed with the tensile diagram of the material.

Figure 2. Marking line of samples.

Measuring the hardness

Hardness test is carried out at several position along the marking lines I to IV Microvickers hardness testing as per ASTM E-384 is considered the suitable method for analysing the mechanical properties of material. Small load of the test enables the measurement of two indentation at a closer distance. For materials in which plastic deformation is predominant, the influence of the load on the measured value of micro-hardness is statistically significant. The relationship between applied load and microhardness manifests reverse Indentation Size Effect (ISE) for all annealing temperatures [8]. Along with the observation of microstructure and elongation value, hardness value indicates a change of material properties due to the bending process.

Figure 3. Area of observation.

Microstructural observation

Microstructural test consists of testing of grain shapes, grain orientation and grain dimension. Grain shape is determined by the shape factor resulting from the ratio of two perpendicular diagonal. Grain orientation described the angle between the longer diagonal of grain and the center line . A study on the microstructure evolution of mechanically formed samples under varying load conditions has been reported [9]. It concluded that the grain sizes of the deformed mild steel plate showed elongated grains and it was directly proportional to the applied loads. Finally, the study showed that the grain size elongation and hardness obtained in the deformed samples were linearly dependent on the applied loads. Metallographic examinations are therefore carried out on the pre-determined spots along the lines as described in Figure 3. For this purpose an optical microscope is used on the already prepared samples.

Results and discussion

The examination is described in average value for each of the test result.

Strain at the inner side and outer side at various position

Table 2 shows the deformation of the samples which is indicated by the elongation at inner side and outer side of the bending radii. The inner side in general does not experience significant elongation, whereas the outer side is elongated up to 15.9%. The maximum elongation remains nevertheless in the area of proportional plastic deformation.

Table 2. Elongation at the bending radii.

outer side

7.80

8.80

12.82

band II inner side

7.80

7.82

0.26

outer side

7.80

8.94

14.62

band III inner side

7.80

7.80

0.00

outer side

7.80

9.04

15.90

initial (mm) final (mm) elongation % band I inner side 7.80 7.82 0.26

Hardness vickers[132]

Hardness[133] value of the material at the bending side is described[134] in the Table[135] 3 Compared[136] to the middle part of the cross-section[11] area, the inner side and the outer side of the bending radii show higher value[137] respectively[138]. The Increasing hardness shows that the material has undergone a plastic deformation by[139] using a non linier[140,141] regression formula, the[142] lowest hardness was calculated[143]. It indicates the lowest internal[144]

stress[145] in the material which[146] can furthermore be considered[147] as the neutral area. A neutral line was then then[148] achieved by connecting each point of the lowest state of internal stress.

Table 3. Hardness value at several bending positions.

Vickers hardness number at various position (HV 0,3)

a

b

c

d

e

F

Free Area

205

205

204

204

205

205

Line I

204

206

206

204

204

206

Line II

259

254

233

228

250

260

Line III

266

257

240

240

254

260

Line IV

274

266

268

267

270

276

inner[149] side of the bending radii, measured on the surface of sample[150]

0.8 mm from the inner side, measured on the cross section[151] area.

1.6 mm from the inner side, measured on the cross section[152] area.

2.4 mm from the inner side, measured on the cross section[153] area.

3.2 mm from the inner side, measured on the cross section[154] area.

outer[155,156] side of the bending radii, measured[157] on the surface of sample.[158]

Microstructural observation

Figure 4 shows the micrograph of the sample at various positions. During the bending process[159] he outer[160] side of the sample[161] was stretched and experienced therefore[162] tension[163] stress[164], which is indicated[165] with the elongated grain (flattening of the grain).[166] Figure[167] 4c, 4f and[168] 4i describe the microstructure of the outer side. The grain directions in[169] this side are mostly perpendicular to the centreline. This tensile stress stress[170] after dies displacement is consistent with the previous work by Min Zhang [12], which prooved[171] that the metal farther away from the

neutral axis was stressed beyond the yield strength, and plastically or permanently deformed. The micrographs reveal also the differences in grain roughness in the middle and sides of the sample. Microstructure in the middle part of the sample is almost the same as the initial condition prior to the deformation. The grain at the inner side is slightly smaller than the initial condition. The microstructure was composed of ferrite grains and pearlite can be shown in Figure 4.

Figure 4. Micrograph of material.

Discussion

As shown in the Figure 5 the center line of bending (Line IV) exhibit the highest increase of hardness. Higher deformation on this site is considerably the cause of the microstructural change and its mechanical properties. It complies also with the flattened grain of microstructure and its orientation. At the inner side compressive load occures on the material, which produces furthermore slightly smaller grain. The grain orientation is herewith nearly parallel to the centerline of the bending radius.

The result complied with the previous study [10], which declared that mechanical properties of metal strongly depend on the microstructure. The influence becomes more significant with decreasing thickness. The stress at the inner side results in the increase of hardness. The lowest hardness value

for each area has been determined and located mostly close to the centerline of sample. Lower hardness value can be considered as lower state of internal stress in the material, which complies in this case with the initial condition of sample and can therefore be determined as the neutral area. However the lowest hardness area shifts slightly to the inner side of bending radii [11].

Figure 5. Hardness value in average.

Conclusions

The bending process results in plastic deformation due to tension stress on the outside and compression stress on the inside. Grain size,orientation and shape change related to the degree of deformation. Microstructure and properties of the material at crosssection area varies related to the distance to the inner side. The most deformed part (outer side) as indicated by the elongation value shows finer, flattened grain and high hardness value. The neutral line which imaginary connects areas of lowest energy in the cross section area shifts slightly to the center of the bending radius.

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1.	~~a forming~~ → the forming	Determiner use (a/an/the/this, etc.)	Correctness
2.	, microstructural	Punctuation in compound/complex sentences	Correctness
3.	~~occurs~~ → occur	Faulty subject-verb agreement	Correctness
4.	~~outside~~ → outer	Word choice	Engagement
5.	, while	Punctuation in compound/complex sentences	Correctness
6.	~~in~~ → on	Wrong or missing prepositions	Correctness
7.	, and	Comma misuse within clauses	Correctness
8.	*speed and temperature were applied*	Passive voice misuse	Clarity
9.	~~test~~ → tests	Incorrect noun number	Correctness
10.	*Microstructural observation and hardness test were carried out*	Passive voice misuse	Clarity
11.	*cross-section; crosssection*	Text inconsistencies	Correctness
12.	~~plate~~ → container, vessel	Word choice	Engagement
13.		Intricate text	Clarity
14.	*is revealed*	Passive voice misuse	Clarity
15.	~~material~~ → fabric	Word choice	Engagement
16.	~~which is~~	Wordy sentences	Clarity
17.	, and	Comma misuse within clauses	Correctness
18.	value,	Punctuation in compound/complex sentences	Correctness
19.	~~is~~ → are	Faulty subject-verb agreement	Correctness

20.	processes,	Punctuation in compound/complex sentences	Correctness
21.	*the sheet material was cut*	Passive voice misuse	Clarity
22.	, and	Comma misuse within clauses	Correctness
23.	~~and~~ → And	Improper formatting	Correctness
24.	*amounts were examined*	Passive voice misuse	Clarity
25.	*The effect of material thickness on bending processes was reported*	Passive voice misuse	Clarity
26.	*been observed*	Passive voice misuse	Clarity
27.	*Stress state determination numerical analysis during the bending process was applied*	Passive voice misuse	Clarity
28.	*was found*	Passive voice misuse	Clarity
29.	the plate	Determiner use (a/an/the/this, etc.)	Correctness
30.	~~thickness~~ → thicknesses	Incorrect noun number	Correctness
31.	*Content from this work may be used*	Passive voice misuse	Clarity
32.	~~licence~~ → license	Mixed dialects of English	Correctness
33.	~~title of the work~~ → work title	Wordy sentences	Clarity
34.	~~work~~ → book	Word choice	Engagement
35.	, and	Comma misuse within clauses	Correctness
36.	~~licence~~ → license	Mixed dialects of English	Correctness
37.	The bending	Determiner use (a/an/the/this, etc.)	Correctness

38.	*It was observed*	Passive voice misuse	Clarity
39.	a 4	Determiner use (a/an/the/this, etc.)	Correctness
40.	plate,	Punctuation in compound/complex sentences	Correctness
41.	a remarkable	Determiner use (a/an/the/this, etc.)	Correctness
42.	~~crack~~ → cracked	Faulty tense sequence	Correctness
43.	~~occured~~ → occurred	Misspelled words	Correctness
44.	, and	Comma misuse within clauses	Correctness
45.	~~to~~ → on	Wrong or missing prepositions	Correctness
46.	*is mainly governed*	Passive voice misuse	Clarity
47.		Passive voice misuse	Clarity
48.	~~change~~ → difference	Word choice	Engagement
49.	the strength	Determiner use (a/an/the/this, etc.)	Correctness
50.	, as	Punctuation in compound/complex sentences	Correctness
51.	~~strength~~ → power	Word choice	Engagement
52.	*is defined*	Passive voice misuse	Clarity
53.	~~against~~	Wrong or missing prepositions	Correctness
54.	~~harder~~ → more challenging, more rigid	Word choice	Engagement
55.	, and	Punctuation in compound/complex sentences	Correctness

56.	~~and its~~ → . Its	Hard-to-read text	Clarity
57.	*is based*	Passive voice misuse	Clarity
58.	~~material~~ → fabric	Word choice	Engagement
59.	~~occur~~ → occurs	Faulty subject-verb agreement	Correctness
60.	*are controlled*	Passive voice misuse	Clarity
61.	, and	Comma misuse within clauses	Correctness
62.	~~coarsegrained~~ → coarse-grained, coarse grained	Misspelled words	Correctness
63.		Intricate text	Clarity
64.	~~the purposes of~~	Wordy sentences	Clarity
65.	, low	Punctuation in compound/complex sentences	Correctness
66.	plates,	Comma misuse within clauses	Correctness
67.	, and	Comma misuse within clauses	Correctness
68.	*AISI 1015 with the size of 200mm length, 20 mm width and 4 mm thick were used*	Passive voice misuse	Clarity
69.	the sample	Determiner use (a/an/the/this, etc.)	Correctness
70.	~~inhomogenous~~ → inhomogeneous	Confused words	Correctness
71.	an inhomogenous	Determiner use (a/an/the/this, etc.)	Correctness
72.	, and	Comma misuse within clauses	Correctness
73.	*Normalizing is carried out on the*	Hard-to-read text	Clarity

	material to homogenize the microstructure and eliminating stresses caused by the previous rolling process.		
74.	~~Since~~	Wordy sentences	Clarity
75.	~~in~~	Wordy sentences	Clarity
76.	, cracks	Punctuation in compound/complex sentences	Correctness
77.	~~fully~~	Wordy sentences	Clarity
78.	The steel	Determiner use (a/an/the/this, etc.)	Correctness
79.	, therefore	Punctuation in compound/complex sentences	Correctness
80.	~~therefore~~	Wordy sentences	Clarity
81.	~~grinded~~ → ground	Misspelled words	Correctness
82.	~~occurance~~ → occurrence	Misspelled words	Correctness
83.	~~crack~~ → damage	Word choice	Engagement
84.	*is carried out*	Passive voice misuse	Clarity
85.	a 90	Determiner use (a/an/the/this, etc.)	Correctness
86.	*is done*	Passive voice misuse	Clarity
87.	a constant	Determiner use (a/an/the/this, etc.)	Correctness
88.	~~constant speed of~~ → a constant	Wordy sentences	Clarity
89.	the ambient, or an ambient	Determiner use (a/an/the/this, etc.)	Correctness

90.	~~Prior to~~ → Before	Wordy sentences	Clarity
91.	process,	Comma misuse within clauses	Correctness
92.	~~4~~ → four	Improper formatting	Correctness
93.	~~the~~ figure	Determiner use (a/an/the/this, etc.)	Correctness
94.	~~one-eighth~~ → one-eighth	Misspelled words	Correctness
95.	distance,	Punctuation in compound/complex sentences	Correctness
96.	*are obtained*	Passive voice misuse	Clarity
97.	*is determined*	Passive voice misuse	Clarity
98.	~~distance~~ → stretch, length, space, span	Word choice	Engagement
99.		Intricate text	Clarity
100.	~~analysed~~ → analyzed	Mixed dialects of English	Correctness
101.	The hardness	Determiner use (a/an/the/this, etc.)	Correctness
102.	~~position~~ → positions	Incorrect noun number	Correctness
103.	~~analysing~~ → analyzing	Mixed dialects of English	Correctness
104.	the material, or a material	Determiner use (a/an/the/this, etc.)	Correctness
105.	A small	Determiner use (a/an/the/this, etc.)	Correctness
106.	~~indentation~~ → indentations	Incorrect noun number	Correctness
107.	load's influence	Wordy sentences	Clarity

108.	the applied	Determiner use (a/an/the/this, etc.)	Correctness
109.	the hardness	Determiner use (a/an/the/this, etc.)	Correctness
110.	The microstructural	Determiner use (a/an/the/this, etc.)	Correctness
111.	, and	Comma misuse within clauses	Correctness
112.	*is determined*	Passive voice misuse	Clarity
113.	~~diagonal~~ → diagonals	Incorrect noun number	Correctness
114.	~~center line~~ → centerline	Confused words	Correctness
115.	*Microstructural test consists of testing of grain shapes, grain orientation and grain dimension. Grain shape is determined by the shape factor resulting from the ratio of two perpendicular diagonal. Grain orientation described the angle between the longer diagonal of grain and the center line.*	Monotonous sentences	Engagement
116.		Intricate text	Clarity
117.	, and	Punctuation in compound/complex sentences	Correctness
118.		Intricate text	Clarity
119.	purpose,	Comma misuse within clauses	Correctness
120.	*is described*	Passive voice misuse	Clarity
121.	an average	Determiner use (a/an/the/this, etc.)	Correctness
122.	~~result~~ → results	Incorrect noun number	Correctness
123.	, which	Punctuation in	Correctness

		compound/complex sentences	
124.	the inner	Determiner use (a/an/the/this, etc.)	Correctness
125.		Intricate text	Clarity
126.	, in	Punctuation in compound/complex sentences	Correctness
127.	~~in general~~	Wordy sentences	Clarity
128.	general,	Punctuation in compound/complex sentences	Correctness
129.	~~elongation~~ → extension, lengthening, stretching	Word choice	Engagement
130.	*is elongated up*	Passive voice misuse	Clarity
131.	~~elongation~~ → extension	Word choice	Engagement
132.	~~vickers~~ → Vickers	Misspelled words	Correctness
133.	The hardness	Determiner use (a/an/the/this, etc.)	Correctness
134.	*is described*	Passive voice misuse	Clarity
135.	~~the~~ Table	Determiner use (a/an/the/this, etc.)	Correctness
136.	. Compared	Punctuation in compound/complex sentences	Correctness
137.	~~value~~ → values	Incorrect noun number	Correctness
138.	, respectively	Punctuation in compound/complex sentences	Correctness
139.	~~by~~	Wordy sentences	Clarity
140.	~~non-linier~~ → nonlinier, non-linier	Misspelled words	Correctness

141.	~~linier~~ → linear	Misspelled words	Correctness
142.	~~, the~~ → ; the, . The	Punctuation in compound/complex sentences	Correctness
143.	*the lowest hardness was calculated*	Passive voice misuse	Clarity
144.	internal.	Closing punctuation	Correctness
145.	~~stress~~ → Stress	Improper formatting	Correctness
146.	, which	Punctuation in compound/complex sentences	Correctness
147.	*be considered*	Passive voice misuse	Clarity
148.	then ~~then~~	Misspelled words	Correctness
149.	the inner	Determiner use (a/an/the/this, etc.)	Correctness
150.	the sample	Determiner use (a/an/the/this, etc.)	Correctness
151.	~~cross-section~~ → cross-section	Misspelled words	Correctness
152.	~~cross-section~~ → cross-section	Misspelled words	Correctness
153.	~~cross-section~~ → cross-section	Misspelled words	Correctness
154.	~~cross-section~~ → cross-section	Misspelled words	Correctness
155.	~~outer~~ → Outer	Improper formatting	Correctness
156.	the outer	Determiner use (a/an/the/this, etc.)	Correctness
157.	~~measured~~ → calculated	Word choice	Engagement
158.	the sample	Determiner use (a/an/the/this, etc.)	Correctness

159.	process,	Comma misuse within clauses	Correctness
160.	*he*	Intricate text	Clarity
161.	~~he outer~~ → the outer	Confused words	Correctness
162.	~~sample~~ → model, piece, selection, example	Word choice	Engagement
163.	, therefore	Punctuation in compound/complex sentences	Correctness
164.	, tension	Punctuation in compound/complex sentences	Correctness
165.	*is indicated*	Passive voice misuse	Clarity
166.		Intricate text	Clarity
167.	~~Figure~~ → Figures	Incorrect noun number	Correctness
168.	, and	Comma misuse within clauses	Correctness
169.	~~in~~ → on	Wrong or missing prepositions	Correctness
170.	stress ~~stress~~	Misspelled words	Correctness
171.	~~prooved~~ → proved	Confused words	Correctness
172.	strength,	Punctuation in compound/complex sentences	Correctness
173.		Intricate text	Clarity
174.	~~reveal also~~ → also reveal	Misplaced words or phrases	Correctness
175.	The microstructure	Determiner use (a/an/the/this, etc.)	Correctness
176.	~~middle~~ → central	Word choice	Engagement
177.	~~sample~~ →	Word choice	Engagement

	model, piece, selection, example		
178.	~~prior to~~ → before	Wordy sentences	Clarity
179.	~~condition~~ → state, infection	Word choice	Engagement
180.	*The microstructure was composed*	Passive voice misuse	Clarity
181.	, and	Punctuation in compound/complex sentences	Correctness
182.	~~the~~ Figure	Determiner use (a/an/the/this, etc.)	Correctness
183.	, the	Punctuation in compound/complex sentences	Correctness
184.	~~center line~~ → centerline	Confused words	Correctness
185.	~~Line IV~~ → Line-IV	Misspelled words	Correctness
186.	~~exhibit~~ → exhibits	Faulty subject-verb agreement	Correctness
187.	*As shown in the Figure 5 the center line of bending (Line IV) exhibit the highest increase of hardness.*	Incomplete sentences	Correctness
188.	~~considerably~~ → considered	Confused words	Correctness
189.	~~complies also~~ → also complies	Misplaced words or phrases	Correctness
190.	, compressive	Punctuation in compound/complex sentences	Correctness
191.	~~occures~~ → occurs	Misspelled words	Correctness
192.	*At the inner side compressive load occures on the material, which produces furthermore slightly smaller grain.*	Incomplete sentences	Correctness
193.	the mechanical	Determiner use (a/an/the/this, etc.)	Correctness

194.		Intricate text	Clarity
195.	~~the increase~~ → an increase	Determiner use (a/an/the/this, etc.)	Correctness
196.	increases	Wordy sentences	Clarity
197.	~~of~~ → in	Wrong or missing prepositions	Correctness
198.	sample's centerline	Wordy sentences	Clarity
199.	the sample	Determiner use (a/an/the/this, etc.)	Correctness
200.	The lower	Determiner use (a/an/the/this, etc.)	Correctness
201.	*Lower hardness value can be considered*	Passive voice misuse	Clarity
202.	a lower	Determiner use (a/an/the/this, etc.)	Correctness
203.	~~in this case~~	Wordy sentences	Clarity
204.	~~sample~~ → model, example, selection, illustration	Word choice	Engagement
205.	the sample	Determiner use (a/an/the/this, etc.)	Correctness
206.	*be determined*	Passive voice misuse	Clarity
207.	However,	Comma misuse within clauses	Correctness
208.	~~in~~ → on	Wrong or missing prepositions	Correctness
209.	*The bending process results in plastic deformation due to tension stress on the outside and compression stress on the inside.*	Intricate text	Clarity

210.	, orientation	Improper formatting	Correctness
211.	, and	Comma misuse within clauses	Correctness
212.	the crosssection	Determiner use (a/an/the/this, etc.)	Correctness
213.	~~varies~~ → vary	Faulty subject-verb agreement	Correctness
214.	, as	Punctuation in compound/complex sentences	Correctness
215.	~~as~~	Wordy sentences	Clarity
216.	value,	Punctuation in compound/complex sentences	Correctness
217.	~~finer~~ → more adequate, more OK, more sufficient	Word choice	Engagement
218.	, and	Comma misuse within clauses	Correctness
219.	, which	Punctuation in compound/complex sentences	Correctness
220.	~~cross section~~ → cross-section	Misspelled words	Correctness
221.	, shifts	Punctuation in compound/complex sentences	Correctness
222.	, and	Comma misuse within clauses	Correctness
223.	~~Tekiner~~ → Tekin	Misspelled words	Correctness
224.	, and	Comma misuse within clauses	Correctness
225.	~~K K~~ → KK	Confused words	Correctness
226.		Passive voice misuse	Clarity
227.	~~research~~ → study, analysis, examination	Word choice	Engagement

228.	*It was found that there is no significant difference*	Fertiliser from Urine (Struvite) | SSWM - Find tools for ... https://sswm.info/sswm-university-course/module-3-ecological-sanitation-and-natural-systems-wastewater-treatment-1/fertiliser-from-urine-(struvite)	Originality
229.	*Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI. Published under licence by IOP Publishing Ltd 1*	IOP Conference Series: Materials Science and Engineering ... https://iopscience.iop.org/article/10.1088/1757-899X/103/1/012012/pdf	Originality
230.	*The ductility (in terms of the reduction in area) is influenced by the grain aspect ratio. In contrast, the ultimate tensile strength is independent of the grain aspect ratio but shows an explicit dependency on the specimen orientation*	Influence of grain shape and orientation on the mechanical ... https://www.sciencedirect.com/science/article/pii/S0921509312013755	Originality
231.	*process. The material is heated up to 900°C*	econ VacuDry - VacuDry Vacuum Thermal Desorption ... https://www.environmental-expert.com/products/econ-vacudry-mercury-waste-treatment-units-432821	Originality