Slurry pipeline: Cost effective solution for steel industry for transportation of iron ore/ coal for long distance

by

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Background

- **India's steel production in 2016 : 95.6 Mt**
- **3rd largest producer in the world**
- **Second largest producer of DRI in world in 2016**
- **National Steel Policy document : 300 Mt/yr steel production by 2030-31**
- **Key assumption for such growth**

Background

- **Increase in per capita steel consumption : 63 kg to 130-140 kg**
- **Factor responsible for raising per capita steel consumption are :**

  - ► **Massive investment in infrastructure**
  - ► **10 % projected growth of manufacturing sector**
  - ► **Development of 100 smart cities**
  - ► **Emergence of rural market**

Background

- **Crude steel capacity by 2030-31 : 300 Mt**
- **Each 1 t steel requires 1.6 t prepared ore i.e. 2.0 – 2.1 t ROM**
- **ROM for domestic steel production incl. DRI by 2031 : 600 Mt**
- **Considering export of ore only 75 Mt**
- **Total ROM requirement by 2031 : 675 Mt**

Iron ore scenario in India

- **Total resources of ore : 28.5 billion t**

- **Hematite : 17.88 billion t**
  - **Reserve category : 8.09 billion t**
  - **Remaining resources : 9.79 billion t**

Magnetite : 10.62 billion t

- **Reserve category : 0.02 billion t**
- **Remaining resources : 10.62 billion t**
- **Av. Fe content in magnetite : 35-40 %**

Iron ore scenario in India

- **Magnetite reserves are not being exploited , these are mostly in eco fragile zone of Western Ghats**

- **These reserves remain locked for next decade, can be considered for exploitation through sp. mining method to take care of environmental issues.**

- **Entire present steel production comes from hematite ore. Over 85% hematite ore reserves are medium to high grade (+ 60 %), used directly in BF & DRI plants**

Iron ore scenario in India

- **These reserves will last for only 45 years**
- **IBM has revised the cut off from 55% to 45 % Fe for minable reserves.**
- **Total reserves with cut off of 45 % Fe will be much higher than present estimate.**
- **Over 6 decades mining of +63 % Fe ore & washing ore to get favourable alumina silica ratio resulted in piling of over 100 Mt rejected**

Iron ore scenario in India

low grade fines & slimes with Fe of 45-55 % at various mine heads

- **Slimes / lean ore mountains are not only occupying precious land at mines but posing environmental problem**

- **Economical steel production by metallurgical processes desires ore burden with + 62% Fe**

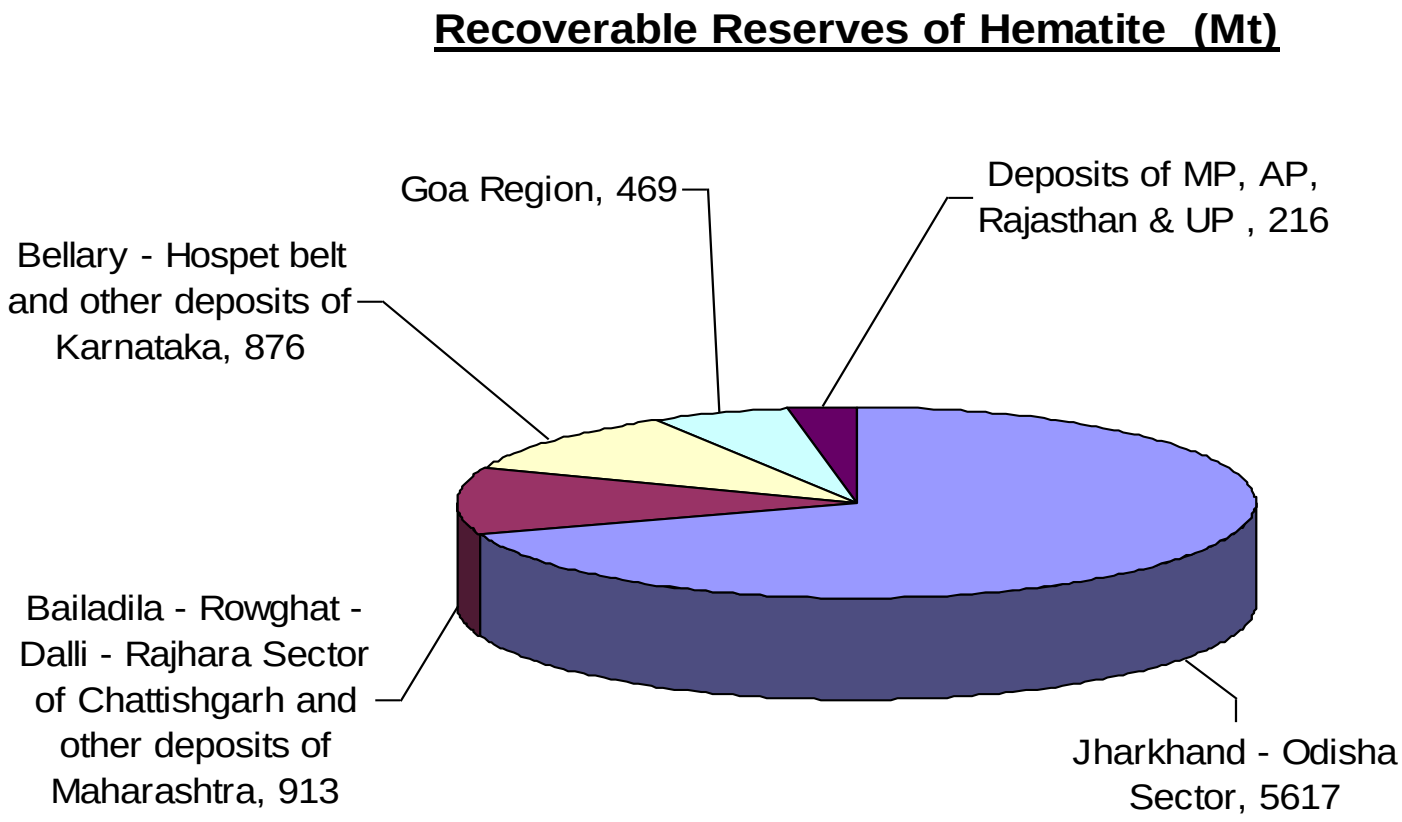
Iron ore scenario in India

- For effective utilisation of lean ore & to conserve precious natural resources for sustainable development , beneficiation is must in today's context

- Mineralogical characteristic of lean ore revealed removal of undesirable elements by grinding to minus 200 mesh for enriching Fe from 45 to 60 %

- In general beneficiation units are installed at mine site for ease of handling of ROM & concentrate is transported to consuming centres

Hematite ore reserve



Annual freight by Railways : Major material

Year	Total, Mt	Coal , Mt	Ore , Mt	Ore Prod. , Mt	Finished Products, Mt
2011- 12	970	455	119	167	35.5
2012-13	1009	493	96	136	37.2
2013-14	1051	508	124	141	39.0
2014-15	1095	546	112	129	42.8
2015-16	1101	551	117	135	44.9

Need for slurry transportation

- **Railways is most preferred mode of transportation for bulk commodities e.g. coal, ore etc.**
- **Steel related traffic is about 27%**
- **Tremendous pressure on railway transportation system by 2031 due to**

  ► **Increase demand of iron ore , other input materials & dispatch of associated finished products**

Need for slurry transportation

- Increase demand of coal both for steel plant & power plants
- Existing railway transportation is not capable of handling fine ore concentrate
- Over saturated route (120% capacity utilisation in some sections)
- Poor last mile connectivity

Need for slurry transportation

- No guaranteed transit time , freight train takes 6 to 8 days for 2000 km journey
- Common track for freight & passenger
- Logistic cost is 13-14% of GDP against 8-10% in developed world
- Pace of infrastructure development is not matching with industry's requirement

Need for slurry transportation

- No movement of freight train in night in some sensitive areas

- Suffer from lack of adequate haulage capacity & has low heavy haul freight compared to global players 5400 t as compared to China 20,000 t , South Africa 22,000 t & Australia 32000 t

- Freight car turn around time is very low.

Gandhamardhan- Daitari- Maangtoli region in Orissa, Bababudhan of Karnataka, Ongole region of A.P are still not adequately supported by Railway infrastructure

Advantage of slurry transportation

- **Bulk transportation of iron ore concentrate in slurry form is environment friendly.**
- **Eliminate the dependency on the railways and reduce the cost on transportation of ore.**
- **Insensitive to surface condition such as storm, inclement weather etc.**
- **25 Mt/yr of material transportation reduces extra load on railway to the tune of 50 rakes (25 inward & 25 outward) per day.**

Advantage of slurry transportation

- **Large distance transportation of ultra fine concentrate will require special wagons, which can be avoided by slurry transportation.**

- **Don’t require return of empties to starting point , ideal for uni - directional traffic**

- **Up-gradation and utilization of the unused low grade iron ore available at different mine sites across the country will enhance the resource base and support mineral conservation**

Advantage of slurry transportation

- **Fulfill the statutory requirements of IBM for utililsation of +45% Fe iron ore by way of beneficiation**

- **Slurry transportation has minimum social impact, shorter route, easier river crossings (without bridging) and minimum en-route losses**

- **Easier access for construction, operation and maintenance**

Global scenario of slurry pipeline –Iron ore

- **Samarco : from Germano to Point Ubu Pellet Plant in Brazil, 396 km , capacity : 15Mt/yr**
- **Da Hong Shan pipeline in China for Kunming Iron & Steel Corp, 171 km , capacity 3.5 Mt/yr**
- **Anglo Ferrous Minas-Rio in Brazil , 522 km capacity 23 Mt/yr**
- **Savage River , Tasmania , Australia, 85 km**

Global scenario of slurry pipeline –Iron ore

- **Minas Gerais to Iiheus Port, Brazil, 420 kms, capacity : 25 Mt/yr**
- **Wellstead to Albany port, Australia, 100 km**
- **Chongin, North Korea, 98 km, capacity4.5My/yr**
- **Zanada Project : Mines to Pointe Noire Port, Cango, 370 kms, capacity 12 Mt/yr (1st phase) under engineering stage**

Global scenario of slurry pipeline –Iron ore

- **Mount Gibson Ranges to Geraldton, Asia Iron Holding , Australia, 278 km, capacity 10 Mt/yr**

- **Balla Balla Mines to Port Hedland , Aurox Resources, Australia 110 km ,capacity 10 Mt/yr**

Slurry pipeline for other mineral

- **Coal**

Black Mesa, USA : 439 km , Cap : 4.8 Mt/yr

Belevo-Novosibink, CIS : 256 km , Cap : 3 Mt/yr

- **Copper Concentrate**

Irian Jaya, Indonesia : 112 km, Cap : 0.3 Mt/yr

KBI, Turkey : 61 km, Cap : 1 Mt/yr

Bougen Ville, Papua New Guinea : 27 km, Cap: 1 Mt/yr

- **Copper Tailing**

Japan : 64 km, cap : 1.0 Mt/yr
Ceba, Phillipines: 19 km, cap: 24 Mt/yr

- **Limestone**

Kensworth Beds, UK : 92 km, cap: 2.0 Mt/yr
Calveras, USA : 28 km, cap: 1.5 Mt/yr

- **Phosphate Slurry**

Velep, Brazil: 120 km, cap: 2.0 Mt/yr
Golasfertil, Brazil : 14 km, cap: 1.0 Mt/yr

- **Uranium bearing gold slime**

Barldrosco, South Africa : 19 km, cap: 1 Mt/yr

Indian scenario- Existing Iron ore Slurry pipeline

Kudremukh to Mangalore , KIOCL, 68 km, capacity 8.0 Mt/yr

- **Kirandul (Baildaila Sector) to Vishakhapatnam Essar Steel , 267 km, capacity 8.0 Mt/yr**
- **Barbil to Kalinganagar, BRPL ,Orissa, 230 km , capacity 4.0 Mt/yr**
- **Joda(Dabuna)- Paradip, Orissa, Essar Steel, 253 km, capacity 8Mt/yr**

Indian scenario- Proposed iron ore Slurry pipeline

Kirandul –Bacheli – Nagarnar - Vizag , NMDC 455 km , capacity 10 Mt/yr (Ongoing project)

- **Mangalore to Tornagallu: 350 km by JSW (Advance stage of implementation) both for ore/ coal , investment Rs 2100 crores**

- **Barbil to Angul, Orissa, JSPL , capacity 12 Mt/yr (Ongoing project)**
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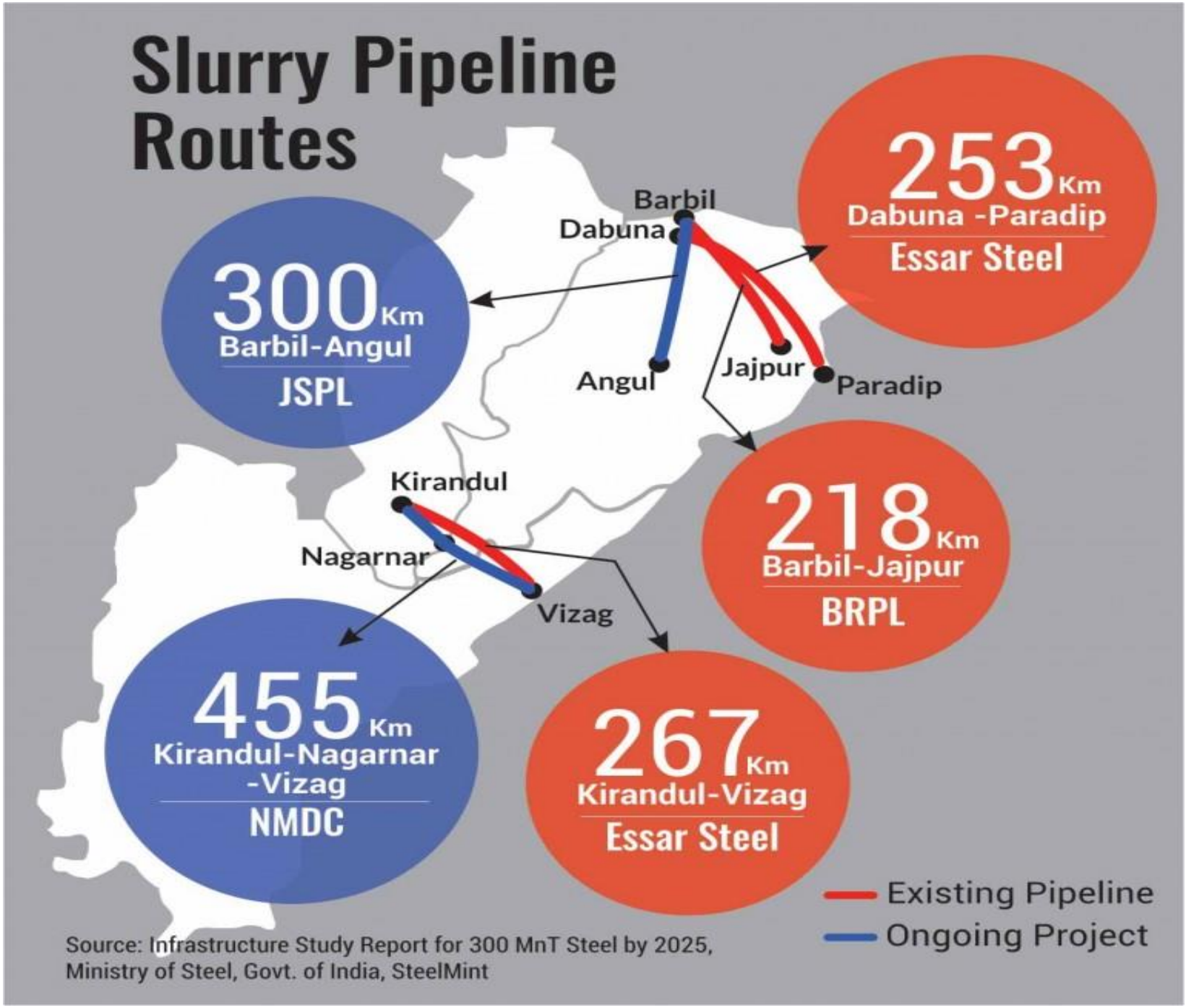
Slurry Pipeline Routes
253 Km
Dabuna -Paradip
Essar Steel
300 Km
Barbil-Angul
JSPL
218 Km
Barbil-Jajpur
BRPL
455 Km
Kirandul-Nagarnar -Vizag
NMDC
267 Km
Kirandul-Vizag
Essar Steel
Barbil
Dabuna
Angul
Jajpur
Paradip
Kirandul
Nagarnar
Vizag
Existing Pipeline
Ongoing Project
Source: Infrastructure Study Report for 300 MnT Steel by 2025, Ministry of Steel, Govt. of India, SteelMint

Major System of slurry pipeline

- Storage tank & agitator
- Dispatch & Receiving terminals
- Slurry Pipeline
- Pumping stations
- Valves / Choke stations

System design of slurry pipeline

- Pressure monitoring stations
- Scraper Launcher / receiver
- Cathodic protection system
- SCADA System
- Return water pipeline (Optional)

Cost benefit analysis

- **Investment cost : Rs. 4.50- 5.0 / t/ km (for min. distance of 100 km & 10 Mt/yr capacity)**
- **Operating cost : Rs 0.60 / t/ km**
- **Railway freight charges for ore : Rs 1.60/ t/ km**
- **Road charges : Rs 3.50-5.0 / t/ km**

For JSPL , Angul Plant

Transporting iron ore from Barbil to Angul by road : Rs 2000/t

Same distance by Train : Rs 820 /t

Same by slurry pipeline : Rs 400 /t

80 % saving compared to road & 50 % saving compared to rail

Essar is saving Rs 1200/t from for transporting ore slurry from Barbil , Keonjhar to Paradip Pallet Plant.

Report prepared for slurry pipeline from Mangalore to Vijaynagar for JSW shows only 15% of the cost of transport by slurry pipeline over other means of transport.

Conclusion

- **Railway is unable to cope up with ever increasing demand of iron ore & other input materials by steel sector in next one decade**

- **To enhance ore reserve base , beneficiation of lean ore is must, Railway is not in a position to transport ultra fine ore/ concentrate as it needs special wagons.**

- **Iron ore slurry transportation is well established mode of transportation in world as well as in India.**

Conclusion

- **Ore transportation by slurry pipeline is cost effective , efficient & environmental friendly**

- **Common carrier slurry pipeline can be laid to cater to many consumers in a zone / region**

- **Formation of Slurry Transportation Authority under the Ministry of Steel (MoS) in line with NHAI for laying and operation of slurry pipeline in country.**

THANK YOU