UNIVERSITI PUTRA MALAYSIA

WEAR PERFORMANCE OF CONCRETE MIXTURE PADDLES WITH HARDENED SURFACES.

CHIONG KUNG KWONG

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Chairman : Associate Professor Yousif A. Khalid, PhD.

Faculty : Engineering.

Throughout this investigation, paddles from the SIMEM concrete mixer plant were selected as the subject for this wear analysis. The numbers of paddles studied are twenty. The performance and wear progress of the paddles were monitored periodically. In this project, six types of hard facing alloy were welded onto the same base metal, cast manganese materials. Hard surfacing is an effective method of modifying the surface properties without changing the whole materials of the paddle. These hard-facing alloys (severe wear resistant and moderate impact resistance characteristics) were welded onto the surfaces and edges of each paddle respectively (each hard facing alloys on three paddles). These welds were as cross lines of 20 mm apart all over the top surface of each paddle and full weld on the front side edges for maximum wear protection. Each weld bead deposited is 3 to 4mm thick and 5 to 6mm wide.

Two paddles were selected without any hard facing protective layers in this analysis as a reference purpose. Hard facing alloys used in this research are high Chromium high Carbon alloys (Paddles A1, A2, A3, A4, A5, A6, A7, A9, A11), Complex Chromium Carbide alloys with Boron (Paddles B1, B2, B3, B4, B5 and B6) and Tungsten Carbide material on paddle B7, B9 and B11. The main parameters measured were the side dimensions loss, thickness loss, volume loss and mass loss. Data collection was collected on a monthly basis in order to obtained higher accuracy. Two sets of paddles were used for each type of hard facing. As one set is in the measuring stage, the next set is fitted in the concrete mixer.

The results of the project show that cast manganese materials can be surfaced with various hard facing alloys to modify the surface layers characteristics. The results show that the front dimension loss is the determining factors which decide on the usability of the paddle. Other parameters such as mass loss, volume loss and thickness loss did not have any direct influence on the usability of the paddles. The results obtained from side dimension loss show that there is an increase in the service life of the mixer paddle by 1.45 times of paddle A3, 1.40 times of paddle A4 and 1.43 times of paddle A9 as compare to the reference paddle A10. On the other hand, the increase of service life of the mixer paddle B3 was 2.00 times, paddle B4 was 1.46 times and paddle B9 was 1.01 times when compare with reference paddle B10.

The finding on the front edge materials loss show that tungsten carbide hard facing alloys have lowest performance compared to other hard facing alloy. The main reason is that tungsten carbide is too brittle to be applied on the side edges of the mixer paddle. On the other hand, complex chromium carbide alloys with boron have double service life of the paddle as compared to the reference paddle. Chromium carbides hard facing alloy have 40 to 45% of service life improvement.

The overall result shows that hardest hard facing alloy is not the most suitable protective layer for the front edge but it has good abrasion resistance property when applied on the paddle surface. The chromium carbide hard facing alloys show better wear resistance property for front edge protection compared to tungsten carbide alloys but not on paddle surface. Complex chromium carbide alloys gave the best desirable performance in this analysis.

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TINGKAH LAKU PENDAYUNG KONKRIT DENGAN PENGERASAN PERMUKAAN

Oleh

Chiong Kung Kwong

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Pengerusi : Profesor Madya Yousif A. Khalid, PhD

Fakulti : Kejuruteraan

Dalam siasatan ini, pendayung konkrit dari kilang pembancuh SIMEM telah dipilih sebagai subjek dalam analisis kehausan. Jumlah pendayung yang dikaji adalah dua puluh keping. Tingkah laku dan perkembangan kehausan pendayung telah diikuti dari semasa ke semasa. Dalam projek ini, enam jenis keluli keras muka telah dikimpal keatas asas logam yang sama iaitu mangan acuan. Kimpalan keluli keras muka adalah cara berkesan untuk mengubah ciri-ciri sesuatu permukaan tanpa menukar keseluruhan bahan pendayung tersebut. Keluli keras muka ini (dengan sifat-sifat tahan kehausan yang tinggi dan tahan hentaman yang sederhana) telah dikimpal keatas permukaan and tepi setiap pendayung masing-masing (setiap jenis keluli keras muka dikimpal keatas tiga pendayung. Kimpalan ini adalah berbentuk petak dengan jarak di antara setiap baris kimpalan sebanyak 20mm dan kimpalan penuh pada tepi pendayung untuk perlindungan maksimum. Setiap garis kimpalan yang dikimpal adalah berbentuk 3 ke 4 mm tinggi dan 5 ke 6 mm lebar.

Dua pendayung tanpa sebarang perlindungan keluli keras muka telah dipilih sebagai pendayung rujukan untuk tujuan perbandingan. Jenis keluli keras muka yang digunakan dalam penyelidikan ini adalah dari jenis kromium tinggi karbon tinggi (pendayung A1, A2, A3, A4, A5, A6, A7, A9 dan A10), kromium kompleks dengan tambahan boron pada pendayung B1, B2, B3, B4, B5 dan B6 dan jenis tungsten karbid pada pendayung B7, B9 dan B11. Parameter-parameter utama yang diukur adalah kecutan dimensi sisi, kekurangan ketebalan, kehilangan isipadu dan kehilangan jisim. Untuk memperolehi kejituan data, data-data dikumpul pada selang masa setiap bulan. Dua set pendayung telah dipilih untuk keluli muka keras supaya semasa satu set dalam process pengukuran, satu set yang lain dipasang dalam pencampur konkrit.

Projek ini menunjukkan bahawa mangan acuan boleh dikimpal dengan pelbagai keluli keras muka untuk mengubah cirri-ciri permukaannya. Data yang dikumpul dianalisis dan keputusan menunjukkan kehausan dimensi sisi depan adalah factor utama yang menentukan kebolehan-gunaan pendayung. Parameter lain seperti kehilangan jisim, kehilangan isipadu dan kehilangan ketebalan tidak memberi kesan secara langsung keatas keboleh-gunaan pendayung. Keputusan yang diperolehi dari kehilangan dimensi sisi menunjukkan penokokan kitar servis sebanyak 1.45 kali untuk pendayung A3, 1.40 kali untuk pendayung A4 dan sebanyak 1.43 kali untuk pendayung A9. Sementara kitar servis menambah sehingga 2.00 kali untuk pendayung B3, 1.46 kali untuk pendayung B4 dan 1.01 untuk pendayung B9.

Keputusan dari kehilangan sisi hadapan menunjukkan bahawa keluli muka keras jenis tungsten karbid mempunyai tingkah laku paling lemah berbanding dengan keluli keras muka yang lain. Sebab utama adalah tungsten karbid terlalu rapuh untuk digunakan pada sisi depan pendayung. Sementara itu, kromium kompleks dengan boron menunjukkan penambahan sebanyak 2 kali ganda berbanding dengan pendayung rujukan. Dan pendayung yang dikimpal dengan keluli keras muka kromium karbid menunjukkan penambahan kitar servis antara 40% hingga 45%.

Keputusan keseluruhan menunjukkan bahawa keluli keras muka yang terkeras adalah tidak sesuai untuk digunakan sebagai perlindungan sisi depan tetapi menunjukkan kebolehan menegurangkan kehausan yang baik pada permukaan pendayung. Sementara itu, keluli keras muka jenis kromium karbid menunjukkan kebolehan menghalang kehausan dimensi sisi depan yang baik berbanding dengan keluli tungsten karbid. Keseluruhannya, kromium karbid Kompleks menyembahkan tingkah laku yang paling memuaskan dalam analisis ini.

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CHAPTER 1

INTRODUCTION

1.1 General.

Wear occur whenever there is undesirable materials loss on any surfaces. Results from the undesirable materials loss may be due to different types of wear mechanisms. These wears are preventable if the cause of the wear is studied and analysed carefully. Each year a huge amount of resources are wasted due to improper wear prevention measurement and seriousness in reducing possible wear mechanisms. The selection of suitable hard facing materials is very important in order to achieve the desire service life cycle of a wear components.

Wear exist in various industries and the concentration in this investigation is on a SIMEM concrete batching plant. Common wears presence in the batching plant are erosion and abrasion type of wear. Components that are facing the wear problems for example are the shovel bucket, conveying belt and roller, measuring bin, inlet chute, center mixer paddle, end scrapping paddle, mixer wall liner, discharge chute etc. This research concentrated on evaluating the wear of the center mixer paddles. The wear rate of these mixer paddles was observed and the paddles were found to be replaced every 25,000m^3 to 30,000m^3 of the production output. This practice leads to frequent replacement of mixer paddles every 2 to 3 months.

1.2 Existing Wear Problems.

The thought is prevalent that it is easier to replace the part when it wears rather than to provide adequate solution to prolonging the service life of these wear components. The paddles at the center of the mixer have been selected for investigation due to the wear rate on these mixer paddles are the highest among the others. The proposed investigation is to conduct a scientific analysis to determine the wear performance of mixer paddles cladded with various hard facing alloys. In this investigation, various parameters are determined to enable the adequate wear data can be collected from time to time. Six hard facing alloys are selected for analysis in the investigation.

1.3 Objectives.

The main objectives of this investigation are outline as follows;-

1. To investigate the effective service life of each paddles cladded with various hard facing alloys.
2. To determine the most suitable type of hard facing alloys which provide the optimum protecting layers for the mixer paddles.
3. To compare the results obtain for each individual mixer paddles with hard facing cladding with the reference paddle without hard facing cladding.

1.4 Thesis Layout.

The thesis is divided into six chapters. In this thesis, a review of literatures is presented in chapter 2 which discussed about the previous research work and theories development on wear resistance alloys. In chapter 3, methodology used for this experimental (i.e. measuring rigs, selection of parameters for analysis and table for recording data) are discussed. Chapter 4 is about the experimental work (i.e. rigs design and welding procedures for hard facing alloys are outlined in this chapter). While chapter 5 discussed about the results obtained from this experimental work and are interpreted into useful graphs and statements. Finally, chapter 6 is about the conclusion of this research and recommendation for future study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction.

In this chapter, literature related to type of wears, wear mechanisms, wear variables, effect of wear rate by wear variables, wear particles, methods to resist wear and hard facing methodology will be discussed. In the first section, types of wear and their mechanisms is explored. Then, the wear variables and their effect on wear rate and the properties of wear particles is discussed. It will then be followed by the discussion on methodology to resist wear. The final discussion is concentrated on the hard facing materials and their application to resist wear.

2.2 Wear Definition and Wear Processes Classification.

Several research has been carried out to define wear and its processes. Wear is generally defined as "unwanted removal of material by chemical or mechanical action"[1]. Another factor that affecting the wear is the temperature of the wear component. Such definition is not precise since plastic flow may occur, clearances become larger, and, for all practical purposes, wear has occurred even though no material has been removed. However, the point of view that all definitions are approximations could be adopted, and some inaccuracies will occur. With this point of view in mind, the latter definition appears to be adequate. [1]

There have been many attempts to classify wear processes. The conventional method is called as the "process" descriptions where the classification is based upon a physical description of the process: abrasion, adhesion, deformation, fretting, thermal, etc. On the other hand, wear can also be classified by the type of materials, that is, metal versus nonmetal or abrasive, metal versus metal, or metal versus liquid or vapor. In addition, the distinction is made between lubricated or non-lubricated wear [1].

The advantage of this classification is that it confirms to the definition of wear as a removal process. Even more important, it allows the establishment of the fundamental quantities to each wear process. The difficulty with this classification is that it is cumbersome from a practical point of view.

2.3 Types of Wear.

Different types of wear has been described and categorized by various investigators throughout the years [1,2,3,4,5,10,14]. It is generally held that the most common types of wear are (1) adhesive, (2) abrasive, (3) corrosive, (4) erosive, (5) cavitation, (6) fatigue (7) fretting and (8) impact [2]. It is important, however, to recognize that, in wear, material is removed from surfaces permanently. The form of that removal can take place in different manners according to the mechanisms operating in the system. Of the aforementioned wear mechanisms, one or more wear factors may be operating in one particulars mechanical system [3].