technical notes

STRUCTURAL USE OF PLYWOOD.

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SUMMARY

In terms of lightness, strength, stiffness stability and cost plywood merits a favourable rating with other makes it used for structural purposes. A feature of plywood is the cross-banding of veneers which distributes the high longitudinal strength of the wood in all directions. The uniformly distributed strength of plywood, make it an ideal material for structural uses where large areas are to be covered and where stresses occur at different angles to the grain.

Introduction

Plywood may be defined as a cross banded assembly built up of layers of veneer or veneers usually an odd number of them, with the grain direction of adjacent plies at right angles to one another joined with an adhesive. Though there are two kinds of plywood, namely veneer plywood and lumber core plywood, only veneer plywood is common. A characteristic feature of plywood is the cross banding of the veneers as a means of distributing the high longitudinal strength of the wood in all direction. The properties of plywood depend on the quality of the different layers of veneer, the order of layer placement in the panel, the glue used, and the control of gluing conditions in the gluing process. In general two classes of plywood are available – hard-wood and soft wood.

Advantage of Plywood over solid Timber

By virtue of its cross-laminated construction, plywood offers certain advantages over solid wood. There are equalization of strength properties along the length and width of the panel, minimisation of checking and splitting, and greater dimensional stability. Due to the absence of a line of cleavage, plywood can be nailed or screwed close to the edges of the panel without danger of splitting in addition to which, the cross arrangement of the fibres offers considerable resistance to the pull through of nail or screw heads.

The same property also has its effect on the impact strength of plywood. Due to the multiple layer construction, it prevents splitting by distributing the pressure at the point of impact. The longitudinal fibres fracture on the underside of the panel with successive shattering of the other plies, but no complete break will occur as in the case of solid wood subject to similar loading.

Plywood when used for panelling has got definite fire retardant properties, especially in the case of phenolic bonded plywood. In addition the lack of joints does prevent the penetration of the flames until the panel is completely burnt. Plywood has got the advantage of using in the bent form, as its resilient properties enable it to be bent to a reasonable small radius of curvature without suffering damage. What is of particular interest to engineering designers is the very considerable increase in shear through thickness strength of plywood as compared to longitudinal shear strength of solid wood.

Presnnt day plywood has got so many advantages due to the following developments. Firstly it is possible to predict the performance of plywood in engineering structures as working stresses could be established by tests. Secondly, adhesives fully resistant to weathering are available for the manufacture of plywood. Lastly using inherently durable wood species or where necessary preservatives for less durable species, plywood can be made to resist the attack by fungi, insects and even by fire.

Strength and Related Properties

Plywood is a compound material of alternate layers of wood and glue and hence possesses different strength and elastic properties according to the direction in which it is stressed. The properties of plywood depend on the quality of the different layers of veneer, the order of position of the layer in the panel, the glue used and the quality control of the manufacturing process.

The tendency of the plywood to warp as a result of uneven shrinking and swelling due to changes in the moisture content is largely eliminated by balanced construction. A substantial balanced effect in the plywood panel may be achieved by having an odd number of plies; for example when three plies are glued together with the grain of the outer two identical plies at right angles to the grain of the core. If the panels are to remain flat, balanced construction is very important. In the same way for certain curved members, the natural effect of cupping of an even number of plies may be made to advantage.

If plywood is to be used as an engineering material, it is required to determine its working stresses. The procedure adopted in this case is similar to that in determining stresses for timber using small clear specimens. The main factors taken into account are reliability of strength, duration of load, factors of safety, moisture content and grade and make-up of veneers.

For plywood in tension and compression, only the effect of the veneers having their grain parallel is considered, as the strength of wood in the direction perpendicular to the grain is relatively low.

In the case of bending in plywood, plies having their grain perpendicular to the span generally contribute little to its stiffness.

The shear strength of plywood depends on the direction in which the shearing force acts whether perpendicular to the veneer surface or parallel to it.

Structural Design

In the design of plywood structural elements, only the plies, having their grain parallel to the direction of the stress are considered. The plies perpendicular are subjected to stress across their grain and therefore can contribute little to the strength of the panel. The error on the safe side involved in ignoring the perpendicular plies is small when plywood is placed so that its face grain is parallel to the span.

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Shear stress in plywood are of two different types. First is the shear perpendicular to the plane of the panel or "Shear through Thickness" for which the full cross-sectional area is considered. The other is occurring in the plane of plies and is termed rolling shear.

The uses in Building Contruction

Plywood, being a remarkably versatile material, is now used at almost every stage of building construction.

As shuttering for concrete, plywood withstands high pressures and abrasion as well as rough handling on site and specially treated surfaces enable it to be re-used many times to produce smooth concrete free from blemishes.

With the development of system building, plywood is used increasingly as a light stressed skin for prefabricated wall and roof panels, The high strength of weight ratio of plywood makes it particularly suitable material for wall sheathing and relatively thin panels will act as diaphragms to distribute vertical and lateral loading on wall. In some countries, there are now several patented plywood beam/floor proof system designed to carry pre-determined loads. Tongued and grooved plywood panels with accurately machined and matched joints are used extensively for flooring, roof cladding, partitioning, wall panels, ceilings and a variety of other applications. The other uses of plywood in building contruction are Box and I beams, rigid frames folded plates, space frames, etc.

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TABLE 4 – SCHEDULE OF DAILY PRODUCTION (100% TIME)

Row	Concrete as a Percentage	labour as a Percentage	A	B	C	D	E	F	G	H	Profit in Dollars
1	100	100	2	2	4	8	34	14	28	116	4590.00
2		95	2	2	4	8	34	14	28	116	4590.00
3		90	2	2	4	8	34	14	28	116	4590.00
4		85	2	2	4	8	34	14	28	116	4590.00
5		80	2	2	4	8	25	14	28	116	4297.50
6		75	2	2	4	8	15	14	28	116	3972.50
7	95	100	2	2	4	8	25	14	28	116	4752.50
8		95	2	2	4	8	25	14	28	116	4752.50
9		90	2	2	4	8	25	14	28	116	4752.00
10		85	2	2	4	8	25	14	28	116	4752.50
11		80	2	2	4	8	25	14	28	116	4752.50
12		75	2	2	4	8	15	14	28	116	3972.50
13	90	100	2	2	4	8	23	14	28	110	4169.50
14		95	2	2	4	8	23	14	28	110	4169.50
15		90	2	2	4	8	23	14	28	110	4169.50
16		85	2	2	4	8	23	14	28	110	4169.50
17		80	2	2	4	8	23	14	28	110	4169.50
18		75	2	2	4	8	15	14	28	116	3972.50
19	85	100	2	2	4	8	15	14	28	116	3972.50
20		95	2	2	4	8	15	14	28	116	3972.50
21		90	2	2	4	8	15	14	28	116	3972.50
22		85	2	2	4	8	15	14	28	116	3972.50
23		80	2	2	4	8	15	14	28	116	3972.50
24		75	2	2	4	8	15	14	28	116	3972.50
25	80	100	2	2	5	8	11	14	28	98	3796.50
26		95	2	2	5	8	11	14	28	98	3796.50
27		90	2	2	5	8	11	14	28	98	3796.50
28		85	2	2	5	8	11	14	28	98	3796.50
29		80	2	2	5	8	11	14	28	98	3796.50
30		75	2	2	5	8	11	14	28	98	3796.50
31	75	100	2	2	6	8	7	14	28	78	3599.50
32		95	2	2	6	8	7	14	28	78	3599.50
33		90	2	2	6	8	7	14	28	78	3599.50
34		85	2	2	6	8	7	14	28	78	3599.50
35		80	2	2	6	8	7	14	28	78	3599.50
36		75	2	2	6	8	7	14	28	78	3599.50

TABLE 5 – SCHEDULE OF DAILY PRODUCTION (EQUAL PERCENTAGES OF TIME AND CONCRETE)

Row	Time and Concrete as a Percentage	Labour as a Percentage	A	B	C	D	E	F	G	H	Profit In Dollars
1	100	100	2	2	4	8	34	14	28	116	4590.00
2		95	2	2	4	8	34	14	28	116	4590.00
3		90	2	2	4	8	34	14	28	116	4590.00
4		85	2	2	4	8	34	14	28	116	4590.00
5		80	2	2	4	8	25	14	28	116	4297.50
6		75	2	2	4	8	15	14	28	116	3972.50
7	95	100	2	2	4	8	31	14	28	101	4335.00
8		95	2	2	4	8	31	14	28	101	4335.00
9		90	2	2	4	8	31	14	28	101	4335.00
10		85	2	2	4	8	31	14	28	101	4335.00
11		80	2	2	4	8	27	14	28	107	4268.00
12		75	2	2	4	8	17	14	28	107	3942.00
13	90	100	2	2	4	8	28	14	28	97	4195.50
14		95	2	2	4	8	28	14	28	97	4195.50
15		90	2	2	4	8	28	14	28	97	4195.50
16		85	2	2	4	8	28	14	28	97	4195.50
17		80	2	2	4	8	28	14	28	97	4195.50
18		75	2	2	4	8	19	14	28	99	3924.00
19	85	100	2	2	6	8	18	21	30	58	3928.50
20		95	2	2	6	8	18	21	30	58	3928.50
21		90	2	2	6	8	18	21	30	58	3928.50
22		85	2	2	6	8	18	21	29	59	3925.25
23		80	2	2	4	8	21	14	28	90	3894.50
24		75	2	2	4	8	21	14	28	90	3894.50
25	80	100	2	2	4	8	21	14	28	72	3705.00
26		95	2	2	4	8	21	14	28	72	3705.00
27		90	2	2	4	8	21	14	28	72	3705.00
28		85	2	2	4	8	21	14	28	72	3705.00
29		80	2	2	4	8	21	14	28	72	3705.00
30		75	2	2	4	8	21	14	28	72	3705.00
31	75	100	2	2	5	8	16	14	28	54	3497.00
32		95	2	2	5	8	16	14	28	54	3497.00
33		90	2	2	5	8	16	14	28	54	3497.00
34		85	2	2	5	8	16	14	28	54	3497.00
35		80	2	2	5	8	16	14	28	54	3497.00
36		75	2	2	5	8	16	14	28	54	3497.00

CONCLUSIONS

Tables 4 and 5 are very useful documents for the site officer who could easily determine the day's target to maximize the company's profits. The approximations made in the percentages in deciding the rows in Tables 4 and 5 could be minimized by having smaller intervals in the percentages.

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