Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 4, Issue 2; April-June, 2017, pp. 118-120

http://www.krishisanskriti.org/Publication.html

Recycling of Steel: A Need in Today's Construction Practices

Dakshayani Shete

Sinhgad College of Architecture, Savitribai Phule Pune University, Pune
E-mail: shete.dakshayani@gmail.com

Abstract—*Use of steel is rapidly increasing due to its suitability range from commercial projects, long span structures, bridges, tensile structures, and so on which makes it most used material in the construction industry today. Sustainability could be a subjective term with various parameters ranging from use of green materials, technology, re-use and recycling of materials. Steel is usually referred as a hazardous and a non- sustainable material due to the pollution it creates in the manufacturing processes. Therefore, it becomes essential to follow recycling technique to reduce the pollution and to make it greener. This paper aims to focus on the methods of recycling, its advantages, by studying case studies of Henley Street Bridge, USA; where a massive 700tons of steel was recycled and re-used for conservation of bridge and second case study where use of scrap steel is carried out in a construction of rigid pavement. Ultimately a concluding note is made by discussing its effect on environment and possible applications of utilizing recycled steel in construction practices.*

Keywords*: Scrap, Sources of Scrap, Methods of recycling, Henley Street Bridge, scrap used in Rigid pavement design, healthy environment.*

1. INTRODUCTION

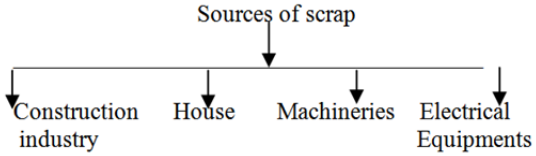
Use of steel is increasing day by day due to their structural properties in terms of strength, durability, flexibility and durability. Use of construction material should be done to its fullest strength to reduce the waste which is generating due to construction industry and for that re-use, recycling should be promoted. Conserving a structure to maintain its use and to keep its identity in the history of the structure it is recommended to adopt re-use and recycling practices. Now-a-days in the constructions are going on larger scale to match the infrastructure requirement of the country. Therefore it becomes essential to understand the process of recycling of steel so that it will reduce environmental pollution, could improve economic benefits as well. Advantages of recycling includes reduction in the volume of generated waste, re-use of structure in its current form, reducing the hazardous manufacturing process turns over the raw materials. It is observed that steel has a 90% capacity to get recycled and therefore this paper aims to understand the procedure and future scope of steel recycling.

2. LITERATURE REVIEW

Steel is available in various grades in market almost 2500 types are available and which are being used for construction practices which itself suggesting its scope of wide use. It is classified as base steel, quality steel, high grade steel. To address the issue of reducing the environmental pollution and the waste which is generating due to construction industry following solutions should be given a thought which is setting up a priority for use of re-used, reclaimed and recycled materials in practices .Generating a greater ready supply of reclaimed steel by ensuring that during the demolition process all useful steel components are extracted undamaged. Developing a greater demand for reclaimed steel components by increasing designer and client knowledge about the opportunities for such reuse and creating a greater "comfort level" about such reuse. Facilitating an easier exchange of available steel by creating easier links between supply from demolition and scrap dealers and demand from designers/contractors and clients, thus creating more effective markets for reclaimed steel. [9]

3. SOURCES OF SCRAP

Source of ferrous scrap available for recycling is from home, electrical equipments, heavy machineries, construction industry etc. Impurities from scrap known as tramp element which need to be kept in permissible limits are important. Further these impurities could be removed in the refinement process during recycling.



4. UTILIZATION OF SCRAP

Scrap collected from construction industry can be re-used directly or can be recycled depending upon their physical and

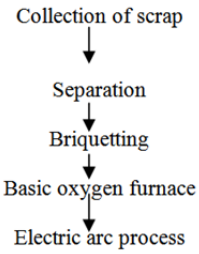
mechanical properties. It can be broadly divided into three categories as-

- Re-use of Steel: Re-use of steel environmental friendly than recycling. It is possible to re-use for small or temporary structures however standardization for checking the quality of re-used steel is essential to ensure about its quality.
- Reclaimed Steel: Reclaimed steel is the one which cannot be directly used but requires certain processes like cutting into pieces as per requirement. As far as possible steel should be re-used or reclaimed which will save cost of handling and also its mechanical properties will be retained.
- Recycled Steel: Recycling involves melting the old scrap and formulating new steel which could be used as per requirement in construction practices or any other uses.[9]

5. PROCESS OF RECYCLING

In general scrap collected for recycling process can be sorted out by following collecting, separation, melting steps. Separation can be divided into three categories i.e. vibration of separation which involves separation of chips by inducing vibrations, melting separation involves melting scrap at certain temperature, magnetic separation is carried out to separate ferrous and non ferrous materials etc. Magnetic separation can be carried out in different categories like overband magnets, suspension magnets. Briquetting involves preparation of slurry

Oxygen furnace consists of molten iron + 25% scrap which will be processed to produce steel. This process requires oxygen to create extreme heat which is essential to produce steel. Duration of this process requires 45 minutes. Electric arc process is a mechanical method to carry out pre-sorting of the scrap and to remove impurities from the scrap. Here electrodes are used to create extreme which will melt scrap and impurities et burnt into the powder form which can be easily removed as a electric arc dust. [9]



6. CASE STUDIES

To understand the recycling importance and processes two case studies are studied here which includes-

1. Henley Street Bridge, Tennessee, USA
2. Experimental Study from literature available where scrap is used for construction of rigid pavement.

7. HENLEY STREET BRIDGE, TENNESSEE, USA

Henley Street Bridge is the most historic structure constructed in the year 1930 in Knoxville, Tennessee, USA. It was responsible for the economic and social development of the city at the time when constructed. The structure was 80 years old which required rehabilitation due to deterioration of concrete over the 80 years after construction and reinforcement was getting exposed, to accommodate more traffic and sidewalks and also to conserve landmark structure in the history of the city decision was taken to do rehabilitation of the structure by adopting recycling process of original steel reinforcement bars used in the construction the bridge so that it will continue to serve as a landmark to the city at the same time will be responsible for economical, social growth of the city. [4]

(*Source*: Internet)

Fig. 1 Henley Street Bridge

Details of the bridge includes-

- Year of construction-1930-31
- Type of bridge-6 Span Arch
- Materials used- Concrete and Steel
- Original Cost- $1.15 million
- Duration of Original Constrction-15months
- Recycling of steel is done by Gerdau Longsteel manufacturing company, Knoxville, Tennessee which uses scrap as a raw product

Details of recycling: 35000 cubic yard concrete and 700 tons of steel bars are recycled and re-used. Out of 800 tons of original steel bars, 100 tons were kept as it is while 700 tons were recycled. Original shape of bar was square which is now given oval shape due to melting and recycling processes. Oxygen and calcium added in the process to remove impurities from the steel pieces. [4]

(*Source*:http://archive.knoxnews.com/business/gerdau-plant-recycling-steel-it-made-for-henley-bridge-in-1930-ep-361085969-357147851.html)

Fig. 1: Old bar square in cross section and new bar oval in cross section.

8. RIGID PAVEMENT DESIGN USING STEEL SCRAP

Fiber reinforcement is highly recommended in situations involving high impact and fatigue loading. Adding steel fibers can improve toughness, resistance to fatigue, impact, thermal, flexural strength, etc. Steel scraps derived from lathes were used in the concrete for construction on experimental basis study.. Length of steel scraps used ranges between 25-30cm, Modulus of elasticity 200 GPa, specific gravity 7.8. Addition of steel scrap proved to improve mechanical properties of concrete when mixed in certain proportions in concrete. Also after addition of steel scrap fibers abrasion resistance seem to be improved when tested in lab. [10] The impact and abrasion resistance of pavement has been carried out for optimized fiber content of M30, M35, and M40 concrete grades. The experimental results show that the mechanical properties such as compressive strength, flexural strength, impact strength and abrasive resistance of concrete are found to be increased due to the addition of steel scrap fiber in the concrete here the locally available Scrap Steel Fibre Reinforcement is used. Also, addition of small amount of reinforcement proved to reduce thickness of the pavement which will ultimately reduce material usage and will be important parameter to achieve economical benefit. [8]

9. CONCLUSION

From above study it is clear that re-use, reclamation and recycling of steel is essential in now-a-days as it has numerous advantages ranging from reduction in the volume of waste generated, energy saving due to less load on heavy machineries involved in the manufacturing process, also it will help to maintain healthy and livable cities. Steel is the most recyclable material up to 99% it can recycle. Recycling helps in reducing waste which ultimately dumped at certain location. The above study helps to use that scrap steel for reusing it with the help of recycling and using it again as a part of structural component. During the recycling process Oxygen, Calcium, Carbon can be added to keep the properties of steel back to the original one. With the help of experimental study mechanical properties of steel are discussed and it also gives the idea of wide application of steel as a construction material. Case Study: Henley Bridge Recycling helps to understand Structural Application of recycling in actual constructional purposes. This proves that steel is the most Sustainable Construction Material and helps to reduce the emissions of CO2 in the ore extraction processes. Thus, recycling of steel must be promoted in construction industries.

REFERENCES

[1]BIR, Report on the environmental benefits of recycling, 2008.

[2] Scrap based steel production and Recycling of Steel by D. Janke, L. Savov, H.-J. Weddige, E. Schulz, Institute of Iron and Steel Technology, Freiberg University of Mining and Technology,(2000)

[3] www.gerdeumeristeel.com

[4]Tenessee department of transportation-www.tdot.state.tn.us/henley

[5] End of waste criteria, report JRC-IPTS, 2008

[6] IRC-58:2002, 'Guidelines for the Design of Rigid Pavements.' Fig. 5: Control Concrete specimens failed under Impact Fig. 6: SSFRC specimen failed under impact

[7]Structural steel enhancement of rigid pavement reinforced with scrap steel fibres by Dr. Samson Mathew, Assistant Professor, and Dr. P. Jayabalan NIT,Tiruchirapalli

[8] K. Balasubramaniam, B. H.Bharat Kumar, S. Gopalakrishnan and V.S. Parameswaran, 'Impact Resistance of Steel Fibre Reinforced Concrete,' The Indian Concrete Journal (May, 1996), pp. 257-262.

[9]Chip Recycling: Recycling of Chips from BZZ Conditioning Processes, Project by Faculty of Worcester Polytechnic Institute (2007)

[10] Copper and Tin Scrap in Steel recycling by Luben Svov, D. Janke, Elena Volkova Institute of Iron and Steel Technology, Freiberg University of Mining and Technology, (2003)

[11] Facilitating greater reuse and recycling of Structural steel in the construction and demolishing process by Dr Mark Gorgolewski, Prof. Vera Straka, Jordan Edmonds, Carmela Sergio(2006)

[12] JRC Standard and Technical Reports-End of Waste Criteria for Iron and Steel: Technical Proposals, Lenka Muchová and Peter Eder, Spain

[13] Photos of Henley Bridge Reinforcement Recycling by Michel Patrick Knoxville News Sentinel Co.

[14] http://archive.knoxnews.com/business/gerdau-plant-recycling-steel-it-made-for-henley-bridge-in-1930-ep-361085969-357147851.html