EVALUATION OF WELDING SEQUENCES FOR PATCHING IN STEEL GEARS

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ABSTRACT

The present work deals with an experimental investigation of the effect of surfacing parameters on the final quality of large gear surfacing. This gear forms a vital part of the drive train of cement furnace at the Iraqi Cement Company. The gear is made of DIN CK 45 steel with an analyzed carbon content of 0.429% and core hardness 185 HV. The gear is considered large, with dimensions of 490 mm in diameter, 250-mm width and 27 mm module, its weight is 350 Kg. The aim of the present work is to study the possibility of repairing this type of gear using SMAW process.

The gear surface is cleaned by sand blasting, followed by dye penetrate testing for crack detections. DIN E1-UM350 hardfacing electrode is selected to hardface the gear. This electrode has a nominal composition (0.08%C, 3.3%Cr, 1%Mn) and a minimum hardness 350 HV. The gear teeth are surfaced with one, two, and three layers with and without preheating. The preheating temperature is 200 C°, which is, selected according to carbon equivalent of the DIN CK 45 base metal.

Cracks were observed in the weld metals when surfacing with three layers of EI-UM350 electrode. So, E 8018-B_2, and E 9018-D_1 are selected to butter the gear surface with one layer, followed by two layers of E1-UM350 electrode. These low hydrogen electrodes are selected based on their mechanical properties compared with DIN CK 45 base metal and low hydrogen content which eliminate hydrogen induced cold cracking. Preheating the gear surface gives good hardness distribution across the weld, HAZ, and base metals due to reducing the cooling rates and prevents hard structure to form at the interface region.

A set of destructive and non destructive tests are carried out. Including, tensile, wear, impact, chemical analysis, metallographic, micro hardness, macro etchent, and dye penetrate tests. Both of wear and impact resistance of all specimens is greater than the base metal. All weld deposits of E1-UM350 hardfacing electrode gives martensitic structures with different hardnesses depending on the cooling rates and number of layers. Using of low hydrogen electrodes (E 8018-B_2 and E 9018-D_1) as buttering layers, solve the cracking problem of weld deposits when surfacing with three layers of E1-UM350 electrodes.

الخلاصة

في هذا البحث تم دراسة إمكانية إصلاح التروس باستخدام تقنية اللحام اليدوي. الترس المستخدم في هذا البحث هو فولاذ متوسط الكربون(DIN CK 45) تم جلبه من شركة السمنت العراقية. يشكل هذا الترس جزء حيوي في منظومة التدوير لافران تجفيف السمنت. نسبة الكربون لهذا الفولاذ 0.429% وله صلادة قلب (185 HV) . يعتبر هذا الترس كبيرا نسبيا حيث يزن 350كغم ،قطره الخارجي 490 ملم ،عرضه 250ملم،و تضمينه 27ملم.

IDENTIFICATION TYPE OF NOISE IN GRAY SCALE IMAGES USING WAVELET-NETWORK (WN)

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ABSTRACT

In this paper, Wavelet-Network (WN) model has been recently proposed and applied to image processing, e.g., identification type of noise in Gray-Scale Images (GSI). This paper develops a new technique, which employs a Discrete Wavelet Transform (DWT) and an Artificial Neural Network (ANN). This WN technique uses special mother wavelet $\psi(x1,x2)$ of (DWT) as activation function for (ANN) instead of the traditional activation functions like (Log sigmoid, Tan sigmoid, etc). It is shown here that the benefit of WN circuits which uses WN is a good approximation tool for GSI images. These approximation patterns for images forced ANN to learn on these images which will be used in the test phase after that.

الخلاصة:

يستخدم هذا البحث شبكة المويجة–الخلايا العصبية(W N)، كنموذج اقترح مؤخرا وتم تقديمه كنموذج لمعالجة الصور، وكمثال على ذلك، تصنيف أنواع الضوضاء الذي يصيب الصور الرمادية. وقد تم تطوير واستخدام تقنية جديدة والتي تتضمن كل من تحويل المويجة (D WT) مع الشبكة العصبية (ANN). هذه التقنية تستخدم معادلة المويجة ألام (activation function) بدلا عن الأنواع المستخدمة في (ANN). لقد تبين أن الفائدة من (WN) يكمن في تحديد نوع الضوضاء الموجود في الصور و استخدامها كأداة تقريبية جيدة للصور الرمادية. وقد لوحظ أن هذا العمل يؤدي إلى إجبار (A NN) على التعلم على هذه الصور حيث يؤدي إلى تحسين الأداء في طور الاختبار.

KEY WORDS

Wavelet Networks, Wavelet Transform, Outlier, Function approximation.

INTRODUCTION

The approximation of general continuos functions by nonlinear networks such discussed in [T. Poggio, 1990], [K. Hornik, 1989] is very useful for system modeling and identification case. Such approximation methods can be used, for example, in black-box identification or noise identification of nonlinear systems. Function approximation involves estimating (approximating) the underlying relationship from a given finite input-output data set has been the fundamental problem for a variety of applications in pattern classification, data mining, signal reconstruction, and system identification. In this paper, we propose a method to identify five types of noise (Gaussian, Salt & Pepper, Speckle, Uniform & Random noise which is mixture of tow or more types of noise). Using WN in this method is just an approximation tool to the noisy images, that's

FEATURE EXTRACTION IN ELECTROMYOGRAPHY BY DIGITAL SIGNAL PROCESSING TECHNIQUES

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ABSTRACT

Myoelectric signals are the electrical manifestation associated with the movements exerted by the muscular system in the mamal beings (including the human). Examination of these signals should reveal the status of the muscles as well as the driving nervous system, This is important in diagnosis as well as prosthesis for the health of mankind and aids for handicaped . This would not be possible unless powerful digital processing techniques are available. In this paper, several techniques are investigated so as to extract the features of the ME signals both in time and frequency domains. The extracted features are subsequently employed in an automatic diagnostic classification system to decide whether or not they correspond to a normal muscle

الخلاصة

اشارات المخطط العضلي عبارة عن تغيرات كهربائية ملازمة لحركة العضلات في الثديات (ومنها الانسان) فحص هذة الاشارات تعطي حالة العضلات و الاعصاب المسيطرة عليها و هذا الامر مهم جدا في التشخيص الطبي للحالة الصحية. ان استخدام معالجة الاشارة الرقمية في الهندسة الطبية يسهل هذة المهمة . ورقة البحث قدمت عدة تقنيات لاستخراج و تحليل الاشارة العضلية الكهربائية في البعدين الزمني و الترددي . ان الاستخراج لشكل و طبيعة هذة الاشارة الكهربائية يشكل العنصر الاساسي في التشخيص الطبي .

KEY WORD

Application of digital signal processing in biomedical Engineering .

INTRODUCTION

To determine the characteristic features of the ME signals nonparametric and parametric processing approaches can be applled. Nonparametric techniques are applied to ME signal without paying attention to its decomposition as a source and auto-regressive (AR) filter to determine a set of characteristics. Among these techniques are the evaluation of the probability denisty function (pdf), mean, variance with their relations to the muscle force, autocorrelation function (ACF) and spectral domain techniques (FFT) [A.S.88]. Parametric techniques are applied starting from decomposing the signal and separating source parameters from filter related parameters and yield parametric characterization for the filter and the source. Section 2 is devoted to the nonparametric characterization of the ME signal , mainly through the:- FFT and histogram determination. In section 3_t signal decomposition is considered and a parametric model for the shaping filter la determined, Moreover, the source characteristics are evaluated. Section 4 considers the problem of automatic diagnosis for voluntary muscular system disorders.

THERMAL ANALYSIS OF AN OCTAGONAL SHELL EARTH ORBITING BODY

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ABSTRACT

The thermal behavior of an octagonal shell orbiting body in space environments had been simulated theoretically in the present work, and a simplified experimental test in a thermal vacuum chamber was also made on half-scale model of the prototype to investigate the problem. A mathematical model was built and simulated numerically by using lumped system technique and finite difference control volume approach with explicit scheme. The body in its orbit around the earth is assumed to receive solar, albedo and earth radiation heat fluxes. The orbit is circular of (500-Km) height and (40^{o}) inclination. The developed computational algorithm is capable of calculating the heat fluxes on body faces and the temperature distribution of the body at any time instant. The results showed that the albedo and earth heat fluxes are smaller when the orbit is higher. In the side faces, the heat fluxes are maximum when orbit inclination is minimum, and vice versa, the inverse behavior is true for the upper and lower faces. The heat fluxes are maximum in winter solstice and minimum in summer solstice. If the difference between the emissivity and absorptivity values is low, the body reaches to synchronous steady state faster. The emissivity is affected more than absorptivity. The temperatures of faces, which see the earth, are more fluctuated than the other faces. Comparison between theoretical and experimental results showed good agreement.

الخلاصة

تم في هذا البحث دراسة التصرف الحراري لجسم ثماني مجوف يدور حول الأرض نظريا، مع إجراء دراسة عملية داخل حجرة حرارية مفرغة على نموذج بنصف أبعاد الطراز لدراسة المسالة. تم بناء نموذج رياضي تم حله عددياً باستخدام تقنية نظام الكتل و طريقة عددية هي الفروق المحددة لحجم محكوم. يستلم الجسم في مداره حول الأرض الفيض الحراري الشمسي ، الفيض الحراري المنعكس (البيدو) ، و الفيض الحراري الأرضي . المدار دائري الشكل ارتفاعه (500) كيلومتر ، و زاوية ميلان (40^{o}) درجة. النموذج الرياضي له القابلية على حساب الفيوض الحرارية على اوجه الجسم وتوزيع درجة الحرارة على الجسم عند أي لحظة زمنية. أظهرت النتائج أن الفيوض الحرارية الالبيدو والإشعاع الأرضي تقل عندما يزيد ارتفاع المدار . في السطوح الجانبية تكون الفيوض الحرارية أعلى ما يمكن عندما يكون الميل المداري اقل ما يمكن،والعكس بالعكس، وعكس هذا التصرف يحدث في السطحين العلوي و السفلي. الفيوض الحرارية أعلى

EXPERIMENTAL AND THEORETICAL STUDY FOR SEALING EFFECTS OF SQUEEZ AIR FILM.

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ABSTRACT

The sealing effects of squeeze air film were analyzed experimentally and theoretically .The air flow rate and the sealed pressure were measured in a squeeze face seal. The air flow rate can be expressed as the difference between the flow rate by the pumping and the flow rate by the leakage. The air flow rate by the pumping increases proportionally to the square of the vibration amplitude of the surface, as does the sealed pressure. The air flow rate by the leakage increases proportionally to the pressure difference between the vessel pressure and the ambient pressure. The experimental results showed good agreement with the theoretical results.

الخلاصة

اجري تحليل عملي ونظري لتأثيرات منع التسريب لطبقة الهواء المضغوط.تم قياس معدل التـــدفق للهـــواء وضغط منع التسريب عند وجه مانع التسريب المضغوط.

إن معدل التدفق للهواء يمكن التعبير عنه بالفرق بين معدل التدفق بالضخ ومعدل التدفق بالتسريب ، حيث أن معدل التدفق للهواء بالضخ يزداد بالتناسب مع مربع الطول الموجي لإهتزاز السطح وكذلك الحال مع ضغط منع التسريب بينما يزداد معدل التدفق بالتسريب تناسباً مع فرق الضغط بين ضغط الوعاء وضغط المحيط .

كانت النتائج العملية متوافقة بصورة جيدة مع النتائج النظرية.

KEY WORD

Sealing effect, Squeeze, Air film, squeeze face seal.

INTRODUCTION

There are very few reports about sealing effects of a squeeze air film, although research findings pertaining to squeeze films have been reported by various authors, e.g., Salbo [Salbo1964] , Pan[Pan 1967],from different points of view. The pressure distribution between two disks is reported by Taylor and Saffman [Taylor 1957].

In this paper we deal with gas sealing effects of the squeeze air film. This research is the sequel to a report [Takăda1983] on air flow through the a spherical squeeze air film.The outer gap between two dises is thicker than the inner gap see in **Fig.(1)**.In this case,air flows outward due to the vibration

ELASTIC STABILITY OF FRAMES HAVING CONCAVE TAPERED STRUTS

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ABSTRACT

The aesthetic and architectural shapes of the beam-column elements may enhance the elements strength depending on the maximum and minimum bending moments effect. Therefore, the stability value of the non-linear taper member in concave configuration may be more efficient than linear taper or prismatic members.

The modified stability functions will be obtained from the solution of the basic differential equation, where this basic differential equation depends on the non-linearity factor [1] λ of the beam-column shape and the shape factor of the cross-sectional area. These two factors, multiplied by others, produce the modified shape factor, which affects the results of the basic differential equation solutions.

الخلاصة

إنّ الأشكال الفنية والمعمارية للعناصر المحملة بأحمال محورية ممكن أن تزيد من قوة هذه العناصر عند توافقها مع العزوم القصوى والدنيا. لذلك فان قيمة الأستقرارية للعناصر الموشورية لاخطياً كما في الهيئة المقعرة ربما تكون اكثر كفاءة من العناصر الموشورية خطياً أو المنتظمة المقطع.

إنّ الدالة المعدلة للأستقرارية سوف يتم إيجادها من حل المعادلة التفاضلية الأساسية المستندة إلى معامل اللاخطية λ للأشكال المحملة أحمال محورية ومعامل المقطع. إنّ حاصل ضرب هذين المعاملين ينتج معامل المقطع المعدل والذي يؤثر على نتائج الحلول للمعادلة التفاضلية الأساسية.

KEY WORDS

Beam-column, Stability function, Non-linear problems, Non-prismatic members, Shape factor, Concave sections.

INTRODUCTION

Present day demands for economy of materials together with sufficient strength leads to the use of more slender structural members and thus a greater understanding of the stability behavior becomes essential. Increasing the second moment of area for each strut, which can very often be accomplished by increasing the cross-sectional dimensions, can enhance the strength of the structure.

The increase of depth, width or both dimensions of struts is followed by and associated to the increase of the subjected bending moment and axial force. The configuration of the struts may be

STUDY OF PERFORMANCE AND PREDICTION OF HEAT RELEACE IN COMPRESSION IGNITION ENGIN WORKING ON ETHYL ALCOHOL AND GAS-OIL SOLUTION

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ABSTRACT

The effect of using solutions of ethanol and gas-oil (duel fuel) to fuel the diesel engine on engine performance and heat release have been studied experimentally . A single cylinder diesel engine type Recardo (E6/US) was used and the ethanol percentage in the solution was varied from 0 to 20 percent. The results showed that, in general, addition of ethanol to gas-oil cause the maximum power output to decrease at medium and high range of speed and it was nearly the same as that of the straight gas –oil at low speed ranges . The specific fuel consumption of the dual is nearly the same as that of straight gas-oil at low and medium ranges of load. But at high ranges of load the specific fuel consumption was increase. In general , the addition of ethanol to gas-oil cause the maximum rate of heat release to increase during the first stage of combustion and decrease during the second stage of combustion. Further substitution of gas-oil with ethanol(higher than 20 percent) was limited by knock. .

الخلاصة

تم في هذا البحث دراسة تأثير استخدام وقود ثنائي يتكون من محلول الايثانول وزيت الغاز على أداء محرك ديزل و استنتاج الحرارة المتحررة منه ولتحقيق ذلك فقد استخدم محرك ديزل نوع ريكاردو (E6/US) وتراوحت نسبة الايثانول في المحلول من (صفر إلى 20) جزء.

أظهرت النتائج المستحصلة إن إضافة الايثانول إلى زيت الغاز تؤدي إلى تناقص القدرة العظمى الخارجة من المحرك عند السرع المتوسطة والعالية بشكل عام و تبقى مشابهة لتلك المستحصلة من زيت الغاز لوحده عند السرع القليل.

كما أظهرت النتائج بأن الاستهلاك النوعي للوقود الثنائي يكون مماثلا تقريبا للاستهلاك النوعي لوقود زيت الغاز لوحده عند الأحمال المتوسطة والخفيفة ولكنه يزداد عند الأحمال العالية.

وقد أظهرت النتائج بشكل عام آن إضافة الايثانول إلى زيت الغاز تؤدي إلى زيادة معدل الحرارة المتحررة في المرحلة الأولى من الاحتراق و نقصانها في المرحلة الثانية من الاحتراق

لم يمكن إضافة كمية من الايثانول (أكثر من عشرين جزء) لتسببها في إحداث طرق عالي في المحرك.

THE EFFECT OF SELF –EQUILIBRATING STRESSES ON THE NATURAL FREQUENCIES OF ELASTICALLY RESTRAINED RECTANGULAR PLATE

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ABSTRAC
An investigation has been made into the effect of residual stresses on the vibration, characteristics of thin rectangular plates elastically restrained against rotation along three edges and free on the fourth edge .General frequency equation with and without including the effect of residual stresses has been obtained. Exact frequency expressions including the effect of residual stresses for the cases: S-S-S-F,S-S-C-F,C-C-S-F,C-S-S-F, C-S-C-F,C-C-C-F were also obtained. The effect of the position of welding along the width of the plate for all cases was also included. Actual plate models were tested and the results were compared with the theoretical predictions giving good agreement.

الخلاصة

تم في هذا البحث دراسة تأثير الاجهادات المتبقية على خواص الاهتزازات و الكلل للصفائح الرقيقة ذات حدود التثبيت المرنة من ثلاثة حواف والحافة الرابعة حرة . تم التوصل الى اشتقاق معادلة عامة لتأثير الاجهادات المتبقية على التردد الطبيعي و كذلك الحصول على معادلات للحالات التالية:-
S S-S-F, S-S-C-F, C-C-S-F,C-S-S-F, C-S-C-F,C-C-C-F
تم بناء نموذج باستخدام طريقة العناصر المحددة لتدقيق نتائج تاثير الاجهادات المتبقية نتيجة خط لحام موازي لطول الصفيحة مع النتائج التي تم الحصول عليها من المعادلات. تم اختبار نماذج حقيقية تجريبيا لدراسة لتأثير الاجهلدات المتبقية على التردد الطبيعي و مقارنتها مع النتائج النظرية حيث اظهرت تطابقا جيدا.

KEY WORDS
Vibration, Fatigue, Rectangular Plate

INTRODUCTION

fatigue life, Residual stresses are induced at each stage of the life cycle in most engineering components, from original material production to final disposal. Residual stresses are created by welding, forging, casting, rolling, machining, surface treatment and heat treatment. Residual stresses are important in distortion, corrosion resistance, dimensional stability and brittle fracture. Compressive stress increases both fatigue strength and resistance to stress-corrosion cracking, but

ELECTRONIC COMMERCE ON THE INTERNET FACING THE NEW MEDIA

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ABSTRACT
This paper will be present the success of using the World Wide Web as a platform for electronic commerce and explain the necessary security mechanisms for it, Also we will propose a new approach dealing with pre and post sales support activities by using the electronic media as integral and very important parts of the business process that can be implemented to our Iraqi small and medium enterprises.

الخلاصة
يتناول هذا البحث طرق وتقنيات أستخدام صفحات الويب (WWW) كقاعدة لتطبيق تكنلوجيا التجارة الألكترونية والأستفادة من كل ما توفره من خدمات للمستخدمين. وكذلك سيتم مناقشة وأختيار أهم الأليات الأمنية الضرورية من أجل تطبيقها مع هذه التكنلوجيا مما يتيح للعديد من المؤسسات التجارية تبني هذه التقنيات من خلال استخدام شبكة الأتصالات العالمية (الأنترنت) كبنية تحتية سريعة وقليلة الكلفة. وأخيرا سيتم طرح طريقة لأستخدام التجارة اللألكترونية دون الحاجة لتطبيق كافة المتطلبات الضرورية لها من خلال أستخدام الأنترنت في عمليات ما قبل البيع وعمليات ما بعد البيع وبأسلوب يساعد على تطبيق هذه التكنلوجيا في المحيط الحالي للعراق.

KEY WORD
Electronic Commerce, WWW, Internet, Pre-Sales activity, Post-Sales activity, EC security.

INTRODUCTION
The Internet as an infrastructure for electronic commerce was recognized some years ago and some successful experiments have been carried out so far. The first experiments were simple nowadays; however, we face large and serious market trials of electronic commerce on the Internet (Justyna L., 2001). Many companies are taking this into account, but the Internet still has some unsolved problems preventing companies from adopting electronic commerce on such an infrastructure.

The trends in the development of Internet application are directed towards enabling secure and reliable commerce, companied by all other business activities. One of the most effective platform is the World Wide Web (WWW), which is based on hyperlinks of documents and information servers. Some security mechanisms were added to the WWW services and thus, in addition to other security measures to enabled the successful start of electronic commerce. Now a days many companies are aware of the possibilities the Internet provide but they are afraid to use it as a medium for doing

DIGITAL TECHNOLOGY IN PHOTOGRAMMETRY

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ABSTRACT

One of the major advantages of digital photogrammetry is the potential to automate production processes efficiently, thus substantially improving the price \ performance ratio for photogrammetric products. Image processing and computer vision techniques have successfully been employed for facilitating automated procedures in digital aerial images such as interior orientation, relative orientation, point transfer in photogrammetric block triangulation, and the generation of DTM S .

In this paper, the researcher presents her investigations on a digital aerial triangulation of a block consists of two strips of eight aerial photographs. Digital imae data scanned with a resolution of 400 dpi, this gives pixel size of 63.5 μm (corresponding to 0.19m ground resolution. Each one of the eight black-and-white overlapped aerial photograph that have been used in this research has a photo scale equal approximately to 1:3000. The measurements were carried out using Pentium III personal computer with processor (CPU) 733MH,128MB memory and 20GB hard disk. All observations were later adjusted in bundle adjustment program (jadria) that has been written by the researcher herself.

The goal of this research is building a digital aerial triangulation package to be the first trial of digital aerial triangulation in Iraqi Universities .

الخلاصة

ان واحدة من بين الفوائد الرئيسية للمسح التصويري الرقمي هو امكانية تقليل خطوات الانتاج وبكفاءة عالية ، ولهذا يمكن فعليا تحسين القيمة ومعدل الاداء في نتائج المسح التصويري .ان تقنيات المعالجة الصورية (image processing) ورؤية الحاسبة (computer vision) قد طبقت بنجاح لزيادة فعالية خطوات العمل أوتوماتيكيا في الصور الجوية الرقمية مثل التوجيه الداخلي (interior orientation) والتوجيه النسبي (relative orientation) ونقل النقاط (point transfer) في عمليات التثليث الجوي لمنطقة معينة وكذلك في انتاج نمذجة الارتفاعات رقميا (DTM) .

في هذا البحث قدمت الباحثة دراستها عن موضوع التثليث الجوي الرقمي الذي طبق على مجموعة من الصور المتوفرة لمنطقة الدراسة والمكونة من ثمانية صور. هذه الصور تم تحويلها الى الصورة الرقمية باستخدام جهاز المشاط الالكتروني وبوضوح مقداره(400dpi) والذي يعادل قوة وضوح على سطح الارض مقداره (0.19m). كل صورة من الصور المتداخلة والمستعملة في هذا البحث لها مقياس صوري يساوي حوالي (1:3000). القياسات التي اجريت على هذه الصور تمت باستخدام حاسبة شخصية نوع (pentiumIII)

GLOBAL BUCKLING LOAD OF STEEL COLUMNS STRENGTHENED BY FIBER REINFORCED POLYMER

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ABSTRACT
The need for strengthening structural members is well known and research is progressing in this field. In recent years the use of fiber reinforced polymers (FRP) for strengthening has shown to be a efficient method both regarding structural performance and economical aspects. However, most of the research in this field has been undertaken on concrete of old and damaged structures and for flexural and shear strengthening. So, this paper presents axially loaded steel columns strengthened for increased load capacity and improved stability. The topic is studied theoretically. The theory covers analytical method, and a numerical finite elements (FE) analysis. Different types of most common commercial FRP systems have been examined and used in this study.

الخلاصة
إن الحاجة إلى تقوية الأعضاء الإنشائية معروفة و البحوث مستمرة في التطور في هذا المجال. في السنوات الأخيرة تبين إن طريقة استعمال قماش البوليمر المسلح بالالياف لأغراض التقوية فعالة من خلال زيادة الكفاءة الإنشائية و من الناحية الاقتصادية. معظم البحوث في هذا المجال أجريت على الخرسانة المسلحة القديمة والمتضررة لتحسين و زيادة مقاومة القص و الانحناء . في هذا البحث تم دراسة استخدام هذه الألياف لتقوية الأعمدة الحديدية المحملة محورياً و تحسين إستقراريتها بصورة نظرية. الدراسة النظرية شملت الطرق التحليلية و الطرق العددية باستخدام طريقة العناصر المحددة. أنواع مختلفة من هذه الاقمشة البوليمرية الشائعة الاستعمال تجارياً جرى اختبار مدى فائدتها في هذا البحث.

KEY WORDS
Buckling load, FRP, stability, steel column, strengthening.

INTRODUCTION
Columns are the most important members in a structural system. Slender columns subjected to compression should be designed to carry the load requirement without failing by yielding or instability, i.e. buckling. However, for cases of changing, for example due to increased loads or change in use, it is required to improve the load capacity. In addition, structures may be affected by accidents. If the function of a structure becomes inadequate by one of the above reasons, it might be possible to keep it in service by repairing or strengthening. It should be determined whether it is more economical in strengthening the structure compared to replacement.
If a steel column that subjected to compression needs to be strengthened, many methods exist. For example, extra steel sections can be welded or bolted to the column, but sometimes this method is

ESTIMATION OF THE LIFE OF THICK CYLINDER SUBJECTED TO INTERNAL PRESSURE WITH MANUFACTURING CRACKS USING J-INTEGRAL METHOD

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ABSTRACT

Cracks may appear in structures due to manufacturing processes and some time are appeared in the structure product from casting, these structures may be used but in the life less than the design life according to crack propagation on it.

In this research a thick cylinder has one crack or more is investigated to estimate the life under pulsation internal pressure. Finite element method with J-integral approach has been used to evaluate the numerical strain energy release rate (J) for the thick cylinder and the stress intensity factor (SIF).

J-integral method is most accurate method to evaluate the SIF for the elastic-plastic materiel by considering the local plastic zone near crack tip.

Software developed using the FEM; J-integral; SIF and Paris formula to estimate the life of the component is presented with many working examples.

الخلاصة

في اغلب الأحيان تظهر الشقوق في الهياكل المصنعة بواسطة عمليات إنتاجيه و قد تظهر الشقوق أو العيوب أيضا في الهياكل المصنعة بواسطة السباكة. هذه الهياكل قد تكون قابله للاستعمال و لكن بعمر استخدام اقل من العمر المصمم بسبب عمليه توسع الشقوق فيها.

في هذا البحث تم دراسة الاسطوانات السميكة التي تحتوي على شق أو عدة شقوق و المعرضة إلى ضغوط داخليه مكرره و ذلك لحساب عمر الاستخدام لها. تم استخدام نظرية العناصر المحددة و طريقة (J-integral) لحساب كل من معدل طاقة الانفعال (J) و معامل شدة الإجهاد (K) عددياً.

تم بناء برنامج باستخدام نظرية العناصر المحددة و طريقة التكامل المحوري (J-integral) و كل من صيغة (Paris) و صيغة (Forman) وذلك لحساب عمر الاستخدام للهياكل، وتم تجربته على عدة أمثلة مدروسة.

KEY WORDS

Fatigue, crack, fracture mechanics, J-integral, stress intensity factor, finite element method.

INTRODUCTION

Mechanical failures have caused many injuries and much financial loss. Fatigue has accounted for many of these mechanical failures; most of these are unexpected fractures.

EFFECT OF LOADS ON THE STABILITY OF COHESIVE SLOPES IN UNDRAINED CONDITION

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ABSTRACT

The undrained stability of cohesive slopes ($\phi_u = 0$) subjected to surcharge loads is studied in this paper. Problems of this kind are involved in structures rapidly built near the crest of cohesive slopes and heavy equipment (e.g. draglines, buldozers and railways) move on slope. Using the non-linear finite element method, the effects of line loads and uniformly distributed loads are studied and the distribution of stresses under these loads is examined. The value of Pcr (critical line load) required equating the driving and resisting moments for a unit length of the slope was computed using the computer program. The process was repeated until a minimum Pcr was obtained.

الخلاصة

الاستقرارية غير المبزولة للمنحدرات الطينية ($\phi_u = 0$) المعرضة إلى أحمال مختلفة درست في هذا البحث. إن المسائل من هذا النوع مطلوبة في المنشات التي تنشأ سريعا قرب قمة المنحدرات الطينية وحالة المعدات الثقيلة (مثل الحفارات السلكية و البلدوزرات و خطوط السكك) التي تتحرك على المنحدر. باستعمال طريقة العناصر المحددة غير الخطية درست تأثيرات الأحمال الخطية و الأحمال الموزعة بانتظام و أختبر توزيع الإجهادات تحت هذه الأحمال. إن قيمة الحمل الخطي الحرجة المطلوبة لمعادلة كل من العزم المدور و العزم المقاوم لوحدة طول من المنحدر قد حسبت باستخدام برنامج حاسوبي. و قد كررت عملية الحساب مرات عديدة إلى أن تم الحصول إلى القيمة الدنيا للحمل الحرج.

KEY WORDS

Stability, slopes, finite elements, cohesive

INTRODUCTION

Despite its widespread use, the limit equilibrium stability analysis method is subjected to several theoretical shortcomings. This led to the development of the finite element method of stability analysis which eliminates most of the limitations found in limit equilibrium methods. Theoretical objections that apply in general to all limit equilibrium analysis methods, either total or effective stress, have been reported by Wright et al. (1973). These methods also have a number of common characteristics, (Adikari and Cummins, 1985).

Conventional methods of stability analysis are restricted to two-dimensional (plane strain) mode of failure. Baligh and Azzouz (1975 and 1977) studied two and three-dimensional effects on the stability of cohesive slopes and presented the effect of line loads in the form of charts and considered three-dimensional analysis for line loads of finite length.

THE ROLE OF MEMBRANE ACTION IN LOAD TEST

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ABSTRACT

Most of the structures subjected to load tests had successfully passed it, although some of them had failed in cube and core tests. It is believed that membrane action may be the most important factor that made them do so. In the present study, an attempt is made to study the effect of membrane action on load test results.

In this study, two space (3-D) model frames, nine panels (3×3), [consisted of rafts, columns, beams and slabs] were prepared for load test.

The results show the positive role of the membrane action especially with camber beams and slabs in successful passing of the load test. Also there is enhancement in the deflection behavior of camber members compared with straight members.

الخلاصة

معظم المنشآت التي يتم تعريضها لفحوص التحميل تجتاز الفحوص بنجاح، على الرغم من أنها فشلت في فحوص المكعبات واللباب. يتم الاعتقاد بأن الفعل الغشائي من الممكن هو العامل الأكثر أهمية الذي يجعلها تقوم بذلك. في الدراسة الحالية، المحاولة تمت لدراسة تأثير الفعل الغشائي على نتائج فحص التحميل.

في الدراسة الحالية، تم تهيئة نموذجين من الهياكل ثلاثية الأبعاد ذات التسعة فضاءات (3×3) [متكونة من أساس حصيري، أعمدة، عتبات وبلاطات].

بينت النتائج الدور الإيجابي للفعل الغشائي وخاصة مع وجود العتبات والبلاطات المقوسة (المحدبة) نحو الأعلى بالاجتياز الناجح لفحص التحميل. وكذلك هناك تحسن في التصرف نحو الإنحراف للأجزاء المقوسة بالمقارنة مع الأجزاء المستقيمة.

KEY WORDS

Load test, beams and slabs, membrane action, camber, deflection.

INTRODUCTION

If there is doubt concerning load-carrying capacity of a part or all of a structure, a strength evaluation shall be carried out. The National Center for Constructional Laboratories (NCCL) (Ministry, 2000) indicates that the types of tests applied for strength evaluation are (Collapse load test, Load test, Cores test, Pullout test, Ultrasonic Pulse velocity test and Rebound test).

Load test is used when there is inconsistency with code requirements (design, construction). There are two types (Ministry, 2000) of load tests:

DESIGN OF A PERCOLATOR FOR AQUA-AMMONIA LIQUID

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ABSTRACT

A new design concept for a percolator is developed which combine the simultaneous production of ammonia vapor plus the pumping of weak aqua ammonia liquid. The steady state design was based on a balance between the hydrostatic driving head and the total single and two-phase pressure losses in the percolator system. To accomplish this, the results from modeling of the driving pressure and pressure losses, using the separated flow and drift flux methods were compared with the experimental measurements. The Chisholm's model was the best in predicting the measured flow rate versus water level for first stage with a maximum standard deviation of ± 10.1% and was adopted for the theoretical calculations. Parametric design studies that include the cooling power and the strong solution level, inner tube diameter and height for each stage of the percolator were carried out to maximize suitable cost function. The results of the optimization gave a two stage percolator of length 280 mm, inner diameter 5.5 mm for first stage and length 520 mm, inner diameter 5.5 mm for second stage.

الخلاصة

تم تطوير فكرة تصميم جديد لمبخر نفاث والذي يجمع بين انتاج بخار الامونيا وعملية الضخ لسائل أمونيا ضعيف التركيز. إن تصميم الحالة الثابتة قام على أساس التوازن بين القوة الدافعة الهيدروستاتية وبين فقدان الضغط الناجم عن الجريان الاحادي والثنائي الطور في نظام المبخر. لغرض إتمام ذلك فإن النتائج المستحصلة من عملية تمثيل للضغط الدافع وكذلك فقدان الضغط باستخدام الجريان المنفصل والجريان المنبثق الانحرافي تم مقارنة الحسابات النظرية بالقياسات العملية باستخدام الماء كسائل العمل. لتحديد الموديل المناسب لفقدان الضغط تبين أن (موديل جزم) يعتبر الافضل في التنبؤ بقياسات معدل الجريان مقابل مستوى الماء بالنسبة للمرحلة الاولى حيث إن الانحراف المعياري كان ±10.1 %. إن استخدام التصميم البارامتري (الذي يشمل على طاقة التبريد، مستوى المحلول القوي، قطر الانبوب الداخلي وأرتفاع كل مرحلة بالنسبة للمبخر) توصل الى إيجاد الابعاد المثلى للمبخر والمتمثلة بمبخر ذو مرحلتين بطول 280 ملم وبقطر 5.5 ملم بالنسبة للمرحلة الاولى وبطول قدره 520 ملم وقطر داخلي 5.5 ملم بالنسبة للمرحلة الثانية .

KEY WORDS
Percolator, pressure drop, natural circulation and Bubble pump

REDUCTION OF FORMATION DAMAGE DUE TO DRILLING MUDS

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ABSTRACT

An experimental study has been carried out to investigate the possible reduction of formation damage that is result from drilling muds. This was accomplished through making a bridging system with different barite additions 70, 140, 200, 280 lb/bbl to fresh water mud. This bridging system creates an effective sealing of impermeable filter cake, thereby inhibiting continual losses of small solids and mud filtrate into the formation.

The study indicates that all the muds, which were used, have the ability to damage the petrophysical properties of formation, but some additives to mud reduce the damage in petrophysical properties. In addition, it is found that minimum permeability damage can be obtained when the particles of drilling mud are larger than the pore size of formation because no internal mud cake is created. Finally, the relationship between the pore size distribution of the core samples and particle size distribution of drilling muds becomes better and the impairment is reduced, when the particle size distribution in the mud is matched to the pore entry size distribution within the rock; so that each pore entry could be bridged as permitted by the particular fluid flow rate involved.

الخلاصة

أجريت دراسة مختبرية لبحث إمكانية تقليل ضرر التكوين الناتج عن استخدام أطيان الحفر. تم إنجاز هذا من خلال عمل منظومة تجسير مع مختلف إضافات البرايت (280،200،140،70رطل/برميل) إلى طين الماء العذب. هذه المنظومة تولد غلق محكم لكعكة الطين القليلة النفاذة ، وبذلك تمنع الفقدان المستمر للقطع الصغيرة وراشح الطين داخل التكوين.

تبين هذه الدراسة أن كل الأطيان التي استخدمت لها القابلية على إلحاق الضرر بالمواصفات البتروفيزاوية للتكوين. لكن بعض الإضافات إلى هذه الأطيان قلل الضرر في هذه المواصفات. إضافة إلى إن اقل ضرر بنفاذية التكوين ممكن الحصول عليه عندما تكون جزيئات طين الحفر اكبر من حجم مسامات التكوين بسبب عدم تكون طبقة كعكة طين داخل هذه المسامات. و أخيراً العلاقة بين توزيع الحجوم المسامية للنماذج الصخرية وتوزيع حجوم الجزيئات لطين الحفر، تصبح افضل والضرر يقل عندما يتطابق التوزيعان، حيث كل فتحة للمسام ستغلق بجزيئة خلال جريان المائع.

طبيعة العلاقة بين الهوية والإبداع في العمارة
نظرة تحليلية في ضوء مطلب تحقيق الهوية في العمارة العراقية المعاصرة

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الخلاصة

يناقش البحث طبيعة العلاقة بين مفهوم الهوية الذي يوحي بالثبات والتكرار ومفهوم الإبداع الذي يوحي بالتجدد والتغير، ويتقصى المشكلة الناجمة من إدراك التعارض بينهما.

ويفترض البحث أن العمل الأصيل للمعماري "كذات" ومصمم له شخصية وإنتماؤه يحمل هويته ويتسم بالإبداع.

ويتحقق الإبداع في عمله بتحقيق التوازن بين مستويين:

مستوى الفكر ومستوى النتاج الفيزياوي الذي تتضح به علاقة شكل/مادة والتي تدرك بالحس البشري.

يتقصى البحث هذين المستويين من خلاله مناقشة ثلاث حالات:

أ- حالة التقاليد في العمارة حيث يتضح بها الفعل المعماري كمحاكاة.

ب- حالة العمارة الحديثة التي يتضح بها مفهوم تمثيل الفكرة ويمكن تسمية الفعل المعماري بها (بالتصميم).

ج- الحالة المعاصرة ووعي مطلب تحقيق الهوية في العمل المبدع.

THE RELATIONSHIP BETWEEN IDENTITY AND CREATIVITY IN ARCHITECTURE
ANALYTICAL VIEW ACCORDING TO THE DEMAND OF ACCQUIRING THE IDENTITY IN CONTEMPORARY IRAQI ARCHITECTURE.

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ABSTRACT

The research discusses the relationship between "Identity" as a concept giving the impression of "Unchangability", and the concept of "Creativity" giving the Impression of "newness".

سلوكية الخرسانة المسلحة بشرائح القصب في الإنحناء

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الخلاصة

يقدم البحث نتائج جديدة حول سلوكية العتبات المسلحة بشرائح القصب المحلي في الانحناء وتشمل التجارب إيجاد معامل المرونة بطريقة الذبذبات فوق الصوتية. كما يشمل البحث نتائج إضافية حول مقاومة شد القصب وكثافته ومعامل مطيلية العتبات وقساوتها وتأثير طلاء القصب بالمستحلبات الأسفلتية Flinkote على الخواص الانحنائية. ويهدف البحث إلى تطوير استخدامات القصب واستغلاله في الإسكان واطئة الكلفة نظراً لكونه مادة إنشائية رخيصة الكلفة ومتوفرة بكميات كبيرة.

FLEXURAL BEHAVIOUR OF REED REINFORCED CONCRETE

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ABSTRACT

The paper presents further experimental results on the behaviour of reed reinforced concrete joists in flexure. The experiments include the determination of elastic modulus of reeds by pluse velocity method , also additional results are presented on the tensile strength, density, ductility and toughness indices. The results include the effect of asphaltic emulsion paints (Flinkote) on flexural properties. The aim of the work is to develop the uses of reeds in low cost housing due to its low cost and its availability in immense quantities.

المقدمة

استخدم القصب قبل آلاف السنين كتسليح للمواد الرابطة كالجص و الطين و الاسفلت و هناك امثلة كثيرة عن استخداماته في العراق القديم مثل زقورة عقرقوف (١٤٠٠ق.م) ومعبد اور(٤٠٠٠ق.م) وهو مادة إنشائية متوفرة بكثرة في جميع أنحاء القطر و ذات كلفة رخيصة ويمكن استغلاله في بناء دور واطئة الكلفة.

تم تنظيف جميع أسنان الترس بواسطة العصف الرملي ومن ثم فحص الترس بالسوائل النافذة للتأكد من عدم وجود شقوق. أسطح الأسنان هيئت بواسطة تجليخها يدويا. كسيت أسنان الترس بطبقة،طبقتين،وثلاث طبقات من سلك (E1-UM350) باستخدام تسخين مسبق و بدونه. التركيب الكيمياوي لهذا السلك (0.08%C, 3.3%Cr, 1%Mn) وصلادته الدنيا (350 HV) والتي تمثل الصلادة القصوى لسطح أسنان الترس،وعلى هذا الأساس تم اختيار هذا السلك لإجراء ألا كساء.تم اختيار درجة حرارة التسخين المسبق (200° C) لسطح الأسنان اعتمادا على قيمة الكربون المكافئ.

لوحظت تشققات في منطقة اللحام عند ألا كساء بثلاث طبقات من سلك (E1-UM350). وعليه اختيرت أسلاك لحام واطئة المحتوى من الهيدروجين(E 8018-B_2 و E 9018-D_1) لتزبيد سطح الأسنان ثم تتبع بطبقتين من سلك (E1-UM350). اختيرت هذه الأسلاك لغرض التزبيد لخواصها الميكانيكية الجيدة إذا ما قورنت بالمعدن الأصلي وكذلك محتواها الواطئ من الهيدروجين و بالتالي تضمن عدم ظهور شقوق في منطقة اللحام أو المنطقة المتأثرة بالحرارة.

أجريت مجموعة من الفحوصات الاتلافية و غيرالاتلافية لغرض تقييم مناطق اللحام ميكانيكيا و ميتالورجيا. من هذه الفحوصات، فحص الشد،الصلادة المايكروية،مقاومة البليان،مقاومة الصدمة،فحص السوائل النافذة،التحليل الكيمياوي،الفحص المجهري،والإظهار ألما كروي.

إن إجراء التسخين المسبق لسطح الأسنان، أعطى توزيع جيد للصلادة خلال مناطق اللحام،المنطقة المتأثرة بالحرارة، و المعدن الأصلي من خلال خفض معدلات التبريد ومنع ظهور أطوار صلدة في المنطقة المتأثرة بالحرارة. مقاومة البليان والصدمة لمناطق اللحام كانت اكبر من المعدن الأصلي. اظهر الفحص المجهري لمناطق اللحام لسلك(E1-UM350) بنية المارتنسايت بصلادات مختلفة اعتمادا على معدل التبريد و عدد الطبقات. إن استخدام أسلاك لحام واطئة المحتوى من الهيدروجين كطبقة تزبيد،عالج مشكلة التشقق في منطقة اللحام.

KEY WORDS
Welding sequences, steel gears, patching, surfacing, preheating, buttering

INTRODUCTION

Gears are vital parts of most pieces of machinery. The techniques for a wide range of gear repair are described below:

1- Using powder welding process to give a wear resistance layer for teeth surface [C.cookson, 1976, 1977, 1979, C.J.Pelser 1978].
2- surfacing the gear teeth by submerged arc welding using low carbon low alloy steel electrodes followed by case hardening (flame hardening or carbo- nitriding depending on the chemical composition of the base metal),[www.retechbg.com, 2001].

In this work, a suitable rebuilding and hardfacing electrodes were selected for gear repair in order to eliminate the subsequent case hardening process (flame hardening and carbo-nitriding) or powder welding process.

EXPERIMENTAL WELDING SEQUENCE

The basic principles incorporated should help to meet almost any gear repair. Gear surfacing is neither mysterious nor complicated if the instructions and recommendations are followed explicitly. The experimental welding sequence used in this research breaks down into five steps:

1- Selection of the base metal of the gear.
2- Selection of hardfacing electrode.
3- Selection of buttering and rebuilding electrodes.
4- Determination of preheating temperature.
5- Experimental surfacing conditions:

SURFACING PROCEDURE:

The steel gear which has the dimensions shown in **Table (1)** is surfaced with E1UM-350 electrode having standard chemical composition shown in **Table (2).** Preheating temperature was selected, 200° C, based on carbon equivalent of the base metal. **Table (3)** indicates the preheating temperature for different types of steel. To prevent cracking, a buffer layers were used before hardfacing especially for high carbon and alloy contents. **Table (4)** indicates the buffering layers used for different types of steel.

Ten specimens of teeth were surfaced with different electrodes with or without preheating as shown below:

1- Surfacing specimen 1 with one layer using E1-UM-350 electrode without preheating.
2- Surfacing specimen 2 with two-layer using E1-UM-350 electrode without preheating.
3- Surfacing specimen 3 with one layer using E1-UM-350 electrode with preheating.
4- Surfacing specimen 4 with two-layer using E1-UM-350 electrode with preheating.
5- Surfacing specimen 5 with one layer of buttering electrode E80180-B_2 followed by two layer of E1-UM-350 electrode without preheating.
6- Surfacing specimen 6 with one layer of buttering electrode E90180-D_1 followed by two layer of E1-UM-350 electrode without preheating.
7- Surfacing specimen 7 with one layer of buttering electrode E80180-B_2 followed by two layer of E1-UM-350 electrode with preheating.
8- Surfacing specimen 8 with one layer of buttering electrode E90180-D_1 followed by two layers of E1-UM-350 electrodes with preheating.
9- Surfacing specimen 9 with three layers of E1-UM-350 electrode without preheating.
10- Surfacing specimen 10 with three layers of E1-UM-350 electrode with preheating.

EXAMINATION AND TESTING

Different apparatuses and tools were used in non-destructive and destructive (static and dynamic) testing in order to evaluate the metallurgical and mechanical properties for surfaced areas and from these were:

- Chemical analysis: chemical analysis was carried out for all specimens including weld and base metals
- Metallographic testing: metallographic testing was carried out for base, HAZ, and weld metals
- Visual and macro-etchent testing: the purpose of this test is to determine the thickness of surfacing layers.
- Liquid-penetrate testing: entire area of the teeth was tested using dye penetrate technique
- Tensile testing: both base metal and buttering electrodes were tested in order to investigate the suitability of these electrodes for buttering this type of steel.
- Micro-hardness testing: three areas was selected for this test, which are, root, contact, and profile areas
- Impact testing: charpy impact test was carried out for specimens having the dimensions shown in **Fig. (2)**

- Wear testing: the evaluations of wear resistance based on determining volume loss of standard specimens having the dimensions shown in **Fig. (3)**.

RESULTS AND DISCUSSIONS

Chemical Analysis

It has shown from **Table (5)** that the carbon content (C%) in base metal (CK45) was (0.423). After surfacing, the migration of carbon from high concentration area to low concentration area has done. This is appear clearly in **Table (6)**, when surfacing with one layer as in the specimen 1&3 with carbon content (0.152&0.167) respectively. When surfacing with two and three layers, the dilution between the base and weld metals was reduced. The carbon content of two layers was varied from (0.126 to 0.131) for specimen 2&4. Also for three layers the content was varied from (0.042 to 0.077) for specimen 9&10. Using buttering technique also reduced the carbon content because the buttering electrodes have a low carbon as shown in the **Table (7)**, which shows the chemical composition of buttering electrodes.

The carbon content was varied from (0.057 to 0.071) for specimen 5&7 and from 0.058 to 0.069 for specimen 6&8, respectively. The standard percentage of chromium in hardfacing electrode was (3.3) and this percentage may be considered as a sufficient amount of chromium to give a martensitic structure on the surface.

It is known that the chromium is α stabilizer, so gives solid solution strengthening. In addition chromium increasing hardenability of steel by reducing the critical cooling rate of transformation. The minimum chromium content was (2.21) for specimen 3 and the maximum content was (4.07) for specimen 9. In general the amount of chromium in specimen 5&7 is greater than specimen 6&8 because chromium molybdenum electrode (E8018-B_2) was used as buttering electrode.

The third important element was manganese, which is γ stabilizer, increases hardenability by reducing critical cooling rate of transformation and increases the toughness of the welds metal. The table shows that the content of manganese, for all specimens, are greater than (1%), which represents the minimum value of standard chemical composition of E1-UM-350 hardfacing electrode. The manganese content was varied from minimum value (1.001) of specimen 7 to maximum value (1.407) of specimen 9. As in the chromium, the manganese content in the specimen 6&8 is greater than specimen 5&7, because the manganese molybdenum-buttering electrode (E9018-D_1) was used as buttering electrode.

Metallographic Testing

Within each composition examined, the description of the microstructures for both weld deposit and heat affected zone is shown in **Fig. (4)** as follows:

1- Surfacing with one layer (specimens 1&3): etching 2% nital revealed a ferrite plus pearlite for base metal [a.], martensitic structure for specimen 1 [c.] and martensitic structure with small amount of ferrite for specimen 3 [g.] in the interface zone while the martensitic structures were observed in the weld metal deposit [b. and f.].

2- Surfacing with two layers (specimens 2&4): in two layers surfacing, the immediately second layer reheat pat of the weld deposit and HAZ metals and thus produce grain refinement. The interface regions for specimen 2 consist of ferrite, fine pearlite and martensite[e.] while specimen 4 consist of ferrite plus pearlite [i.] due to effects of both preheating and subsequent second layer. Again, martensitic structures were observed in weld deposit for both specimens [d. and h.].

3- Surfacing with two layers using buttering (specimens 5, 6, 7 and 8): using of buttering electrodes (E8018-B_2 and E9018-D_1) gives several advantages and from these preventing cracking from formation and forming ductile structure consisting of ferrite plus fine pearlite. The interface region for specimens 5 and 6 consist of ferrite plus pearlite with small amount of martensite [k. and n.]. Ferrite plus pearlite is the structure of interface region for specimens 7 and 8 [q. and t.]

due to preheating and subsequent layers. Martensitic structures were observed for all four specimens, 5, 6, 7 and 8, [j., m., p., and s.]. The microstructure of buttering electrodes for specimens 5, 6, 7 and 8 was ferrite plus pearlite [l., o., r., and u.]. As shown from these figures, the pearlite of specimens 5 and 6 is finer than that of specimens 7 and 8 due preheating to give more time to pearlite to coarsening. Moreover, the subsequent hardfacing layers give refining to buttering layers. The alloying elements, which E8018-B_2 and E9018-D_1 consist of them, improve hardenability and producing a strong and tough acicular ferrite microstructure. Another benefit of buttering electrodes comes from its ability to prevent cracking in weld metal which observed when surfacing with three layers [z.]. This ability of preventing crack formation explained by low hydrogen content of these electrodes (E8018-B_1 and E9018-D_1) which prevent HICC (hydrogen induced cold cracking), in addition to formation a ductile structure (ferrite plus pearlite).

4- Surfacing with three layers (specimens 9 and 10): the microstructure of the interface region of specimen 9, consist of martensite and small amount of ferrite [w.] while the interface region of specimen 10 consist of ferrite plus pearlite [y.]. Martensitic structures were observed for both specimen 9 and 10 [v. and x.].

HICC was observed in the weld metal [z.] and the reasons for this type of crack are:

a- A crack- sensitive microstructure, usually martensitic as in this case.

b- Sufficient hydrogen concentration in the weld as in surfacing with three layers.

Liquid Penetrate Results

The surface of the gear teeth was tested using instructions of the manufacturer. There are no cracks detected on the surface of the gear teeth except specimens 9&10, which they show cracks on the face of the gear teeth. These cracks are also detected by both macro and micro examinations.

Testing Of Base Metal Of The Gear And Buttering Electrodes

Analysis of the gear material reveals it was a medium carbon steel as shown from table (5), which is similar to DIN CK45 steel. Testing of this base metal also showed mechanical properties typical of the aforementioned specification. The buttering and rebuilding low alloy steel electrodes (E8018-B_2 and E9018-D_1) showed the tensile properties in the range of standard mechanical properties of DIN CK45 gear material. As shown from the **Tables (5 & 7)**, both of E8018-B_2 and E9018-D_1 electrodes are very suitable for rebuilding and buttering this type of steel (DIN CK45) from mechanical properties hand.

Macro Etchent Results

Table (8) shows the dimensions of deposit metal for each specimen in addition to preheating temperature. It has shown that the thickness of weld deposit with two and three layers does not equal to double or triple the thickness of weld deposit with one layer. The reason belongs to dilution occurring between the layers.

Micro Hardness Results

It has seen from **Fig. (5)** that the maximum hardness of the surface of base metal is 350 HV [a] at root area. The figures of hardness distribution show the variation of the micro hardness at the surface and in the HAZ in relation to the condition of hardfacing conditions. It seen from figure that maximum micro hardness is measured at the interface region (426 HV) in the specimen 1. While weld deposits of specimens 1 and 3, have a micro hardness (413 & 396 HV), respectively [b.]. The interface region of specimen 3 has a micro hardness of 378 HV, which is lower than that of specimen 1. When surfacing with two layers, the micro hardness of weld and interface regions are reduced. As seen from figure that micro hardness of specimens 2 and 4 are 368 and 358 HV for weld deposit and 309 &254 for the interface region [c.].

In the same figure [d.] and [e.] show the hardness distribution of root area of specimens 5, 6, 7, and 8 respectively. The weld deposits of these specimens have a micro hardness 372, 389, 363, 373, and that for the interface region are 309, 288, 223, 221, respectively. The average hardness of buttering layers (specimens 5, 6, 7, &8) are 236, 234, 208, and 206, respectively.
The weld deposits of specimens 9&10, when surfacing with three layers, have a micro hardness 410 and 407 HV [f.], which are higher than specimens 2, 4, 5, 6, 7, and 8 and similar to specimens 1&3. The micro hardness at the interface region for both the specimens is 321 and 257 HV, respectively.
In general, the micro hardness's of all specimens in the root area are higher than that of contact area, [g., h., i., j., and k.], because the two areas have a different thicknesses and this factor (thickness) is reflected on the micro hardness's of these areas.
Also, figures [l. and m.] show the micro hardness distribution across the profile area of the tooth for all specimens. It has seen from these figures that the micro hardness varies with the thickness of the teeth. As the thickness of the teeth decreases from the root to the tip, the micro hardness is decreases also.
From the all of the mentioned above, important point must be discussed here, which is the factors influencing hardness in hardfacing. The hardness developed in weld deposits "as-welded" vary according to the following principal factors:

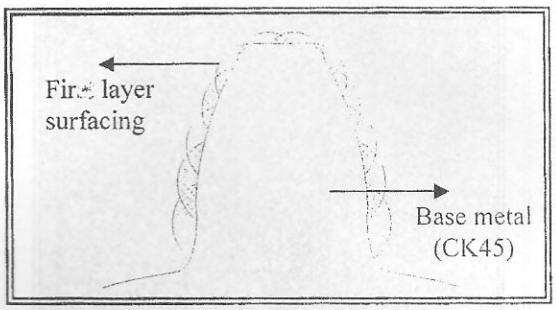
1- Pretreatment such as preheating.
2- Admixture of the base metal with weld deposit (dilution).
3- Rate of cooling: mass and thickness of the object acts upon the rate of cooling.

Impact test results

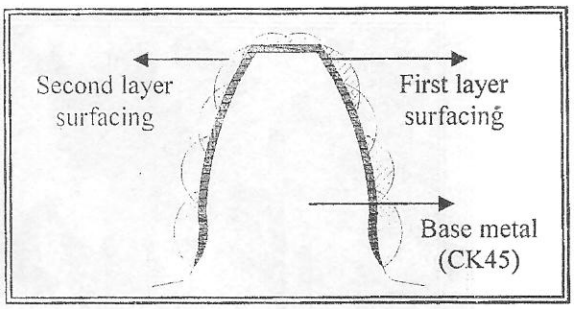
Table (9) shows the results of this test. It has been shown from this table that minimum impact value of the weld deposit was 36 J (specimen 1) when surfacing with one layer. When surfacing with two layers, the impact value raised to 43 J. preheating the teeth surface to 200° C, increase the impact value from 36 J (specimen 1) to 38 J (specimen 3) and from 43 J (specimen 2) to 47 J (specimen 4).
Using buttering technique gives good enhancement to impact values when using E8018-B_2 and E9018-D_1 electrodes as buttering layers. As indicated in the table, the impact values were raised when using buttering in which specimens 5 and 6 gives an impact values 49 J and 51 J.
Again using preheating, raises the impact values to 56 J (specimen 7) and 58 J (specimen 8) respectively. These values represent the maximum values for all cases. The impact values of specimens 9 and 10 are similar to that of specimens 2 and 4.
From the mentioned above, obtaining good weld metal toughness via microstructure control, through optimization of weld chemistry and cooling rate, by means of consumable selection and right weld procedures, respectively.

Wear Test Result

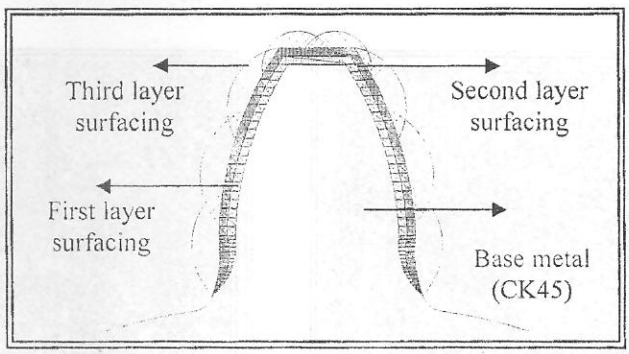
Table (10) shows the result of wear test. It has seen from the table that the lowest volume loss (greater wear resistance) was recorded for specimen 1 (0.451 mm^3) and specimen 9 (0.473 mm^3) and the larger volume loss (lower wear resistance) was recorded for specimen 4 (0.691 mm^3) and specimen 7 (0.652 mm^3).
In general, the wear resistance in this research of all specimens was varied with its hardness i.e. as the hardness increases, the wear resistance increases also. It has shown from **Table (6)** that the specimens 1 &3 have higher carbon content and this reflected on both their hardness and wear resistance, because carbon contents affected the matrix hardness.
Finally, it should be remembered that hardness is not necessarily an indication of wear resistance. As in specimen 9&10, which have higher hardness than other specimen and good wear resistance but these hard deposits were prone to hydrogen, induced cold cracking.



a. Surfacing with one layer.



b. Surfacing with two layers.



c. Surfacing with three layers

Fig. (1) Deposit pattern of surfacing layers.

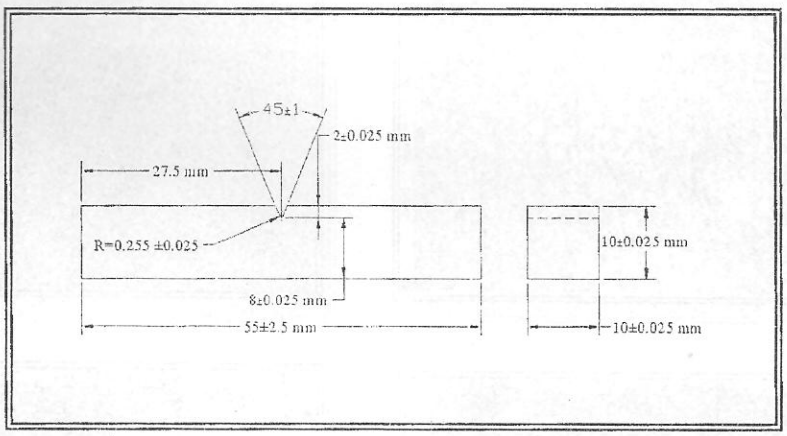


Fig. (2) Standard charpy impact test.

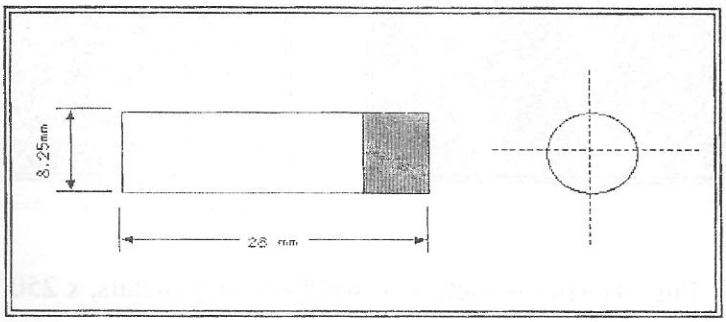


Fig. (3) Standard wear test specimen

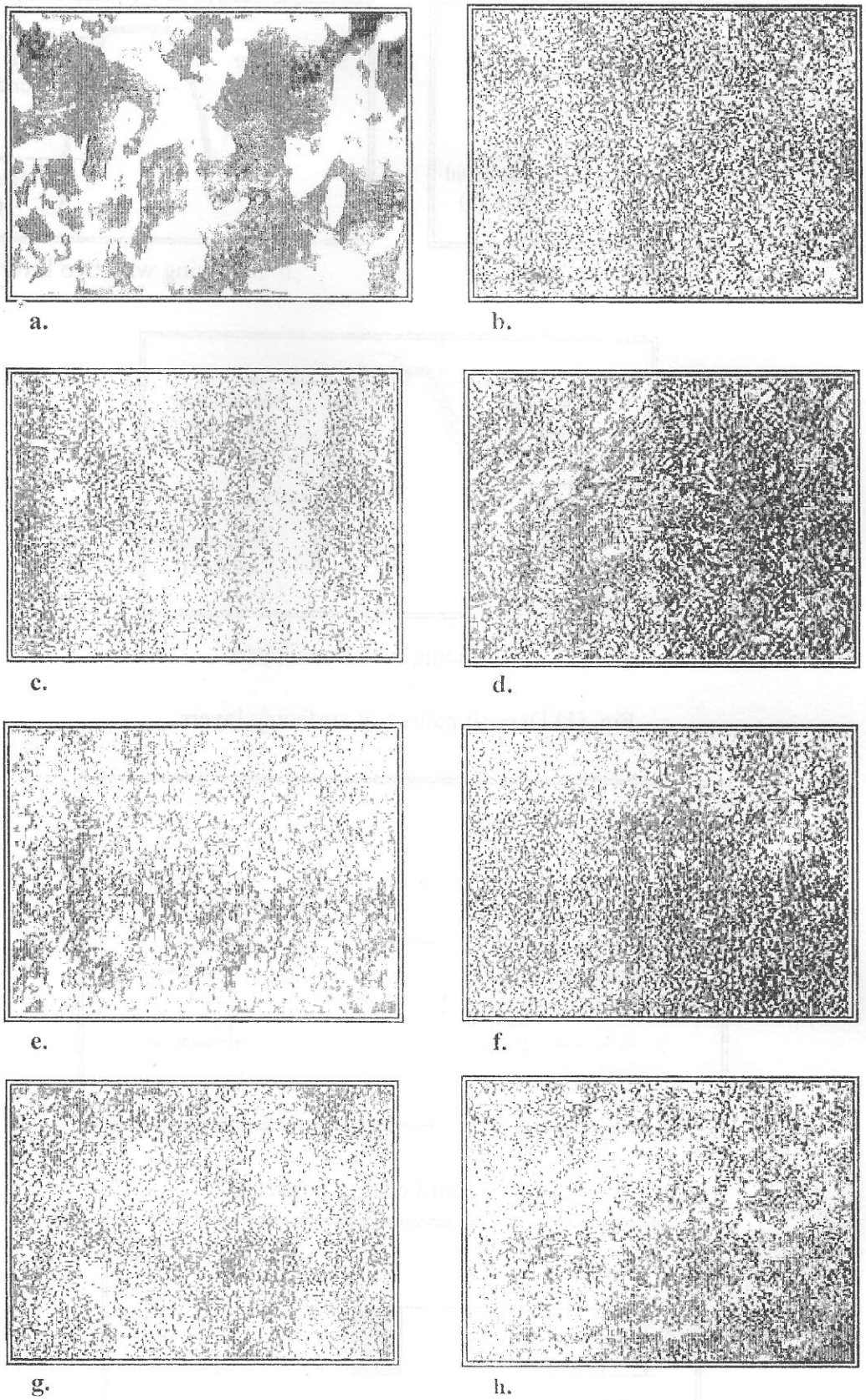


Fig. (4) Microstructure of weld and Haz metals, x 250

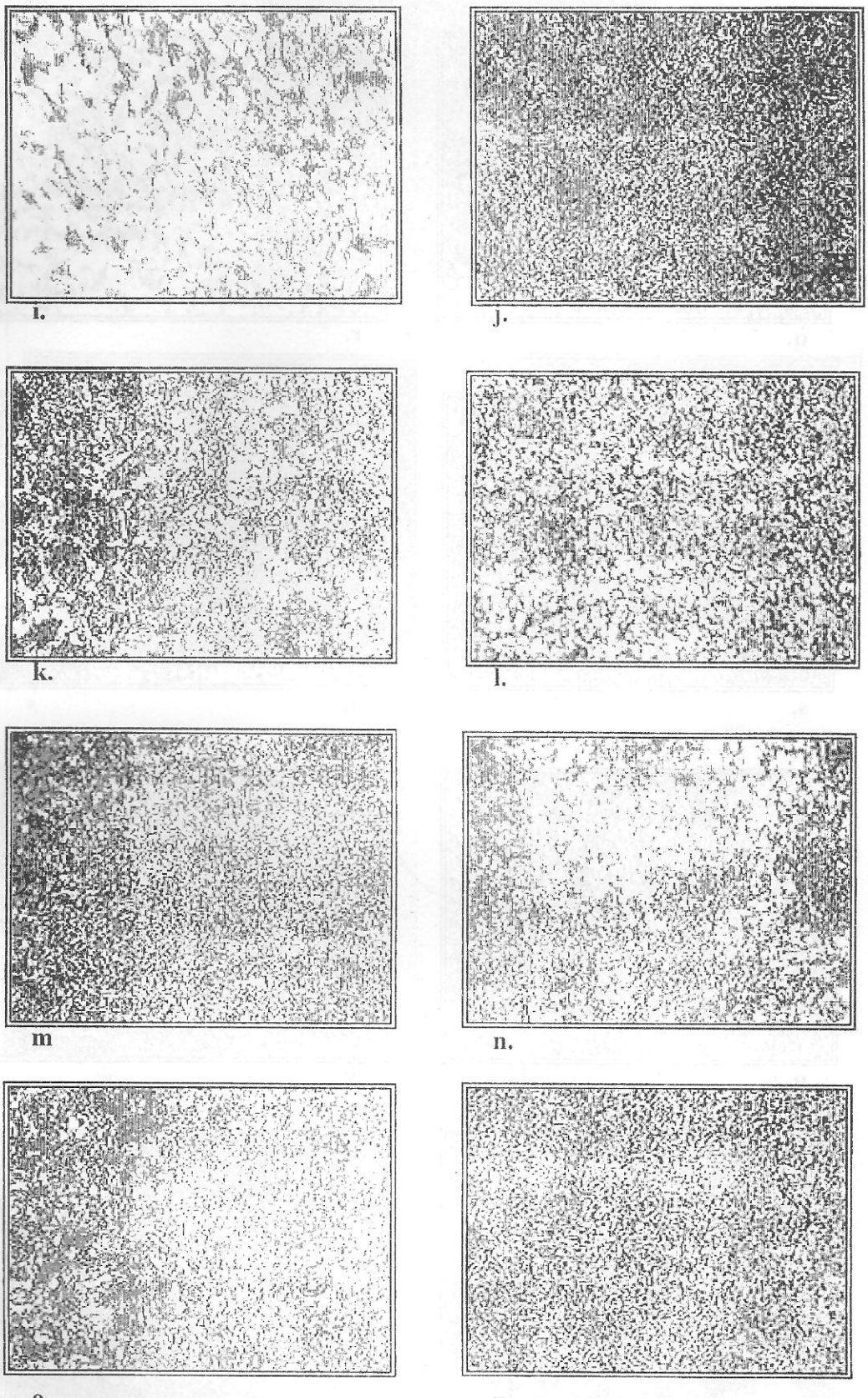
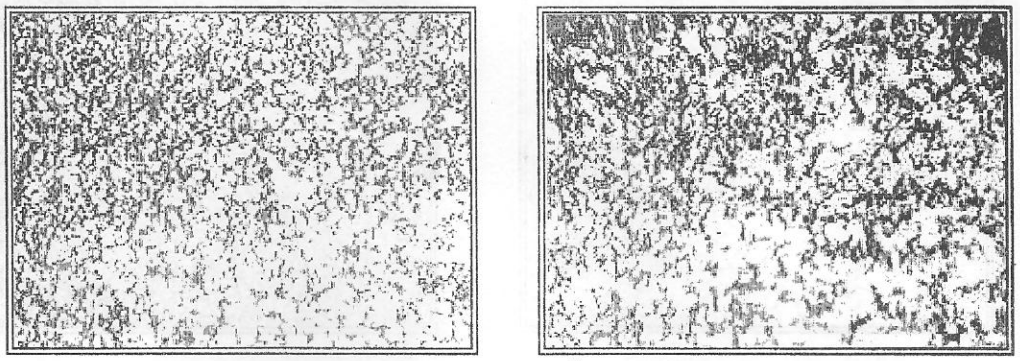
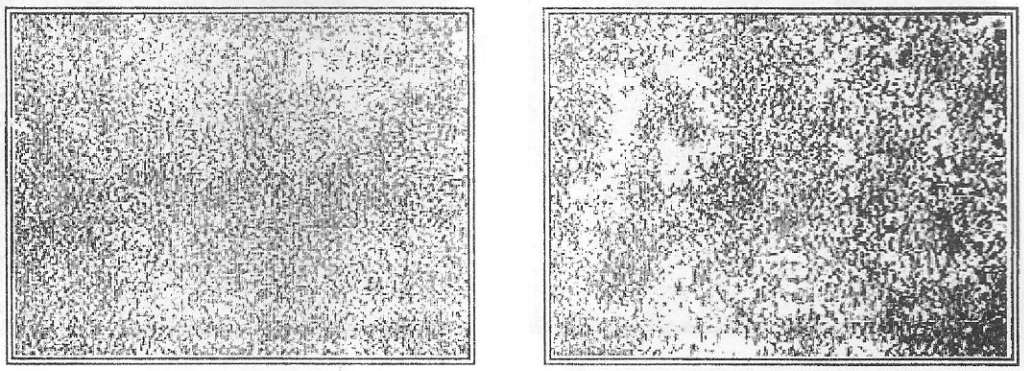


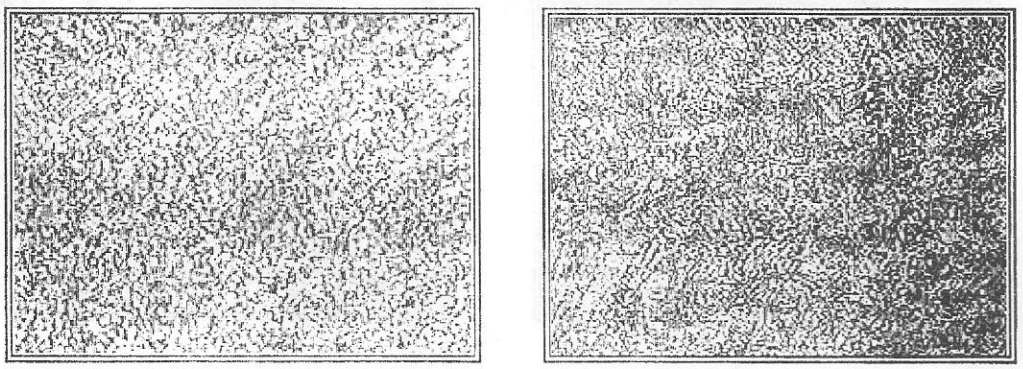
Fig. (4) continued x250



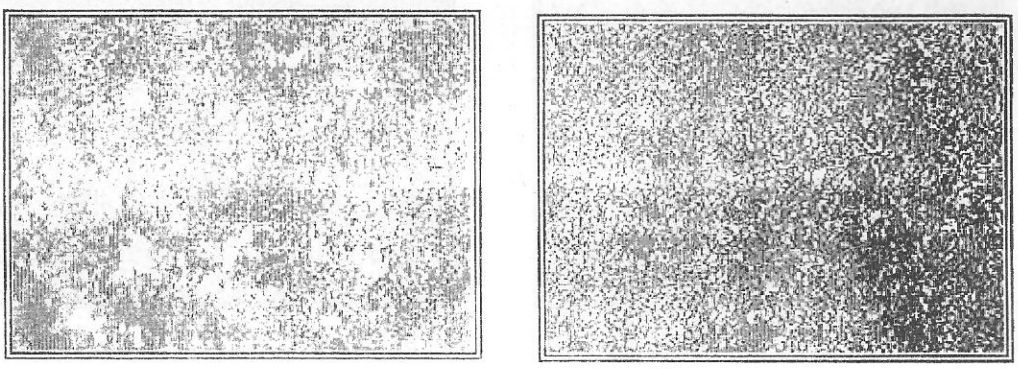
q. r.



s. t.

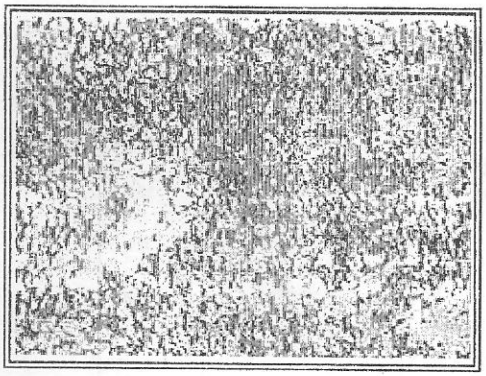


u v.

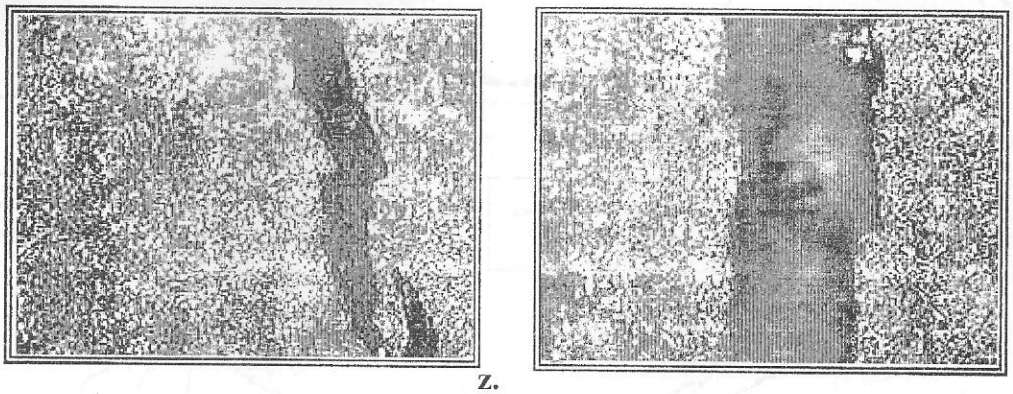


w x

Fig. (4) continued x250



y.



z.

Fig. (4) continued x250

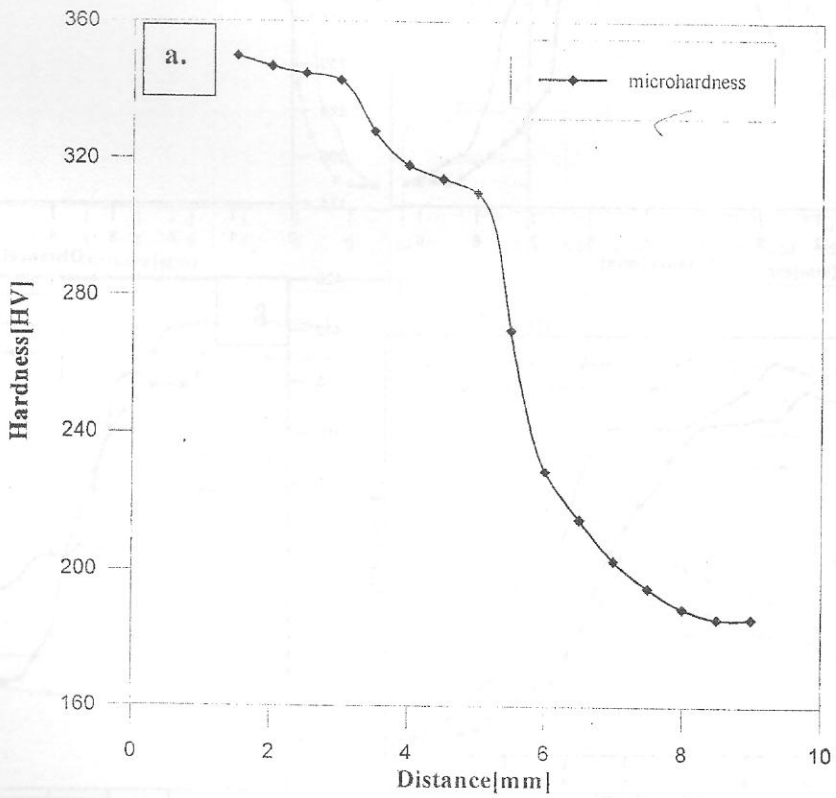


Fig. (5) Micro hardness distribution (from the surface) across root, contact and profile areas of the gear

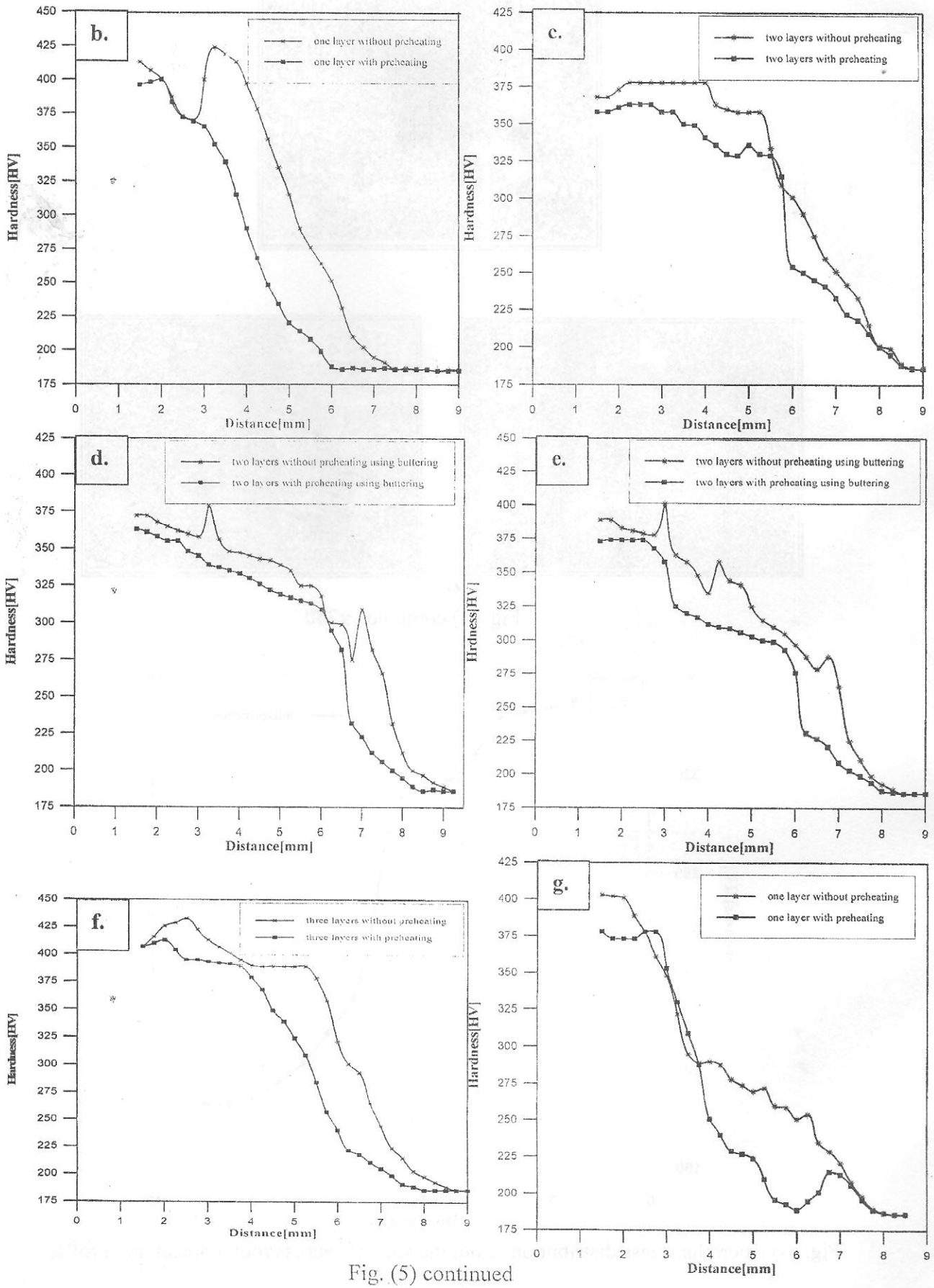


Fig. (5) continued

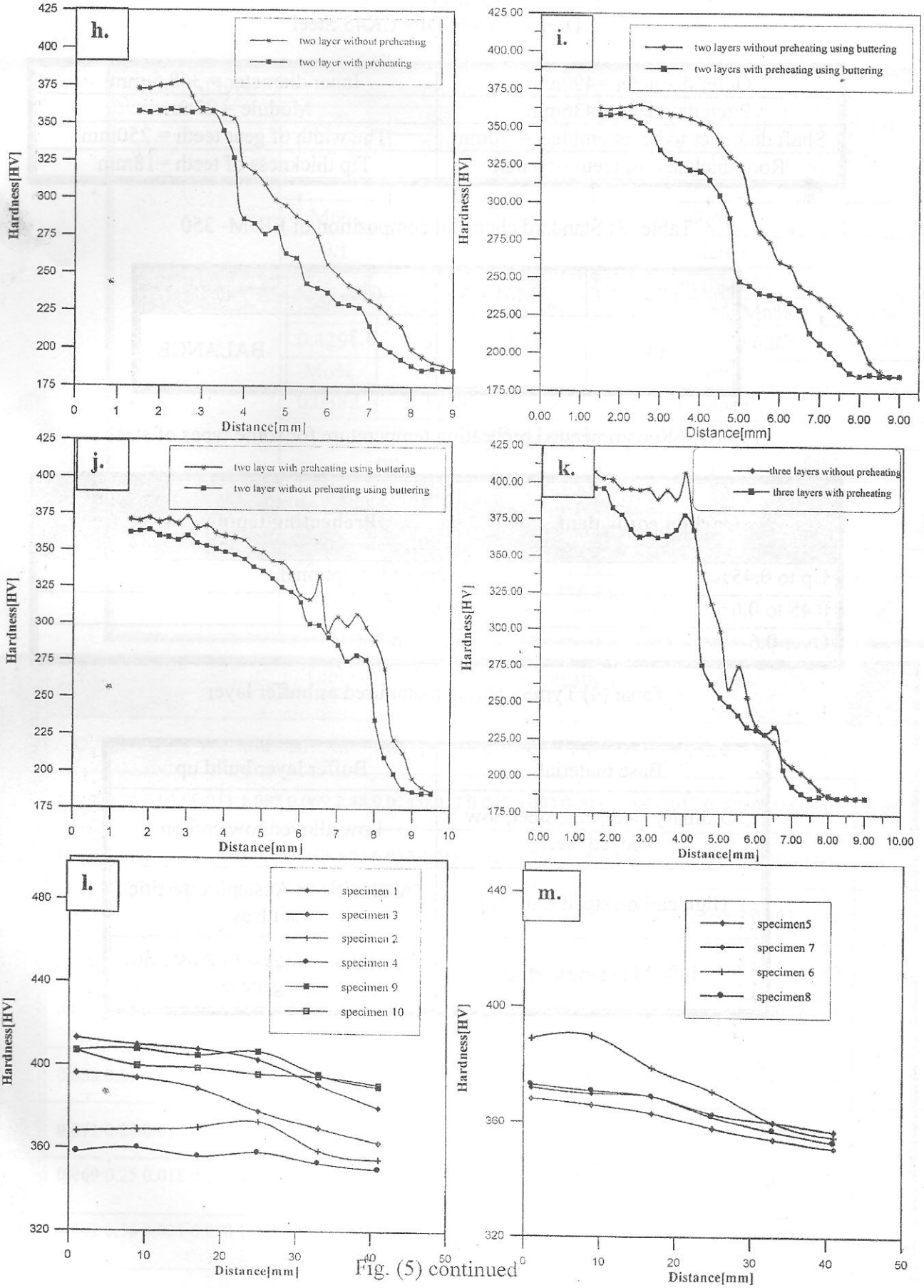


Fig. (5) continued

Table (1)
Dimensions of DIN CK45 Steel

Outer diameter =490mm	Inner diameter = 368.5 mm
Pitch diameter = 436mm	Module = 27mm
Shaft diameter to be assembled =170mm	The width of gear teeth = 250mm
Root thickness of teeth =50 mm	Tip thickness of teeth =18mm

Table (2) Standard chemical composition of EIUM- 350

C%	Mn%	Cr%	Fe%
0.08	1	3.3	BALANCE

Table (3) Recommended preheating temperature for some types of steel

Carbon equivalent	Preheating temperature C°
Up to 0.45%	Preheat is optional
0.45 to 0.6	90 to 200 C°
Over 0.6	200 to 350 C°

Table (4) Types of weld metal used as buffer layer

Base material	Buffer layer/build up
Ordinary steel; cast steel; low Alloyed steel	Low alloyed/low carbon
High carbon steel; tool steel	Austenitic or Austenitic/ferritic stainless
14% Manganese steel	Austenitic stainless or Austenitic manganese

Table (5) standard and experimental chemical composition and mechanical properties of DIN CK 45 Steel gear

Material type	Standard chemical composition analysis					
	C%	Si%	S%	P%	Mn%	Cr%
	0.42-0.5	0-0.4	0.035	0.035	0.5-0.8	0.4
	Mo%	Ni%	Fe%			
	0.1	0-0.4	Balance			
	Experimental chemical analysis					
	C%	Si%	S%	P%	Mn%	Cr%
	0.4291	0.3973	0.012	0.035	0.6265	0.178
	Mo%	Ni%	Fe%			
	0.0382	0.1779	Balance			
	Standard mechanical properties					
DIN CK 45	σu		σy		El%	
	590-710 MPa		>=355 MPa		18%	
	Experimental mechanical properties					
	σu		σy		El%	
	638 MPa		386 MPa		18.5%	

Table (6) Weld metal composition
Chemical composition of weld metals in wgt.%

Specimen no.	C	Si	S	P	Mn	Ni	Cr	Mo	V	Cu	W	Ti	Sn	Co	Nb	Zr	Zn	Fe
1	**0.152**	0.25	0.018	0.011	**1.083**	0.069	**2.48**	0.024	0.017	0.045	0.003	0.008	0.009	0.012	0.006	0.003	0.003	Rem.
2	**0.126**	0.29	0.020	0.014	**1.151**	0.059	**3.54**	0.025	0.018	0.041	0.005	0.006	0.014	0.011	0.006	0.004	0.003	=
3	**0.167**	0.27	0.017	0.019	**1.051**	0.036	**2.21**	0.022	0.026	0.021	0.004	0.008	0.011	0.013	0.009	0.003	0.006	=
4	**0.131**	0.29	0.018	0.022	**1.110**	0.060	**3.29**	0.022	0.026	0.046	0.007	0.010	0.010	0.013	0.009	0.001	0.007	=
5	**0.057**	0.21	0.018	0.012	**1.009**	0.032	**3.58**	0.053	0.020	0.028	0.005	0.007	0.008	0.009	0.006	0.003	0.006	=
6	**0.058**	0.21	0.015	0.018	**1.201**	0.048	**3.24**	0.024	0.027	0.029	0.006	0.014	0.015	0.014	0.009	0.003	0.006	=
7	**0.071**	0.24	0.017	0.020	**1.001**	0.048	**3.51**	0.075	0.027	0.021	0.006	0.015	0.011	0.012	0.008	0.003	0.005	=
8	**0.069**	0.25	0.018	0.021	**1.157**	0.035	**3.16**	0.069	0.026	0.022	0.005	0.011	0.007	0.013	0.009	0.003	0.004	=
9	**0.042**	0.38	0.021	0.028	**1.407**	0.025	**4.07**	0.033	0.031	0.018	0.007	0.012	0.009	0.012	0.012	0.002	0.005	=
10	**0.077**	0.30	0.017	0.023	**1.166**	0.042	**3.69**	0.022	0.028	0.026	0.007	0.009	0.013	0.012	0.010	0.002	0.005	=

Table (7) Standard and experimental chemical composition and mechanical properties of rebuilding and buttering electrodes (E8018-B_2 and E9018-D_1)

Electrode type							
E 8018-B_2	Standard chemical composition analysis						
	C%	Si%	S%	P%	Mn%	Cr%	
	0.12	0.8	0.04	0.03	0.9	1-1.5	
	Mo%	Ni%	V%	Fe%			
	0.4-0.65	-	-	Balance			
	Experimental chemical analysis						
	C%	Si%	Mn%	Cr%	Ni%	Mo%	Cu%
	0.095	0.66	0.68	1.35	0.06	0.58	0.021
	Co%	Al%	Nb%	Ti%	V%	W%	Fe%
	0.0001	0.001	0.013	0.01	0.011	0.012	Balance
	Standard mechanical properties (min. values)						
	σu		σy		El%		
	550 Mpa		460 MPa		19		
	Experimental mechanical properties						
	σu		σy		El%		
	623 MPa		474		20		
E 9018-D_1	Standard chemical composition						
	C%	Si%	S%	P%	Mn%	Cr%	
	0.12	0.8	0.03	0.03	1.25-1.75	-	
	Ni%	Mo%	V%	Fe%			
	-	0.25-0.45	-	Balance			
	Experimental chemical composition						
	C%	Si%	Mn%	Cr%	Ni%	Mo%	Cu%
	0.089	0.72	1.56	0.02	0.04	0.39	0.032
	Co %	Al%	Nb%	Ti%	V%	W%	Fe%
	0.0002	0.003	0.009	0.03	0.021	0.009	Balance
	Standard Mechanical properties (min. values)						
	σu		σy		%El		
	620 MPa		530 MPa		17		
	Experimental Mechanical properties						
	σu		σy		%El		
	651 MPa		537 MPa		18		

Table (8) Dimensions of surfacing layers

Specimen number	Thickness of hardfacing layers (mm)	Thickness of buttering layers (mm)	Length of deposit metal (mm)	Preheating temperature C°
1	3	-	250	-
2	5	-	250	-
3	2	-	250	200
4	3	-	250	200
5	4	3	250	-
6	4	2.5	250	-
7	4	3.5	250	200
8	3.5	3.5	250	200
9	7	-	250	-
10	6	-	250	200

Table (9) Impact values o f weld deposit

Specimen number	Impact value (J)
1	36
2	43
3	38
4	47
5	49
6	51
7	56
8	58
9	42
10	46

Table (10) Wear resistance of weld deposit

Specimen number	Volume loss(mm^3)
1	0.451
2	0.631
3	0.517
4	0.691
5	0.612
6	0.523
7	0.652
8	0.582
9	0.473
10	0.494

CONCLUSIONS

In the process and power generation industries, down time of mechanical equipment means increase costs and lost revenue, thus the minimization of down time is a major priority. In addition, the increased costs of the replacement have become a major part of plant maintenance budgets, which are under very close scrutiny. This research shows the technical feasibility of DIN CK 45 spur gear repair using shielded metal arc welding (SMAW).

The results, based on the investigations, confirm the effect of surfacing parameters on the metallurgical and mechanical properties of E1UM-350, E 8018-B_2, and E 9018-D_1 deposit metals used for surfacing DIN CK 45 steel gear, validates the following conclusions:

1- DIN CK 45 spur gear can be hardfaced with DIN E1-UM350 electrodes.
2- It is essentially to preheat the gear surface to 200 C° for this type of steel.
3- Wear resistance of all specimens is greater than the base metal.
4- Impact resistance of all specimens is greater than the base metal.
5- The considerable increase in the micro hardness at the interface region, especially specimen1, is a result of austenite to martensite transformation.
6- Surfacing with two-layer gives self-tempering in the HAZ area especially with preheating.
7- The cracks have been shown in the weld metal when surfacing with three layers and the reason may be accumulate of hydrogen gas in the weld metal and give HICC when the weld metal has been solidified.
8- It possible to butter and rebuild this type of steel gear by E 8018-B_2 and E 9018-D_1 electrodes, followed by two layers of E1-UM350.
9- 9. Using of low hydrogen electrodes such as E8018-B2 and E9018-D1, as rebuilding and buttering layers, treat the problem of cracking of weld metal that has been mentioned above.

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