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DYNAMICS OF «PLATFORM – CIRCLES OF PIPES» SYSTEM AT IMPACT OF CARS

The device of pipe fastening in two circles on a railway platform is considered. By the method of mathematical modelling the influence of a preliminary tension of elastic elements of fastening on the value of longitudinal displacement of pipe circles and dynamic forces in the elements of fastening of pipes to the platform frame at its impact with a group of motionless cars is investigated. The comparative analysis of dynamic indicators is given.

Получено 21.02.2011

ISBN 978-985-468-924-1. Mechanics. Scientific researches and methodical development. Vol. 5. Gomel, 2011

UDC 621.27

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THE INFLUENCE OF COLD AND HOT ROLL DRAWING ON THE CHANGES IN THE MAIN MECHANICAL PROPERTIES, MICROSTRUCTURE AND CORROSION RATE OF LOW CARBON STEEL SHEETS

The steel is the most widely used material for building structures and machines because it is cheap and extensive. The influences of cold and hot roll drawing processes on the main mechanical properties, microstructure and corrosion rate are different. During both types of drawing the material is subjected to very high pressing under both low and high recrystallization temperature. In the present work the effects of cold and hot roll drawing on the tensile strength, hardness, microstructure and corrosion rate for steel sheets are discussed. In the experimental work we used specimen of different thickness taken from low carbon steel sheets formed by cold and hot roll drawing in Libyan Iron and steel Company – Musrata City. The experimental results indicate the specimen under testing subjected to change in main mechanical properties during thickness reduction in rolling operation. The cold and hot roll drawing causes changes in microstructure due to plastic deformation and temperature effects. Also the influence of cold roll drawing on tensile strength, hardness and corrosion rate were found to be increased while the ductility will be decreased. In hot roll drawing the tensile strength and hardness will be decreased due to high temperature while the ductility and corrosion rate will be increased.

Introduction. Steel is the world's most important, multi-functional and most adaptable material. About 5 % of iron element is present in the earth's crust [1]. As we know without steel the world would not exist: from oil tankers to thumb tacks, from trucks to tin cans, from transmission towers to toasters [2]. Or we can say steel is arguably world's most "advanced" material. It is very versatile material with a wide range of attractive properties which can be produced at a very competitive production cost [3].

Carbon steel is by far the most widely used kind of steel. The properties of carbon steel depend primarily on the amount of carbon it contains. Most carbon steel has a carbon content of less than 1 % [4]. Low carbon steel is easily available and cheap having all material properties that are acceptable for many applications including structural beams, car parts and bodies, kitchen appliances, cans, pipe lines, railways, tractors, agriculture implements, etc. [1, 5].

Iron has a great importance in human life. Human performance has been developed in various fields and scopes especially in industrial activities which are considered a significant turning point for the whole life of the human beings whereas machinery, civil engineering, etc. have been duly developed [6].

It is of great importance to match and procure the mechanical characteristics of the required iron for each performance or application, such as reinforced iron steel, machinery, motors and industrial equipment noting that the main and essential characteristics of the iron are ductility, hardness, stiffness, elasticity as well as flexibility in addition to facility and simplicity of welding and forming whereas at any load you can control the iron structure without a curing any change at its internal structure or mechanical characteristics in order to avoid any collapses or disasters.

Experimental work. In this work a set of standard tests were performed to obtain chemical composition, hardness, microstructure, corrosion rate and full stress-strain relation for the material of the desired specimen. All specimen were prepared and tested at Libyan Iron & Steel Company in Musrata City. The test specimen were token from low carbon steel sheets which produced by that company. The specimen consist of two groups, the first group contains specimen cut from sheets formed by cold roll drawing with 0,5, 1,5 and 2,0 mm thickness, the second group of test specimen contain specimen cut from sheets formed by hot roll drawings with 2,5, 3,0 and 3,2 mm thickness.

Preparation of specimen. Many machining operations were processed on the specimen to prepare them to fulfill requirements of tensile test, hardness test, microstructure analysis and corrosion test. The used specimen prepared to tensile test were cut as standard specimen according to (ASTM) with total length of 250 mm. The tensile test was carried out on (MAN) Universal Testing machine with maximal loading capacity 300 MN, the loading rate on the specimen was 22 kN/min at room temperature.

The specimen prepared to the hardness test were cut and applied on the grinding and polishing operations to get smooth surface. The hardness tests were carried out on the Wilson Rockwell Tester, the hardness number was a function of the degree of indentation of test specimen by action of diamond indenter under a given static load according to (ASTM E18). For microstructure examination the specimen were prepared by grinding the surface with different emery papers number on the grinding machine and then polished, these specimen were immersed in the etching solution. After preparation the specimen were placed under the microscope and captures were taken at 100× times magnification.

Finally, for corrosion test the specimen were figuratively cut, grinded and polished to be smooth, then all the specimen were marked to distinguish them after their exposition in a corrosive environment, all the specimen were weighted after polishing with laboratory balance with 0,01 *g* sensitivity. The corrosion test was designed to obtain more general information by exposure a number of specimen in natural water and then hanged to plastic rope, all specimen were separated from each other and immersed in container with 40 cm depth to make sure that all the specimen dealt with the environment. The exposure time was 50 days. Before the extent of corrosion on the specimen they must have been cleaned by one of mechanical, chemical or electromechanical method. In this work the cleaning method used was mechanical one. For the cleaning a polymer to polish the specimen was used to avoid any surface scratches, after removing the oxide film from the specimen, surface was cleaned by acetone using a piece of cotton and after that the specimen were weighted using the balance.

RESULTS AND DISCUSSIONS. The results obtained in this work from the different tests are divided into five groups according to the type of test.

The first group of the results represents the chemical composition analysis of the cold and hot roll drawing specimen carried out in the laboratory of the company mentioned before. Tables 1,2 indicate chemical composition analyses for cold and hot roll drawing specimen respectively.

Table 1 – **Chemical composition analysis for cold roll drawing specimen**

Specimen Number	CHEMICAL COMPOSITION						*t*, mm
	C	Si	Mn	P	S	Al	
1	0,076	0,12	1,75	0,09	0,07	0,87	0,5
2	0,102	0,19	2,6	0,12	0,05	0,62	1,2
3	0,104	0,19	2,33	0,16	0,55	0,55	2

Table 2 – **Chemical composition analysis for hot roll drawing specimen**

Specimen Number	CHEMICAL COMPOSITION						*t*, mm
	C	Si	Mn	P	S	Al	
1	0,173	0,24	0,44	0,14	0,03	0,39	2,5
2	0,162	0,23	0,39	0,09	0,05	0,51	3,0
3	0,143	0,15	0,44	0,11	0,55	0,51	3,2

As shown in table 1 and 2 there are differences between the values of the all elements of the chemical composition for the cold and hot roll drawing specimen. The contain values of carbon (C), silicon (Si) and phosphors (P) in hot roll drawing are more than in cold roll drawing specimen by 1,5 times approximately but the contain values of aluminum (Al) in the hot roll drawing specimen are twice less than in cold roll drawing, the contain values of the sulpher (S) are practically constant. These differences appeared during recrystalization in hot roll drawing specimen.

The second group of the results is the tensile tests. The full stress-strain diagrams were taken from the typical curves printed on papers of the machine graph meter. These diagrams for cold and hot roll drawing specimen are shown in Figs (1, 2) respectively. The values of the yield stress (σ_y), ultimate strength (σ_u) and elongation percentage (EL %) are presented in the tables 3, 4

Table 3 – **Tensile test results for cold roll drawing specimen**

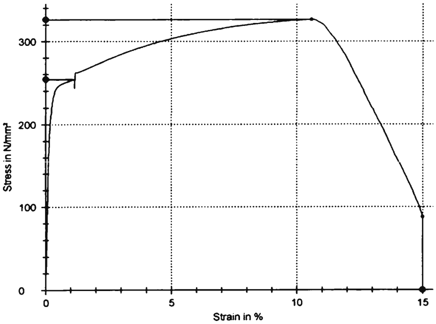
Specimen	Thickness, mm	Area, mm^2	σ_y, N/mm^2	σ_u, N/mm^2	EL, %
1	0,5	10,25	253,77	326,10	14,97
2	1,5	29,14	212,29	324,61	28,10
3	2,0	41,25	198,55	312,79	32,78

Table 4 – **Tensile test results for hot roll drawing specimen**

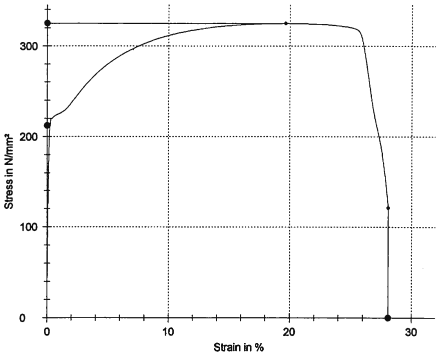
Specimen	Thickness, mm	Area, mm^2	σ_y, N/mm^2	σ_u, N/mm^2	EL, %
1	2,5	52,33	265,50	382,01	33,68
2	3,0	58,07	288,61	386,88	31,26
3	3,2	67,51	312,51	408,93	30,01

The stress-strain diagrams indicate the values of the yield stress and ultimate strength are decreasing for cold roll drawing specimen with the increasing of thickness but for hot roll drawing specimen the values of the yield stress and ultimate strength are increasing with the increasing of thickness of the specimen. The elongation percentage for the cold roll drawing increased with increasing the thickness, but for the hot roll drawing is decreased. The relation between thickness versus yield stress and ultimate strength for cold and hot roll drawing specimen are shown in figure 3, 4.

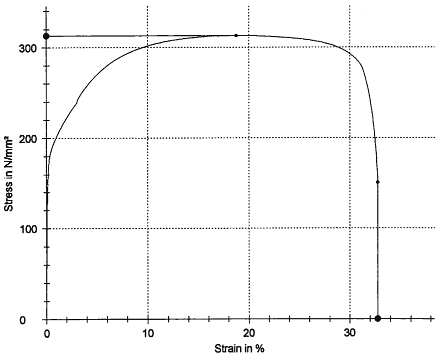
Referring to the test results, the grains of the material are in a complete distortion condition after plastic deformation caused formed by cold roll drawing. All the properties of a metal dependent on the lattice structure are affected by type of drawing. Yield stress, tensile strength, hardness and ductility are affected by cold roll drawing. The results indicate the increase in the values of yield strength, tensile and hardness while ductility decreases. The yield stress generally increases more rapidly than the tensile strength in such a way that the amount of plastic deformation increases.



Thickness = 0,5 mm

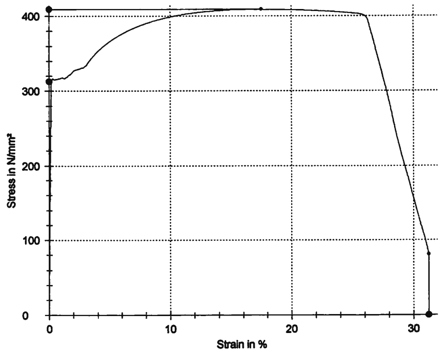


Thickness = 1,5 mm

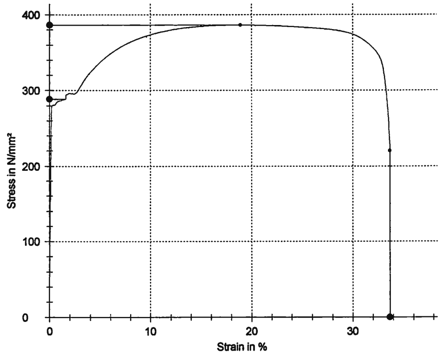


Thickness = 2,0 mm

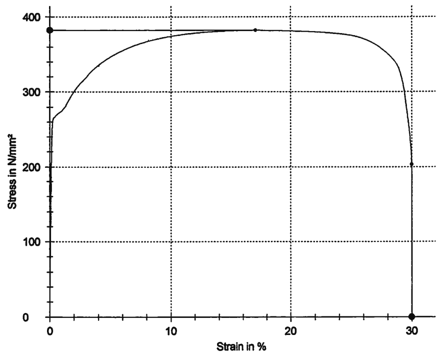
Figure 1– Stress-strain diagram for cold roll drawing specimen



Thickness = 2,5 mm



Thickness = 3,0 mm



Thickness = 3,2 mm

Figure 2 – Stress-strain diagram for hot roll drawing specimen

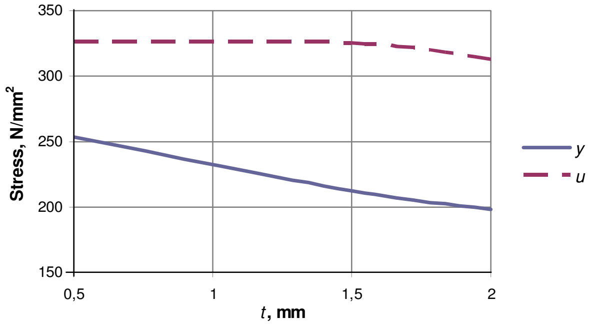


Figure 3 – Relation between thickness versus yield stress (y) and ultimate strength (u) for cold drawing

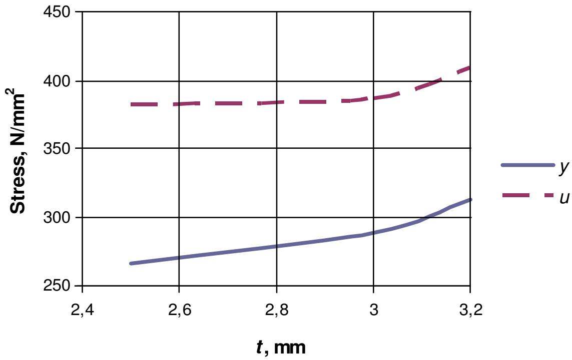


Figure 4 – Relation between thickness versus yield stress (y) and ultimate strength (u) for hot drawing

For hot roll drawing specimen, the tensile strength and hardness decrease due to effect of high temperature exposure.

The third group of the results is the average of Rockwell hardness. Figure 5 represents the results of hardness test for cold and hot roll drawing specimen. The hardness numbers approximately do not change with the change of thickness for both cold and hot roll drawing specimen. Also the values of the hardness number for the hot roll drawing specimen are higher than for cold roll drawing specimen, generally the percentage of increase in hardness numbers is more than 25 %.

The fourth group of the results is the microstructure analysis, this analysis applied on the specimen taken from cold and hot roll drawing sheets content carbon with 0,1 % and 0,2 % respectively. Figure 6 shows the microstructure for cold roll drawing specimen with 0,5 and 1,5 mm thickness, and figure 7 shows the microstructure for hot roll drawing specimen with 2,5 and 3,0 mm thickness.

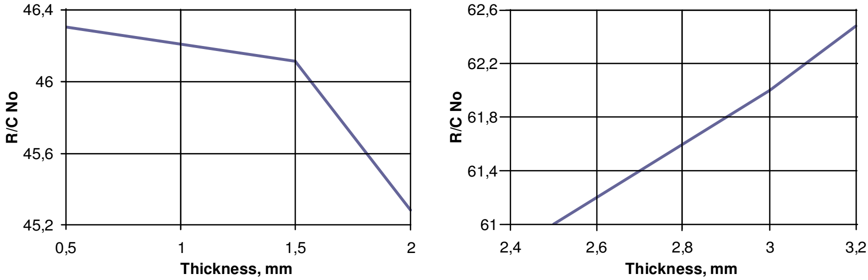
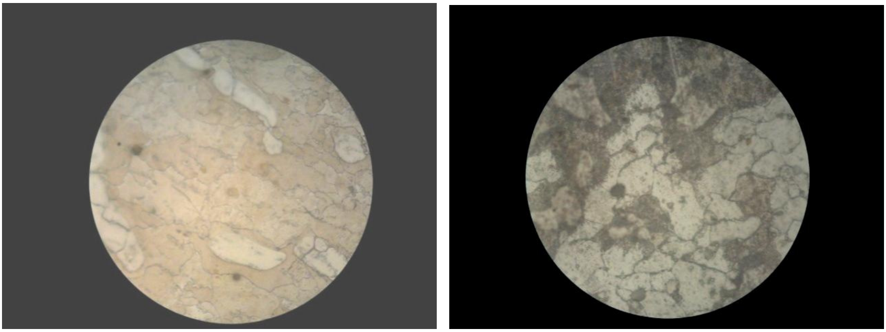
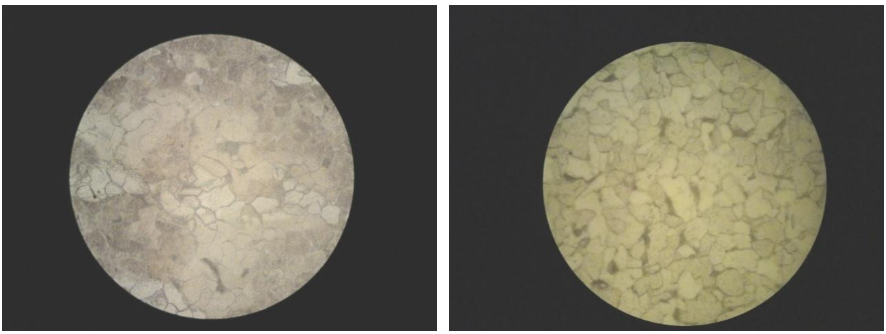


Figure 5 – Hardness Number for cold and hot rolling drawing respectively



Thickness 1,5 mm Thickness 0,5 mm

Figure 6 – The microstructure for cold roll drawing specimen



Thickness 3,0 mm Thickness 2,5 mm

Figure 7 – The microstructure for hot roll drawing specimen

Referring to figure 6 there are indicated some grains elongated due to plastic deformation even after release process. Figure 7 shows more equiaxed grains which have been recrystalised from the deformed grains due to the very high temperature of rolling.

The fifth group of results is corrosion rate analysis. Summary of the results of the performed tests which measure the corrosion rate and expressed as weight loss are shown in table 5. Figure 8 shows the relation between the corrosion rate for the cold and hot roll drawing specimen and thickness of the specimen.

Table 7 – **Corrosion rate expressed as weight loss**

Specimen SPECIFICATION	Average weight before (g)	Average weight after (g)	Average weight loss (g)	Area (cm^2)	Time (day)	c. rate cm/year
Cold rolling 2 mm	15,537	15,357	0,180	22,4992	50	0,00742
Cold rolling 1,5 mm	10,912	10,642	0,178	21,8672	50	0,00755
Cold rolling 0,5 mm	03,647	03,456	0,191	20,6032	50	0,00859
Hot rolling 3,2 mm	24,630	24,443	0,187	24,0160	50	0,00722
Hot rolling 3 mm	21,163	20,968	0,195	23,7632	50	0,00870
Hot rolling 2,5 mm	19,393	19,176	0,217	23,1312	50	0,00870

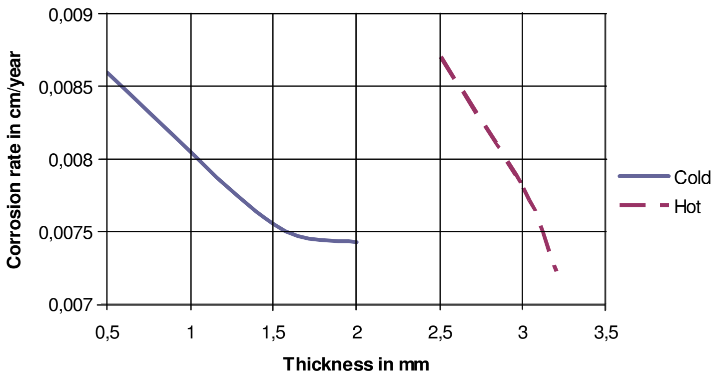


Figure 8 – The relation between the corrosion rate expressed as weight loss and the thickness of the specimen

It can observed that there is an visible effect of different thickness of specimen for steel sheets formed by cold and hot roll drawing, so it could be said that the sheets of 2 and 1 mm thick have lower corrosion rate compare to the ones of 0,5 mm thick due to dislocation and residual stresses, as well as the rate of corrosion in hot work specimen increases due to higher stored stresses in the material due to very high temperature and oxidation.

CONCLUSIONS

The results of this work representing the experimental investigation are the following:

1 The tensile strength, hardness and yield stress will be increased with cold roll drawing and as well as the ductility will be decreased due to plastic deformation effect.

2 Although both the tensile strength and hardness of the sheets formed by cold roll drawing are increasing, the rate of the increase is the same.

3 The tensile strength and hardness in hot roll drawing process will decrease due to effect of high temperature exposed.

4 The metal sheets performed by cold roll drawing will be more susceptible to corrosion than the ones by hot work.

5 The corrosion rate in metal sheets performed by cold roll drawing is higher than performed by hot roll drawing due to the dislocation of density and residual stresses.

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ВЛИЯНИЕ ХОЛОДНОЙ И ГОРЯЧЕЙ ПРОКАТКИ НА ИЗМЕНЕНИЕ ОСНОВНЫХ МЕХАНИЧЕСКИХ СВОЙСТВ, МИКРОСТРУКТУРЫ И СКОРОСТИ КОРРОЗИИ ЛИСТОВ ИЗ НИЗКОУГЛЕРОДИСТОЙ СТАЛИ

Листовая сталь – материал, чаще всего используемый в строительных конструкциях и машинах из-за дешевизны и распространенности. Влияние холодной и горячей прокатки на основные механические свойства, микроструктуру и скорость коррозии различны. При обоих типах прокатки материал подвергается очень высокому сжатию при низких и высоких температурах рекристаллизации. В представленной работе изучается влияние холодной и горячей прокатки на прочность при растяже-

нии, твердость, микроструктуру и скорость коррозии стальных листов. В экспериментальном исследовании использовались образцы листов различной толщины из низкоуглеродистой стали, полученные холодной и горячей прокаткой в Ливийской металлургической компании (город Мисурата). Экспериментальные результаты показывают изменение основных механических свойств при операции прокатки для уменьшения толщины листа. Холодная и горячая прокатка вызывают изменения в микроструктуре из-за пластической деформации и температурных воздействий. Также при холодной прокатке увеличиваются прочность при растяжении, твердость и скорости коррозии, в то время как пластичность уменьшается. При горячей прокатке из-за высокой температуры прочность при растяжении и твердость уменьшаются, а пластичность и скорость коррозии увеличиваются.

Получено 04.01.2011

ISBN 978-985-468-924-1. Механика. Научные исследования и учебно-методические разработки. Вып. 5. Гомель, 2011

УДК 539.3 : 621.311.25

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ЗАДАЧА ОБНАРУЖЕНИЯ ДВИЖУЩИХСЯ ПРЕДМЕТОВ В КОНТУРАХ АТОМНЫХ ЭЛЕКТРОСТАНЦИЙ (АЭС)

Разработан метод определения места и параметров нормального к образующей удара материальной точкой по цилиндрической оболочке. Данное исследование необходимо для обеспечения безопасности атомных электростанций (АЭС) при обнаружении оторвавшихся или полуоторвавшихся тел. Ранее [1, 2] было найдено аналитическое решение задачи об ударе точкой по цилиндрической оболочке и создан метод расчета радиальных ускорений точек оболочки.

В настоящей статье предложено решение проблемы по определению места удара, а также массы и скорости ударяющей точки (тела). Анализ расчетов колебаний оболочки показал, что необходимо за параметр оценки уровня энергетики удара выбирать величину среднего ускорения в спектре ускорений за определенный отрезок времени. Многочисленные расчеты позволили получить зависимости среднего ускорения от расстояния до места удара, скорости точки определенной массы. Зависимости подтверждены экспериментально и использованы для реальных решений многокритериальной задачи.

Одна из проблем обеспечения безопасности АЭС состоит в обнаружении подвижных предметов внутри контура электростанции. Выход из создавшейся ситуации включает решение двух задач: об ударе телом по цилиндрической оболочке [1, 2] и обратной – определения параметров удара.