

Indian Galvanised & Colour Coated Steel Industry

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Introduction

The global stock markets faced a severe downturn during April-September, 2008 and the deterioration is continuing. According to World Steel Dynamics (WSD), the precipitous decline in the global stock markets has adversely affected confidence in many countries. Between April and September, 2008, the stock markets all over the world have collapsed. The drops were : Russia - 42 percent , Brazil-39 percent, Egypt -37 percent, China-36 percent, Malaysia - 29 percent, Thailand - 28 percent, Argentina - 25 percent, Indonesia - 25 percent, Mexico - 22 percent, Hong Kong-22 percent, Milan - 22 percent, London FTSE - 15 percent, Germany - 14 percent, Canada- 13 percent, South Africa - 14 percent, Dow Jones (USA) - 14 percent, Japan - 10 percent and India by 34 percent between March, 17 and October 31,2008.

The global steel demand outlook has deteriorated due to the collapse of stock markets as well as due to the following reasons :

- The sub-prime and related loan crisis is causing lightening of credit conditions globally. This development threatens consumer durables and fixed assets investment spending in many countries.
- Reduced automotive sales in many countries. Auto buyers are facing quadruple whammy: high cost to drive a car, a lower value for their existing vehicle, reduced disposable income to purchase the car because more income is spent on buying energy in various forms and food and toughened credit terms when buying the car.
- A slowdown in the growth rate of the Chinese economy including the real estate construction, automotive and appliance sectors. Apparent steel demand in China in August, 2008 fell 6.5 percent on a crude steel basis year to year, with largest setbacks in construction related steel products.
- Lower activity in steel-consuming industries in the United States-WSD's weighted activity index for 15 steel consuming industries in August, 2008 was down 10.7 percent year-to-year. Durable goods orders in August fell 4.5 percent from the prior month. Non-residential construction activity in the U.S.-an important prop to steel demand since 2003 has turned down.



The Impact of the Global Financial Crisis on World Steel Production

Since July, 2008, global steel output has seen an accelerating decline dropping by 25 percent by November, 2008. Between January to November, the global crude steel production in 2008, declined by 19 percent over the same period of 2007.

According to global steel experts, the key to the future will be whether China will avoid a steep recession and will not flood the global market with exported steel - an unlikely scenario as domestic prices in that country are higher than export prices - and whether mills will maintain their cuts to prevent over supply.

Indian steel industry has also been affected adversely by the global downturn. Companies like JSWL, Ispat Industries and Essar Steel have reduced their production by 20 percent. Ispat Industries may achieve a production 2.5 mt in 2008-09 compared to 2.7 mt in the previous year. Ispat's production target in 2008-09 was 3.1 million tons. SAIL may also go for a cut back in production. SAIL's October, 2008 sales have come down to about 90,000 tons which is about 37 percent less than the target for the month. Tata Steel has set an internal target of "postponing expenditure" worth Rs. 500 crore by six months.

Galvanised Steel

Galvanised plain and corrugated steel sheets (GP/GC) are



value-added products that are sturdy, light weight, bright in appearance, corrosion resistant and environment friendly.

Galvanised steel is basically zinc coated products and includes a range of hot-dipped and electro-galvanised steel. The function of the zinc layer is mainly three-fold. These are :

- To retain the steel intact with its full initial strength
- To provide the surface a more pleasing appearance
- To increase the life of any suitable finishing system applied over it

Advantages of Zinc Coating

The zinc coating on steel offers a two-fold advantage:

A) It protects steel from corrosive attack in most atmospheres, acting as a continuous and lasting shield between the steel and atmosphere, as long as the zinc sheath remains unbroken.

B) It acts as a galvanic protector, sacrificing slowly in presence of corrosive elements, by continuing to protect the steel even when moderate-sized areas of the bare metal have been exposed. This ability of zinc results from the fact that zinc is more electro-chemically active than steel. Of all the industrial coating materials, zinc alone possesses this dual property.

Due to the above qualities of zinc coating, the manufacturers and consumers all over the world are now demanding a higher content of zinc coated steel in construction, automotive and white good sectors. There are about 750 continuous galvanizing lines in operation throughout the world at present.

Recyclability

All types of galvanised steel products are recyclable. The Electric Arc Furnace (EAF) is the principal recycling route for zinc coated steel. Presently, about 80 percent of zinc available in India is being recycled. It may be mentioned here that once steel is galvanised, zinc becomes a part of steel recycling unit.

Galvanising Processes

There are two main processes used in the production of galvanised products.

- a) Hot-Dipped Galvanising
- b) Electrolytic Galvanising

a) Hot-Dipped Galvanising

It is one of the basic and efficient corrosion resistant techniques for producing galvanised steel. During the galvanizing process, steel coils are previously cleaned and pickled and then dipped into a bath of molten zinc to form a series of zinc / iron alloys integrated with the steel surface. As steel is removed from the bath, a layer of relatively pure zinc is deposited on the top of alloy layers. On solidification, the zinc assumes a crystalline metal structure, often called 'Spangling'. The spangles can be enhanced or reduced depending on the end-use.

The life of galvanising coating in steel structures permanently immersed in liquids depends on the corrosion properties of the liquid and the thickness of the galvanised coating in the structure.

Earlier, hot-dipped steel products effectively met the corrosion requirements but had limited formability and also lacked in surface quality. Hence, they were not used in the construction sector and were totally unacceptable in the automotive industry. However, with the dramatic developments in several facets like radiant tube furnaces, coating control and especially with the introduction of galvanealing (GA), there has been a significant shift from the electro-galvanised (EG) to hot-dipped galvanised (HDG). The Japanese and US automaker, who were using up to 45 percent of total steel consumed in the form of electro-galvanised steel, have since switched over to HDG products in a significant manner.

b) Electro-galvanising Process

In the electrolytic galvanizing process, zinc ions from the electrolyte are deposited on the strip surface (cathode) under the influence of electric current using either soluble or insoluble anodes. The electrolyte is usually zinc sulphate or zinc chloride or mixed. The electro-galvanised strips are post-treated with passivation solutions such as phosphate or chromate. The plating process controls the coating thickness resulting in much thinner coatings as well as double-side coatings.

The sheets have excellent finish and press formability for protection from corrosion of autobody, fuel tanks, exhaust pipes etc.

The investment cost of an Electro Galvanising Line (EGL) is almost the same as that of Continuous Hot-Dip Galvanising Line (CGL) with GA facility. However, the EGL does not have annealing and temper rolling as an integral part of the line. Thus, to produce annealed electro-galvanised products, annealing and temper rolling have to be done prior to electrogalvanising, which requires additional capacity in the annealing unit and skin pass mill. This additional investment cost on an EGL makes the line more expensive.

As the operation cost of electricity in India is 2/3 times higher than that in the developed countries and even in some developing countries, CGL are more attractive economically in Indian conditions.

Spangled Products

Spangles are the flowery pattern observed on the surface

of galvanised sheets that are formed by the natural crystallisation of zinc. Spangles are produced by adding small quantities of lead, tin or antimony into the molten zinc bath. Spangles are desirable in applications like corrugated sheets used for roofing or in applications where parts are not exposed and do not require painting. For other applications, the strip has to undergo either skin passing after galvanizing to remove spangles or undergo a mini-spangle treatment, so that spangle formation can be minimised. Outer cover of computers, audio-equipments etc. require the latter type of galvanised products.

Leading Indian producers are manufacturing both mini-spangle and zero-spangle galvanised products.

Applications of GP / GC Sheets

Galvanised steel products are used in the construction sector in roofing, side claddings, agricultural silo, railway platforms, factory sheds and in various areas of housing etc.

These products have also major uses in the automotive and appliance sectors. In the production of colour coated sheets, special types of galvanised steel are used.

According to experts, in the construction sector, zinc coated products have a life of 40 to 50 years. The use of galvanised steel sheets for automotive body panels allows the present day automakers to guarantee of corrosion resistance up to 12 years.

The additional expenditure involved is negligible. In India, the demand of galvanised products by the automobile sector has gone up substantially in recent years. In the appliance manufacturing sector, galvanised steel sheets are used in white goods and other products, have a corrosion free life of over 15 years.

On a macro-scale, the excellent corrosion resistance provided by zinc-coated galvanised steel greatly improves the durability and life cycle of steel products, thus conserving valuable natural resources.

Common Uses of Various Types of Zinc-Coated Products

The common applications and key attributes of various types of zinc-coated products are shown in Table.

Table-1. Applications & key Attributes of Various Zinc-Coated Products

Coated Product	Applications	Key Attributes
Galvanised	Steel Framing, ventilation, air-conditioners roof and floor decking, corrugated culverts, pre-painted building panels agricultural storage, autobody inner panels.	Paintability, formability, and durability range of coating thickness. strength and speed of installation, easy to use and cost-effective
Electro-Galvanised	Autobody outer panels, computer cases.	Excellent surface finish, weldability, paintability and formability
Galvannealed	Autobody outer panels, pre-painted appliance wrappers	Weldability, paintability and formability
Galvalume	Bare and painted roofing, walling in construction, toasters, dryers, refrigerators, air-conditioners	Corrosion performance for bare coating, paintability and durability.
Galfan	Pre-painted architectural panels, automotive equipment	Corrosion performance, very good formability and paintability

Special Quality Galvanised Coated Sheets

(a) Galvanneated (GA) products

The galvanneated process was developed to satisfy the stringent quality requirements of the automobile industry for outer and inner panels at optimum cost. In this process, an inter metallic layer of iron and zinc is formed on the surface of the strip by diffusing iron (to the extent of 7 to 12 percent iron in the coating) from the substrate into the zinc coating. The substrate characteristics become more important in galvannealing than in galvanizing. Typical range of coating in GA product is 60-200 gm/m² (both sides). These steels are used in automotive industry because of its improved manufacturing performance in models which use lighter and stronger grades of steels.

b) Galvalume or Zinalume

Galvalume (also known as Zinalume) consist of 55 percent aluminium, 43.5 percent zinc and 1.5 percent silicon by weight. It provides a tough barrier between the atmospheric condition and inner core of steel. Protection is offered by the corrosion resistance of the coating itself. Galvalume also protects steel from corrosion at the cut edges and scratches which is achieved through the sacrificial protection provided by the zinc in the coating. Galvalume has a life three times more than that of ordinary galvanised steel.

Advantages of using Galvalume are:

- 1) Corrosion Resistance: Resistance to atmospheric corrosion, cut edge and crack protection.
- 2) Yield Advantage: Aluminium makes up 55 percent of Galvalume by weight but comprises 80 percent by volume, so the coating weight is less, giving the end-users more square feet per ton of the material than ordinary galvanised steel.
- 3) Good Formability: Galvalume is suitable for all but severe forming operations. It can be easily bent, rolled formed and drawn without sacrificing coating adhesion.
- 4) High temperature Resistant: Galvalume can easily withstand temperature up to 600° F without surface discoloration. Galvalume is, therefore, not only a superior

material for roofing but also ideal for other operations such as components in toasters, ovens and gas heaters.

- 5) Thermal Reflectivity: Due to its good thermal reflectivity, galvalume steel roofs with proper insulation, makes it cost effective roofing system.

Exceptions

Galvalume coated sheets can not be used for framework in contact with wet concrete, products embedded in concrete, animal shelters where



ammonia levels are constantly high, fertilizer storage sheds and containers, culverts where the material is buried in the ground, water tanks, high alkaline environments, coastal and marine structures.

c) Galfan

Galfan is 95 percent zinc and 5 percent aluminum. When used as substrate, longevity of products is much higher than that of ordinary galvanised steel. It finds applications in marine wire ropes, small springs, pre-painted building panels appliances and automotive parts. Galfan coated steel has outstanding coating adhesion. It is an ideal material for deep drawn and 'zero thickness' bend applications. It is three times more corrosion resistant than ordinary galvanised steel.

d) Galbo Sheets

These are special zinc coated products in which the base material is cold-rolled in Grade -D, skin passed and stretch leveled with normal spangles. It is corrosion resistant with good formability, durability and paintability Galbo sheets are used in white goods manufacturing and in colour coated sheets etc.

Special Applications of Galvanised steel :

(a) Automotive Industry

Galvanised steel sheets are being extensively used in bus and truck bodies. Galvannealed (GA) steel is used in autobody outer panels because of its improved performance in models which use lighter and stronger grades of steel. Electro-galvanised steel sheets have an ultra smooth surface coating thickness which is desirable for autobody exterior panels.

Galfan steel is also used for severally formed components like automotive parts that prone to corrosion.

According to experts, hot-dipped galvanised products are now reaching top quality level as required by the automotive and electronic industries (Hi-Fi and hardware) with production rates as high as 100 T/h per meter width of the coated products.

i) Corrosion Protection of Autobody Panels

In case of automobile body panels, corrosion is usually classified as either of cosmetic type or perforation type.

ii) Cosmetic Corrosion

This is the term used to describe the degradation of visible

external components of vehicles such as door panels, engine hood, boot hood etc. caused by corrosion. This type of corrosion occurs mainly due to gravel impact, small bumps, scratches, edges and other minor injury.

iii) Perforation Corrosion

This type of corrosion results from the local pitting initiated on the unprotected inside surface or corners of the body where moisture or corrosive slush can be trapped or in relatively inaccessible areas difficult to treat and paint, such as hollow sections.

iv) Painting Operation

Typical painting operations for the autobody protection consists of several steps such as pre-treatment (degreasing, washing, activation, phosphating, passivation etc.), cathodic electro-deposition followed by baking (typically at $165 \pm 5^\circ\text{C}$ for 20 minutes), hot air drying and top coat painting (typically at $130 \pm 5^\circ\text{C}$ for about 22 minutes), surface preparation, baking and quality checks. Surface inspection and quality checking after painting are extremely important for automobiles. Typically, it involves paint gloss determination by using a glossometer, distinctness of image check is done by using a DOI meter, checking of surface for blisters, pit holes etc. and a host of anti-corrosion tests.

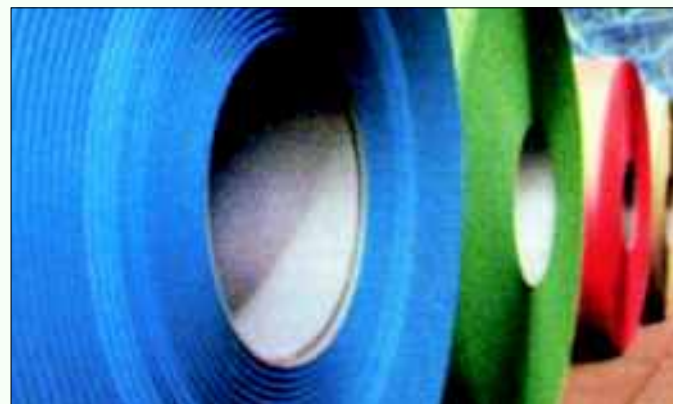
Galvanised Reinforcement Bars

Galvanised coatings provide important advantages for protection of reinforcement. The corrosion resistance of galvanised steel reinforcement has been found to be superior to uncoated steel, while the bond strengths of galvanised and black steel bars to concrete are not very different.

The corrosion protection of the galvanised coating ensures the designed strengths of the concrete are maintained and the possibility of surface rust staining and consequent corrosion of reinforcement and spitting of concrete is removed.

The benefits of galvanised reinforcement include :

- Protection to steel during storage and construction prior to placing the concrete.
- Diminished effect of variations in concrete quality.
- Safeguards against poor workmanship specially misplacement of reinforcement, poor compaction and in



adequate curing.

- Delayed corrosion initiation and the onset of cracking.
- Reduced surface staining.
- Increased structural life of concrete, particularly where chloride presence is high.

The Indian Scenario

The production of GP/GC sheets in India has increased significantly during the recent years. Major producers of galvanised steel in the country have installed state-of-the-art technologies and now capable of producing galvanised sheets for high end applications.

India's galvanised steel products have been well accepted in the global market. In 2007-2008, India exported 2.03 mt of these products which was over 46 percent of the country's domestic production.

Broad Sectorwise consumption of Galvanised Steel in India

The broad sectorwise consumption of GP / GC sheets in India is presented in Table - 2.

Sector	Share In Consumption (%)
Construction	45
Consumer Durables	10
Drums / Barrels / Container	9
Railways / Power / Irrigation	8
CPWD, PWD, Other Govt Depts	7
Tube Makers	4
Furniture Makers	5
Engineering Units	6
Automobiles	4
Others	2
	Total - 100

Production of GP/GC sheets in India

Production figures showing the performance of GP/GC sector in India between 1992-93 and 2007-08 are shown in Table -3.

Year	Production			Y-O-Y Growth (%)
	ISPs	Sec prod	Total	
1992-93	296	270	566	-
1993-94	290	315	605	6.89
1994-95	300	456	756	24.96
1995-96	311	547	858	13.49
1996-97	301	686	987	15.03
1997-98	345	777	1122	13.68
1998-99	301	911	1212	8.02
1999-2000	286	1144	1430	17.99
2000-01	423	1497	1920	34.27
2001-02	521	1835	2356	22.71
2002-03	666	2124	2790	18.42
2003-04	774	2356	3130	12.19
2004-05	804	2868	3672	17.32
2005-06	807	2975	3782	3.00
2006-07	813	3578	4321	16.10
2007-08	729	3630	4359	(-) 0.73

Data Source : JPC. ISPs = Integrated Steel Plants Viz SAIL and Tata Steel

Production of the ISPs started increasing from 2000-01 due to the commissioning of Tata Steel's world class CR Mill complex. The secondary producers contributed substantially to the growth of production of galvanised steel products in India. In 2006-07 and 2007-08 their share in total production was 81.48 percent and 83.27 percent respectively.

Imports

Due to an increased demand of high quality galvanised products in India, the volumes of imports of GP/GC sheets have been increasing in the recent years.

The imports figures of galvanised steel products by India between 1999-2000 and 2007-08 as well as its share in the apparent consumption in the country of GP/GC sheets are furnished in Table-4.

Year	Imports ('000 tons)	% share of Import in Apparent Consumption
1999-2000	75	6.23
2000-01	73	5.24
2001-02	97	5.24
2002-03	92	7.27
2003-04	102	6.03
2004-05	106	5.50
2005-06	134	6.53
2006-07	195	8.13
2007-08	268	10.22

Data Source - JPC

Exports

India has been exporting substantial quantities of galvanised steel products since 2002-03. The country's exports of GP/GC sheets along with its share in domestic production is presented in Table 5

Year	Exports ('000 tons)	% share of Export in Apparent Consumption
1999-2000	320	22.38
2000-01	589	30.68
2001-02	695	24.50
2002-03	1610	57.71
2003-04	1486	47.48
2004-05	1843	50.19
2005-06	1244	32.89
2006-07	2173	49.49
2007-08	2026	46.48

Data Source - JPC

Apparent Consumption

As a result of high growth of the manufacturing sector, India's apparent consumption of GP/GC has shown robust growths during the last six years. India's apparent consumption of these products as well as its yearly growth in percentage terms are shown in Table-6 between the years 1999-2000 and 2007-08.

It may be observed that in 2002-03, the apparent consumption of GP/GC sheets in India went down

Table - 6 : Apparent Consumption of GP/GC sheets In India : 1999-2000 to 2007-08 ('000 tons)

Year	Apparent Consumption	Y-O-Y growth (%)
1999-2000	1204	-
2000-01	1393	15.70
2001-02	1750	22.63
2002-03	1265	(-) 27.71
2003-04	1691	33.68
2004-05	1926	13.90
2005-06	2051	6.49
2006-07	2400	17.02
2007-08	2622	9.25

Data Source - JPC

substantially by over 27 percent. This was due to lower demand in the market which was affected by downtrend in manufacturing growth. The high growth of over 33 percent in 2003-04 was due to a low base in previous year.

Colour Coated Sheets

Colour coating usually refers to the application of liquid paint coat over the substrate in an automatic, continuous process after pre-treatment. The pre-painted colour coated steel is a very high value-added product that combines the best properties of both substrate and organic coating, additionally imparting it an aesthetic finish, high degree of durability and high corrosion resistance.

Colour coating is done on various substrates to produce most cost-effective, quality assured products with the top coat compatible with environment.

The substrates usually used are:

- a) Hot-Dipped Galvanised Steel
- b) Electro-Galvanised Steel
- c) Galvalume
- d) Galfan
- e) Aluminium

a) Pre-treatment

Pre-treatment of the substrate is a very important operation required for better adhesion formability of pre-painted steel sheets.

Leading colour coated producers in India have introduced NO-RINSE technology in place of phosphating (phosphate coating) over galvanised strip because of better bath

maintenance, uniform crystal structure of coating as well as to meet the demand of end-users for more flexibility of coated steel.

No-Rinse coating pre-treatment is a very thin layer of chemical treatment that bonds the coating surface of steel to the subsequently applied paint to ensure excellent paint adhesion and corrosion resistance of the steel substrate.

b) Primer

After the pre-treatment, the primer of uniform layer is applied on the pre-treated surface. The primer provides flexibility to the paint system and corrosion resistance since it contains corrosion inhibitors. The primer is cured in the oven with precise temperature controls with great precision.

Various types of primers are available based on different resins like epoxy, polyester, polyurethane and PVC. Epoxy primers are preferred for use in roofing as it contains chromate pigments for better corrosion resistance.

Hexavalent Chromium (Chromium VI) serves electrochemical couplers that can resist the corrosive action on most metal surface.

However, these compounds are widely used in industrial coatings, are classified as CARCINOGENS (Category 1 and 2) as well being toxic and dangerous to environment. Hence some producers have developed chromate-free primers.

c) Top Coat

After pre-treatment, the primer surface is over coated with top coat at uniformly controlled thickness and then cured in the oven. The top coat contains a combination of colour pigments and additives which provides the required colour and other performance properties like ultra-violet resistance. The coated product is then rigorously tested before clearing for further application.

Most of the roofing and construction markets for colour coated sheets use top coats which are based on polyester, Flurocarbon (PVDF), silicon Modified Polyester (SMD and plastisols for cost effectiveness and durability.

Number of Colour Coated Steel Units in India, Their Capacities & Production

The number of colour coated steel units in India, their capacities and production figures between the years 2004-05 and 2006-07 are shown in Table-7.



Table - 7. Colour Coated Steel Units, Their Capacities & Production : 2004-05 to 2006-07

Year	No. of Units	Capacity ('000 tonnes)	Production ('000 tonnes)
2004-05	4	100	141
2005-06	5	400	244
2006-07	5	465	386

Data Source : JPC

It may be observed from the above table that in 2006-07; capacity and production of colour coated steel units have increased by 16.25 percent and 58.20 percent respectively.

According to industry sources, the production of colour coated sheets has gone up by about 30 percent in 2007-08.

Demand of Colour Coated Sheets

According to experts, the domestic demand for colour coated sheets in India in 2003-04, was 39,000 tons. The demand increased substantially in the following year. The estimated demand of these sheets between 2004-05 and 2007-08 are shown in Table -8.

Table - 8; Estimated Demand of Colour Coated Sheets in India Between 2004-05 and 2007-08

Year	Domestic Demand ('000 tonnes)	Y-O-Y ('000 tonnes)
2004-05	60	-
2005-06	85	41.67
2006-07	110	29.41
2007-08	140	27.27

Data Source : JPC

Due to the current financial crisis, the demand in the year 2008-09 is likely to be flat or may have a marginal growth. Earlier the demand in FY'09 was estimated at 270,000 tons.

Producers of Colour Coated Sheets in India :

Earlier, Ispat Industries and Shree Precoated Steels Ltd. (SPSL) were the only two producers of colour coated sheets in India, each having a capacity of 50,000 tpy. But presently, Ispat is planning to raise its capacity to 100,000 tpy and SPSL to 300,000 tpy. But in view of the present recession, the expansion plans of these two companies may be delayed.

Bhushan Steel & Strips Ltd. has also commissioned a 120,000 tpy capacity colour coated line in Khopoli in Maharashtra. Tata Steel and BlueScope Steel of Australia have entered into a Joint Venture (JV) on 50:50 basis and have set up a metallic and colour coating and painting facility at Bara near Jamshedpur in Jharkhand. Its capacity is 250,000 tpy of premium zinc and aluminium coated steel called Zinalume (Galvalume) and pre-painted zinc and

aluminium coated steel is called COLORBOND whose capacity is 150,000 tpy.

According to media reports, the JV project's capacity may be doubled by August, 2009. But the present demand downtrend may lead to delay the expansion.

Effect of Current Recession

Due to adverse market conditions the commissioning of the following projects which were scheduled for mid-2008 may be delayed

- ♦ JISCO's 100,000 tpy capacity colour coated facing facility at Tarapore.
- ♦ Uttam Galva's 80,000 capacity colour coating line at Khopoli in Maharashtra.
- ♦ Steel Corporation of Gujarat (now owned by Essar Steel) new colour coating line of 50,000 tpy capacity.

The domestic production of GP/GC Sheets in India during April October, 2008 at 2.599 mt has gone down by 2.84 percent as compared to 2.675 mt in the same period of the previous year. In the full year of 2008-09, the decline may increase further.

Market Price

According to JPC, the market prices of GP/GC sheets in the Mumbai market have gone up substantially. For GP sheets the rise in prices has been about 31 percent between January'08 and September'08. For GC Sheets the prices has gone up by about 32 percent during the same comparative period. But in the next 6 months, the prices may come down sharply due to the recessionary trend in the industry.

Conclusion

The Indian galvanised steel industry including the colour coated segment has posted remarkable growths in the last few years. The domestic producers are now capable of manufacturing products for high-end applications which have been well accepted in the global market.

Due to the adverse effect of the present global recession the world steel industry is slowing down. This has also affected the Indian steel industry including the galvanised steel segment India's production and exports in 2008-09 may decline as compared to the previous year. However, according to steel economists and experts, the situation may look better in the third/ fourth quarter of 2008-09

(Acknowledgements: Dr. Amit Chatterjee, Tata Steel and Shri L. Pugazhenty, Ed, IZDA for their various articles)

