Optimisation of Roller press frame in cement industry

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Abstract: In this project it is proposed to find an optimum cross section of the frame member by utilizing the available standard thick plates. In the details of the frame members have been collected, analyzed using Stress Analysis and Simulation Software (ANSYS-11) and found the factor of safety maintained in the existing design. Based on the factor of safety as a constraint for this frame assembly, the alternate cross sections with standard thick plates have been modeled, analyzed and the results are discussed. From the results it has been arrived to a conclusion that alternate section 1 and 3 gives optimized cross sections of the frame members. The alternate cross section 3 has been taken as final cross section for redesigning the frame assembly due to its manufacturing feasibility.

Keywords: Ansys-11, frame member, stresses analysis.

INTRODUCTION

Cement as construction material:

Cement used in construction is characterized as hydraulic or non-hydraulic. Hydraulic cements (e.g., Portland cement) harden because of hydration, chemical reactions that occur independently of the mixture's water content; they can harden even underwater or when constantly exposed to wet weather. The chemical reaction that results when the anhydrous cement powder is mixed with water produces hydrates that are not water-soluble. Non-hydraulic cements (e.g., lime and gypsum plaster) must be kept dry in order to retain their strength.

Clinker, if stored in dry conditions, can be kept for several months without appreciable loss of quality. Because of this, and because it can easily be handled by ordinary mineral handling equipment, clinker is traded internationally in large quantities. Cement manufacturers purchasing clinker grind as an addition to their own clinker at their cement plants. Manufacturers also ship clinker to grinding plants in areas where cement-making raw materials are not available.

CLINKER GRINDING MACHINES

In the present world there all many machines available to grind the clinker to produce cement. Some of the popular known machines for clinker grinding are listed below.

- BALL MILL
- VERTICAL ROLLER MILL
- HYDRAULIC ROLLER PRESS
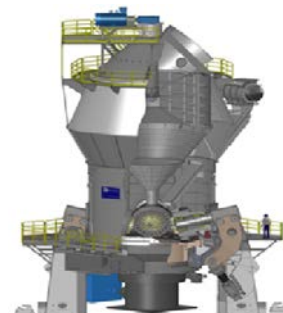- HAMMER CRUSHER

Fig.1 Ball mill

Fig.2 Ball mill

Fig. 3 Roller press

Fig.4 clinker crusher

Since the Hydraulic roller press for clinker grinding is used widely in our country, we focus mainly on the development and cost reduction exercise on this machine. This is done to sell this machine in this competitive world in a competitive price.

METHODOLOGY

I. Collect data of the existing roller press:

- ✓ Specification of existing material used.
- ✓ Dimensional drawings of existing frame members.
- ✓ Find out the conditions for analysis.

II. Perform analysis and discuss the results

- ✓ Make models of existing frame members.
- ✓ Find out the factor of safety maintained in the existing member.
- ✓ Conduct the analysis on the frame members with proposed new cross sections.
- ✓ Review the results.

LITERATURE REVIEW

D.R. Griffiths & J.C. Miles of Cardiff School of Engineering, Cardiff University, made a research on "Determining the Optimal Cross Section of Beams". Constrained shape discovery and optimization are difficult engineering problems. Shape discovery deals with evolving randomly generated solutions into useful intermediate solutions.

These intermediate solutions are then optimised to suite their environment. In this paper a Genetic Algorithm (GA) is applied to the problem of finding the optimum cross section of a beam, subject to various loading conditions.

Previous work using GA's for this problem has relied heavily on heuristics and domain knowledge that operates directly on the genotype to guide the search. It is sound engineering practice to utilize all available information to reduce design and evaluation times, and encourage the formulation of useful solutions

Journal of Mechanics of materials and structures, Vol.2, No. 10, 2007, Ashkan Vaziri, Zhenyu Xue and John W. Hutchinson studied the "Performance and failure of metal sandwich plates subjected to shock loading". Deflection and fracture of metal sandwich plates subjected to intense uniform impulsive pressure loads are studied for plates made of four steels representing a wide range of strength, strain hardening and ductility. Sandwich plates with both square honeycomb cores and folded plate cores are considered.

The primary fracture modes of the sandwich plates are necking and subsequent tearing of the face sheets and webs and shear de lamination of the core webs from the faces. Plates with square honeycomb cores have higher damage tolerance than those with folded plate cores in that they can withstand much larger loads above those at which the first signs of fracture appear. The trade-off between strength and ductility in plate performance is illustrated.

HYDRAULIC ROLLER PRESS OPERATION

Operating principle of Hydraulic Roller Press

The feed material (cement clinker, slag or other cement raw material) is supplied to the roller press through inlet and here it is directed down between the two rollers which rotate against each other. At the same time, the movable roller is forced towards stationary roller at a fixed hydraulic pressure. The hydraulic force is being obtained by the 4 hydraulic cylinders that have been mounted in the frame assembly.

The feed material is drawn down between the rotating and compressing rollers which compress the material to easily grindable flakes with a high content of fine material. When material is drawn in between the rollers, the movable roller will be forced slightly back, and the gap between the two rollers is thus increased and floating. After passage between the rollers the ground cakes drop into machine outlet and from there to the following conveyor which is not part of the roller press structure.
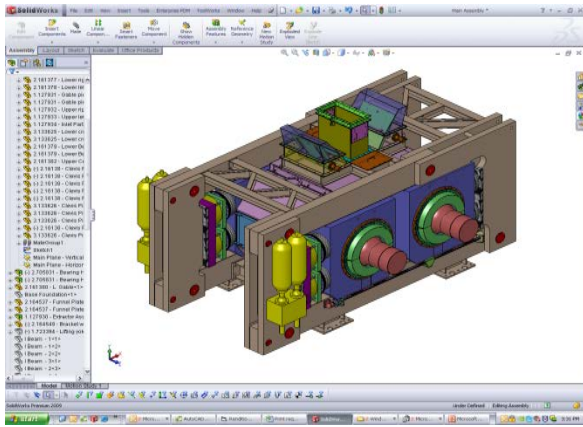
Fig.5 Hydraulic Roller Press without main drives

ROLLER PRESS CYLINDER ASSEMBLY

Hydraulic cylinder assembly

In order to grind the feed material, the movable roller must be forced hard towards the stationary roller. This is done by two hydraulic cylinders pressing on each of the two bearing housings of the movable roller. These two cylinders are built together and called the cylinder arrangement. Each of the two cylinder arrangements is built up around a bottom plate. On this bottom plate there are two cylinders. On top of each cylinder, a top flange is mounted which is bolted to bottom plate with stay bolts. Sealing rings, scraper rings and guide rings are mounted in top flanges. The purpose of these rings is to seal and protect the guide arrangement between the piston and cylinder parts. In cylinders a pipe section is mounted, and on top of it. These parts constitute the piston part in the hydraulic cylinder. On each top section an elastomer block is fitted.

The hydraulic cylinders are single-acting cylinders (they can only press) and are supplied with hydraulic oil through bores in the bottom plate. The cylinder arrangements are also connected to a number of accumulators mounted on valve blocks on gable section of the frame. The accumulators function as springs in the hydraulic system.
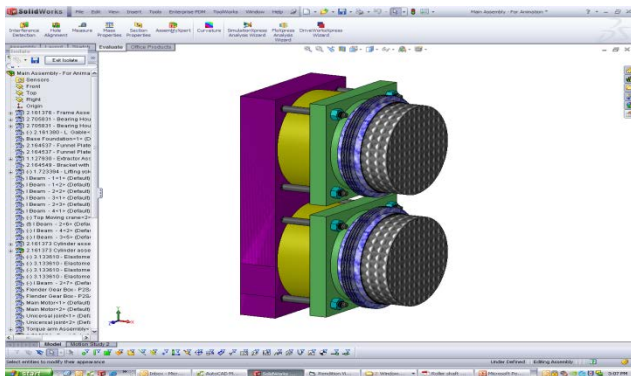

Fig.6 Hydraulic cylinder assembly

ROLLER PRESS FRAME ASSEMBLY

Frame assembly

The frame assembly of the roller press mainly consists of two lower members and two upper members, gable piece and L-gable. All the frame members are interlinked by means of pin joints. The upper and lower members are made up of 260mm thick plates, thickness being non-standard. The two bearing housings housed with roller are mounted over the frame assembly. The frame assembly also houses the other parts of the roller press

Upper and Lower members

The upper and lower members form the upper and lower parts of the frame assembly construction. The inlet and upper cross members are connected in between the two top members. The outlet funnel and lower cross members are connected in between two lower members.

Type of cross section used (C.S)	: Solid rectangular cross section
Overall length of member (L)	: 7597 mm
Thickness of the plate (T)	: 255 mm
Height of the plate (H)	: 630 mm
Material of the plate	: Non alloyed structural steel (In hot rolled condition)
Material standard	: EN 10025-2 (2004)
Yield strength of the material (Ys)	: 265 MPa

Table 1 Details of upper and lower frame members

L-Gable and Gable piece

The L-gable and gable piece form the extreme ends of the frame assembly in construction. The upper and lowers frame members are connected by means of Gable piece and L-gable. The 2 Nos. of Gable pieces are connected individually to the upper and lower members. The L-gable is of single construction and the same is also connected between upper and lower members.

Type of cross section used (C.S)	: Solid rectangular cross section
Overall height of the member (H)	: 3260 mm
Thickness of the plate (T)	: 160 mm

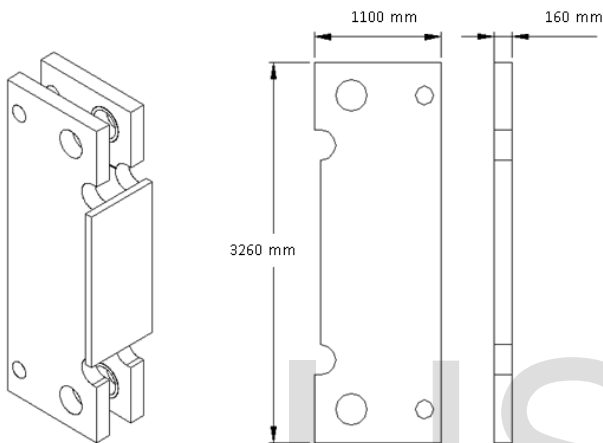| Width of the plate (W)	: 1100 mm
Material of the plate	: Non alloyed structural steel (In hot rolled condition)
Material standard	: EN 10025-2 (2004)
Yield strength of the material (Ys)	: 265 MPa

Table 2 Details of Gable piece and L-gable

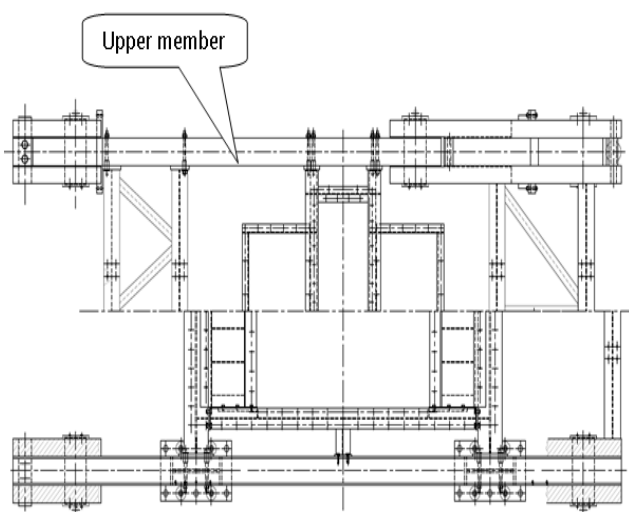

Fig.7 Gable piece and L-gable

FRAME ASSEMBLY VIEWS

Fig.8 Plan view of frame assembly

MODELING WITH ANALYSIS

Gable piece of frame

The Gable piece connects the upper and lower members at the one end of the frame assembly. It is made up of 160 thick plates with a fabricated design.
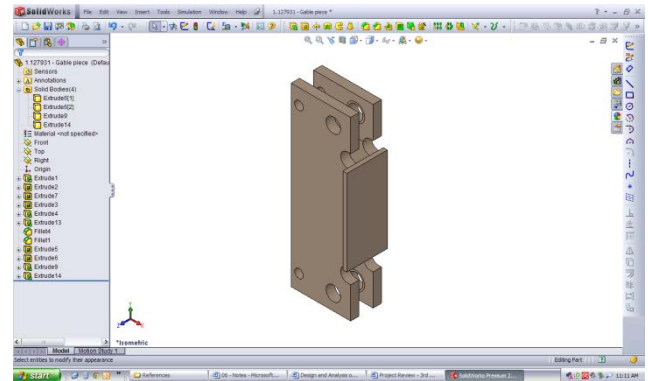
Fig.9 Gable piece

L-Gable of frame

The L-Gable connects the upper and lower members at the other end of the frame assembly. It is also made up of 160 thick plates with a fabricated design. It has L-shape in construction
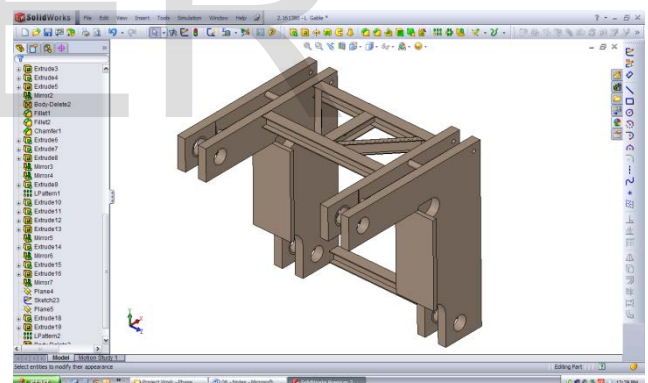

Fig.10 L-Gable

ANALYSIS AND RESULTS

Analysis of Cross sections
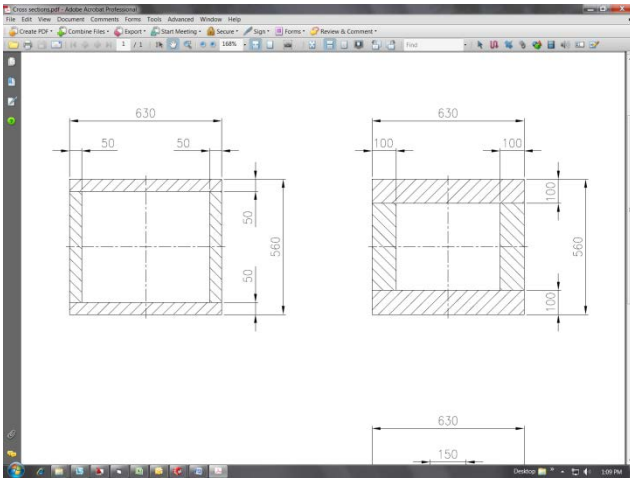
Alternate cross section-1

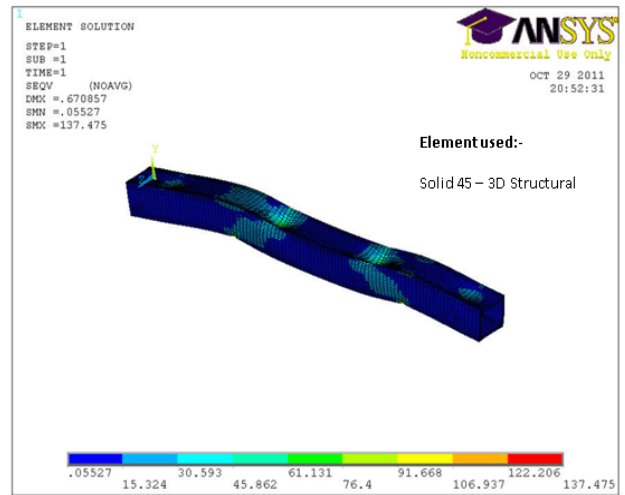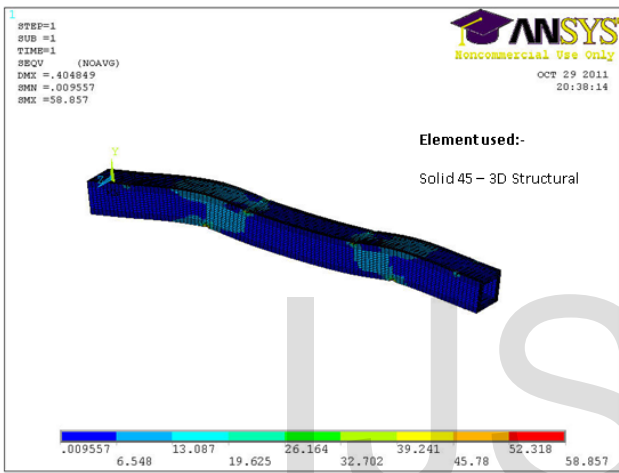**Fig.11 Alternate cross section-1 (All dimensions in mm)**

Fig.12 Von-misses stress distribution plot for alternate cross section-1

From the above stress distribution, the maximum stress value obtained is 59 MPa

Alternate cross section-2

. **Fig.13 Alternate cross section-2
(All dimensions are in mm)**

Fig.14 Von-misses stress distribution plot for alternate cross section-2

From the above stress distribution, the maximum stress value obtained is 137 MPa.
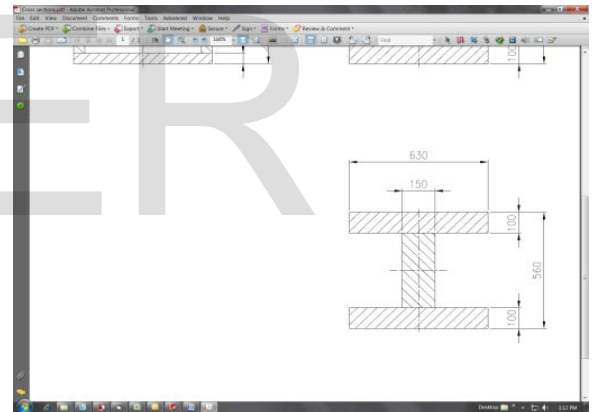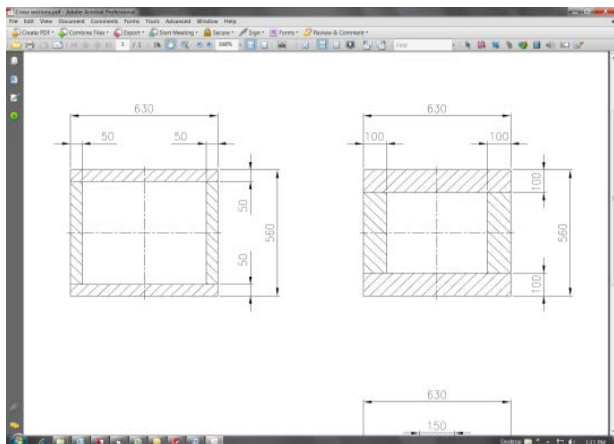
Alternate cross section-3

**Fig.15 Alternate cross section-3
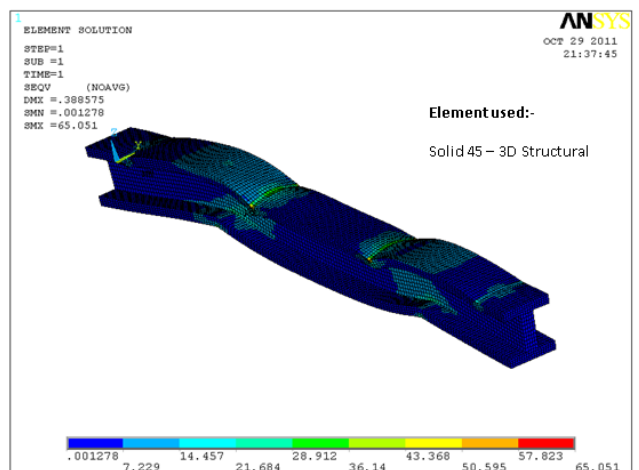(All dimensions are in mm)**

Fig.16 Von-misses stress distribution plot for alternate cross section-3

From the above stress distribution, the maximum stress value obtained is 65 MPa

Comparison of maximum stress values

Sl. No	Type of Cross section	Max. Stress value
1	Existing Solid cross section	76 MPa
2	Alternate cross section-1	59 MPa
3	Alternate cross section-2	137 MPa
4	Alternate cross section-3	65 MPa

From the above table it has been arrived to a conclusion that the alternate cross section 1and 3 found to be and optimised cross sections. The alternate cross section 3 has been taken as final cross section for redesigning the frame assembly due to its manufacturing feasibility.

CONCLUSION

From the results obtained it is concluded that the alternate cross section 1 & 3 found to be suitable for this optimization. The alternate cross section 3 has been taken as final cross section for redesigning the frame assembly due to its manufacturing feasibility.

Also it is planned to do a sandwich plate design, do the analysis on the same and review the result. If the results are found to be satisfactory, the frame re-design can also be made based on sandwich plate design. It is also planned to re-design the other frame members L-Gable and Gable piece with standard thickness plates thereby achieving optimization on the whole frame assembly.

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