

# A Review Paper On Hardfacing Processes, Materials, Objectives and Applications

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**Abstract:** *Wear is the predominant factor that controls the life of any component. Metal parts often fail their intended use not because they fracture, but because they wear, which causes them to lose dimension and functionality. Different types of wears exist, but the most typical modes are abrasion, impact, metallic (metal to metal) heat, corrosion etc. Most worn parts don't fail from a single mode of wear, such as abrasion and impact etc. Research is going on over years to reduce the wear either in the form of using a new wear resistant material or by improving the wear resistance of the existing material by addition of any wear resistant alloying elements etc. Many methods are in practice in the last years hardfacing became an issue of intense development related to wear resistant applications. In this paper an attempt has been made to review few hardfacing processes and materials used for the same and the objectives and applications and the current research being done.*

**Keywords:** Hardfacing, Welding, weld consumables, wear resistance, objectives and applications

## 1. Introduction

Hardfacing also known as hard surfacing is the application of built up of deposits of specialized alloys by means of welding processes to resist abrasion, corrosion, high temperature or impact, such an alloy may be deposited on the surface, an edge or merely the point of a part subject to wear. Welding deposits can functionalize surfaces and reclaim components extending their service life. Welding is a key technology to fulfill these requirements and to apply hardfacing alloys.

A hardfaced part should be thought of as a composite with the base material selected for strength and economy and the hardfacing material (which might be unsuitable as well as too costly for use in fabricating the complete part) selected for the specific wearing conditions to which the critical sections of the part will be subjected in service.

Hardfacing may be applied to a new part during its production, or it may be used to restore a worn-down surface. Hardfacing increases the service life of a part and there by extend the lifetime of machinery equipment efficiently, core components such as crushers are exposed to heavy wear and require efficient surface protection measures to avoid costly down times and to reduce cost for expensive spare parts. This process has been adopted across many industries such as cement, mining, steel, petro-chemical, power, sugarcane and food.

## 2. Hardfacing Processes:

Hardfacing can be applied by a number of welding processes, selection of most suitable welding process for a given job will depend on a number of factors like nature of work to be hardfaced, of the component, accessibility of weld equipment, state of repair of worn components, number of same or similar items to be hardfaced etc. There are various processes for hardfacing. They can be grouped in the following ways:

- Hardfacing by Arc Welding – Shielded metal arc welding, Flux cored arc welding, submerged arc welding.
- Hardfacing by Gas welding - Deposition by Oxy-Acetylene gas welding.
- Hardfacing by combination of Arc and Gas – Tungsten inert gas welding (TIG), Gas metal arc welding (MIG)
- Powder spraying – Flame spraying, high velocity Oxy-Fuel process, Electric arc spraying, and Plasma transferred arc welding.
- Laser hardfacing ( laser cladding)

## 3. Deposites And Base Metals In Hardfacing:

### 3.1 Hardfacing Alloys

Many different hardfacing alloys are available; they fall in to four categories

- Low alloy iron - base alloys: Materials containing up to 12% alloy components usually chromium, molybdenum and manganese.
- High alloy iron – base alloys: Materials with 12-50% alloy content in addition to the chromium found in all iron – base hardfacing alloys some of these alloys might also contain Nickel or Cobalt.
- The Cobalt – base and Nickel – base alloys: Alloys, which contain relatively small amount of iron (1.3 to 12.5%) of these the most costly, but also the most versatile are the Cobalt – Chromium tungsten alloys. All the Cobalt – base and Nickel – base alloys have high resistance to corrosion and oxidation; they processes low coefficient of friction making them especially suitable for applications involving metal to metal wear; and they are almost always selected for applications involving temperatures of 550 degrees or higher. The Cobalt – base alloys retain much of their original hardness at red-hot (800degrees).
- Tungsten carbide materials: Tungsten carbide is one of the hardest materials available for industrial use. It cannot be melted by any flame, it is also rather brittle. For hardfacing purposes, it is crushed and applied in conjunction with a binding metal. The Tungsten carbide

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particles are usually enclosed in a steel tube rod. Recently a tube rod enclosing Tungsten and Vanadium carbides has been introduced. It is said to give more uniform surface coverage than the straight tungsten carbide rod.

### 3.2 Base Metals

Almost 85% of the metal produced and used is steel, the term steel encompasses many types of metals made principally of iron. The various types of steels used in the industry for making different components for different applications are grouped in to the following types.

- Low – carbon steels and low – alloy steels: These steels include those in the AISI series C - 1008 to C – 1020, carbon ranges from 0.10 to 0.25% manganese ranges from 0.25 to 1.5%, phosphorous is 0.4% maximum, and sulfur is 0.5% maximum. Steels in this range are most widely used for industrial fabrication and construction. These steels can be easily welded with any of the arc, gas and resistance welding processes. The low – alloy high – strength steels represent the bulk of the remaining steels in the AISI designation system. These steels include the low manganese steels, low-to-medium nickel steels, the low nickel-chromium steels, the molybdenum steels, the chromium – molybdenum steels, and the nickel-chromium-molybdenum steels. In these alloys, carbon ranges from 0.12 to 0.30%, manganese from 0.40 to 0.60%, silicon from 0.20% to 0.45% and nickel from 3.25 to 5.25%.
- Medium – carbon steels: These steels include those in the AISI series C-1025 to C-1050 the composition is similar to low-carbon steels, except that the carbon ranges from 0.25 to 0.50% and manganese from 0.60 to 1.65% medium-carbon steels are readily weld able provided some precautions are observed. These steels can be welded with all of the processes mentioned above.
- High – carbon steels: These steels include those in the AISI series from C-1050 to C-1095. The composition is similar to medium-carbon steels, except that carbon ranges from 0.30 to 1.00%. Special precautions must be taken when welding steels in these classes. High – carbon steels can be welded with the same processes mentioned previously.
- Other steels are low-nickel chrome steels, low-manganese steels, low – alloy chromium steels and the electric furnace steels, which can be welded without special precautions when carbon is at low end of the range.

### 4. Objectives Of The Hardfacing Process:

- To extend the service life of critical (new) parts and assemblies in machines and mechanisms by depositing on them such metals/ alloys that will impart to them resistance to corrosion, abrasion, wear, impact, heat, galling, erosion, cavitations, hammering, scratching and indentations.
- To rebuilt worn-out or incorrectly cast or forged parts.
- To repair a component.

### 5. Application

- Hardfacing is used in the automobile industries for surfacing the IC Engine components like cylinder, cylinder head and piston etc.
- Hardfacing is used in the surfacing of the earth moving equipments like cranes crushers etc.
- Hardfacing is used in the surfacing of various machine components, which are subjected to wear and abrasion etc.

### 6. Results And Discussions From Current Research

Research is going on in the area of hardfacing using various processes and different consumables and different base metals mentioned above. Most of the research is carried out studying the wear characterization, as the basic aim of hardfacing is to improve or extend the life of various components used across the industry owing to high cost of replacement of original part. The different hardfacing layers produced by shielded metal arc welding (SMAW) process with a bare electrode coated with fluxes and to which different measures of ferrotitanium (Fe-Ti), ferrovanadium (Fe-Va), ferromolybdenum (Fe-Mo) and graphite had been added showed good resistance to cracking and wear when the amount of above elements are controlled within the range of 8-10%, 12-15%, 10-12% and 2-4% respectively [Xinhong et al...(2008)]

### 7. Conclusions

- Hardfacing is the most versatile process to improve the life of the worn-out component
- Hardfacing is the best-chosen process these days for reducing the cost of replacements.
- Hardfacing reduces down time because parts last longer and fewer shutdowns are required to replace them.
- Hardfacing can be done on any steel material using wide variety of welding processes.
- Different alloying elements can be introduced in to the base metal in the form of weld consumables to achieve any desired property like hardness, wear resistance, abrasive resistance, crack resistance etc.

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