Master examination

„Steel Design“

23.03.2018

Name, first name:

Matriculation number:

Declaration: I am healthy and able to take part in the examination.

Signature:

Task	Points	Achieved points	Points after review (additional points)
1	4,5		
2	8		
3	5		
4	4,5		
5	4		
6	3		
7	6		
8	4		
9	2		
10	4		
11	3		
12	2		
Sum	50		

You need 44% to pass the examination.

Task 1 AHSS I 4,5 Point(s)

Based on the targeted mechanical properties different types of Advanced High Strength Steels (AHSS) steel have better mechanical properties.

Complete the given chart. (4.5 Points)

Steel	**DP**	**CP**	**TRIP**
Microstructure			
Yield ratio			
Hole expansion ratio			

Microstructure: α_B bainite, α_M martensite, α ferrite, γ_R retained austenite

Hole expansion ratio: + = good, 0 = moderate

Yield ratio: += high, 0 = low

Head of Department: Univ. Prof. Dr.-Ing. W. Bleck Fon: +49 241 8095782
E-Mail: bleck@iehk.rwth-aachen.de Fax: +49 241 8092224

Task 2 AHSS II 8 Point(s)

a) Sketch the stress strain curves of the following steels in the given diagram (figure 1): (i) a DP-Steel and (ii) HSLA-Steel (without temper rolling). Explain the individual material behavior of the steels. (4 Points)

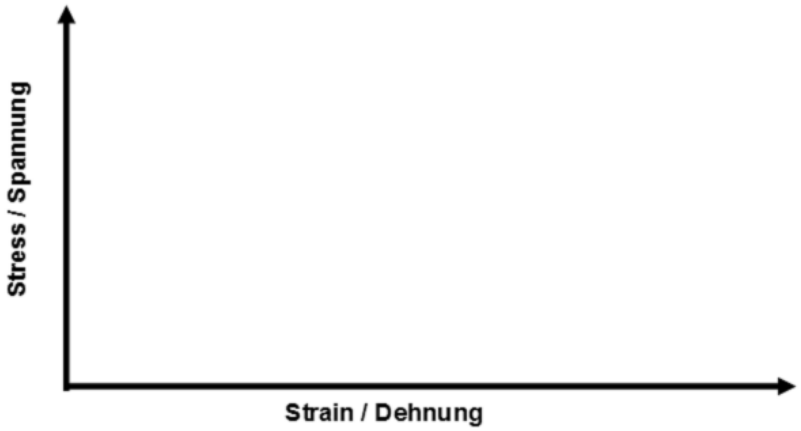

Figure 1 (DP-Steel)

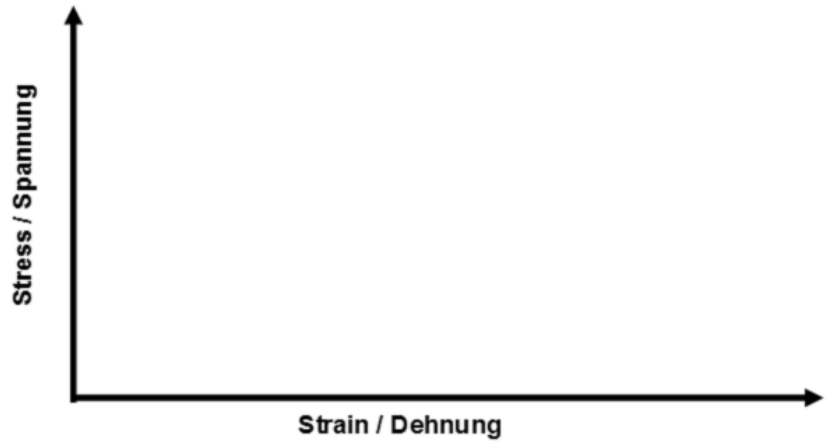

Figure 1 (HSLA-Steel)

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b) What is the influence of the following factors on the ultimate tensile strength of DP-Steels? (3 Points)

(i) A larger martensite volume fraction

(ii) A larger ferrite grain size

(iii) A higher carbon content in martensite

c) Is there any influence of the martensite island diameter on the mechanical properties of DP-steels? Explain your answer briefly. (1 Points)

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Task 3 deep drawing steels 5 Point(s)

The coils A, B, C and D have been manufactured according to the process parameters listed in table 1. Which of the four coils possesses the best deep-drawability properties? Explain why the other three coils are less suitable for deep-drawing i.e. have worse deep-drawability properties. (5 Points)

Table1:

Process parameters	**Coil A**	**Coil B**	**Coil C**	**Coil D**
Al in wt% N in wt% acc. to the chem. analysis	0,031 0,0029	0,042 0,0041	0,025 0,0019	0,035 0,0033
coiling temperature (°C)	550	580	570	600
Cold rolling degree of deformation (%)	58%	69%	71%	75%
Recrystallisation annealing (-)	batch annealing	batch annealing	continuous annealing	continuous annealing

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Task 4 high strength structural steels 4,5 Point(s)

a) Name at least 4 general properties of high strength structural steels (2 Points)

b) What are the typical secondary metallurgy techniques used for high strength steels? (1 Point)

c) Name three benefits of continuous casting of high strength structural steels (1,5 Points)

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Task 5 pipe manufacturing 4 Point(s)

a) What is the name of the first basic processing step used in the production of seamless tubes broadly? (1 Point)

b) Name three typical processing units or techniques, which are used in the following stretch forming process. (3 Points)

Head of Department: Univ. Prof. Dr.-Ing. W. Bleck Fon: +49 241 8095782
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Task 6 Oil country tubular goods OCTG 3 Point(s)

What is the most important aspect in improving the corrosion resistance to sour gas in high strength quenched and tempered steels for oil pipes from materials science point of view? (3 Points)

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Task 7 line pipes 6 Point(s)

a) Name two metallurgical concepts to (i) avoid crack initiation and to (ii) avoid crack propagation in line pipes. (4 Points)

b) Longitudinal welded line pipes are produced by the UOE-process using thermo-mechanically rolled (TM) plates. Describe the microstructure (i) without and (ii) with water quenching! (2 Points)

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Task 8 boiler tubes 4 Point(s)

a) What are the characteristics of boiler tubes? How they are manufactures, where are they used and what are the transport media (1,5 Points)?

b) Which microstructures are used for steel boiler tubes? Which microstructure has the highest creep strength? Name the reason for it. (2,5 Points)

Head of Department: Univ. Prof. Dr.-Ing. W. Bleck Fon: +49 241 8095782
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Task 9 special alloyed steels 2 Point(s)

a) What is the typical heat treatment for duplex steels? (1 Point)

b) Describe the microstructure constituents of duplex steels! (1 Point)

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Task 10 rail steels 4 Point(s)

What are the basic demands on rail steels additional to a high yield and tensile strength ? Name 4! (4 Points)

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Task 11 tool steels 3 Point(s)

Tool steels are usually processed by quenching and tempering.

a) Name at least 2 reasons why tool steels are tempered. (2 Points)

b) What should be considered with respect to the tempering temperature? (1 Point)

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Task 12 additive manufacturing 2 Point(s)

What are the special characteristics of additively manufactured steels regarding (i) grain structure and (ii) texture? (2 Points)

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