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Design of top concrete slabs of composite space trusses

Ahmed El-Sheikh†

Department of Civil Engineering, University of Dundee, Dundee DD1 4HN, U.K.

Abstract. The design of composite space trusses is a demanding task that involves taking several decisions on the truss depth, number of panels, member configuration, number of chord layers and concrete slab thickness and grade. The focus in this paper is on the design of top concrete slabs of composite space trusses, and in particular their thickness. Several effects must be considered in the process of designing the slab before an optimum thickness can be chosen. These effects include the in-plane forces arising from shear interaction with the steel sub-truss and the flexural and shear effects of direct lateral slab loading. They also include a constructional consideration that the thickness must allow for sufficient cover and adequate space for placing the reinforcement. The work presented in this paper shows that the structural requirements on the concrete slab thickness are in many cases insignificant compared with the constructional requirements.

Key words: space trusses; composite action; design.

1. Introduction

Space trusses are popular ways of spanning large open areas with few intermediate supports. The last four decades saw an expanding interest in their use, mainly due to their pleasant architectural appearance, light weight, easy fabrication and fast erection. Earlier research on space trusses, however, unveiled their tendency to collapse in a brittle and progressive manner in which the buckling of one compression member due to overloading possibly shedding enough force to neighbouring members to trigger their failure and initiate a progressive collapse of the whole structure (Schmidt *et al.* 1980, 1982).

Several techniques have been introduced earlier to alter the brittle nature of space truss behaviour by preventing the overloading, and hence buckling, of critical compression members. One of the most successful of these techniques is based on adding a top concrete slab to the steel truss and developing composite action between the two components (Castillo 1967, Ashraf *et al.* 1993, El-Sheikh and McConnel 1993). With a top composite concrete slab, the truss top chord members are relieved from most of their loads and effectively prevented from buckling, hence making the truss dependent on the ductile properties of its bottom tension members. This technique has become more attractive with the development of simple, yet efficient, practical methods to create the composite action, see Fig. 1 (El-Sheikh 1996a). With these methods, the top chord members are designed to directly carry the weight of wet concrete in addition to the internal forces caused by the action of the truss in the non-composite stage (i.e., under the truss self

† Lecturer

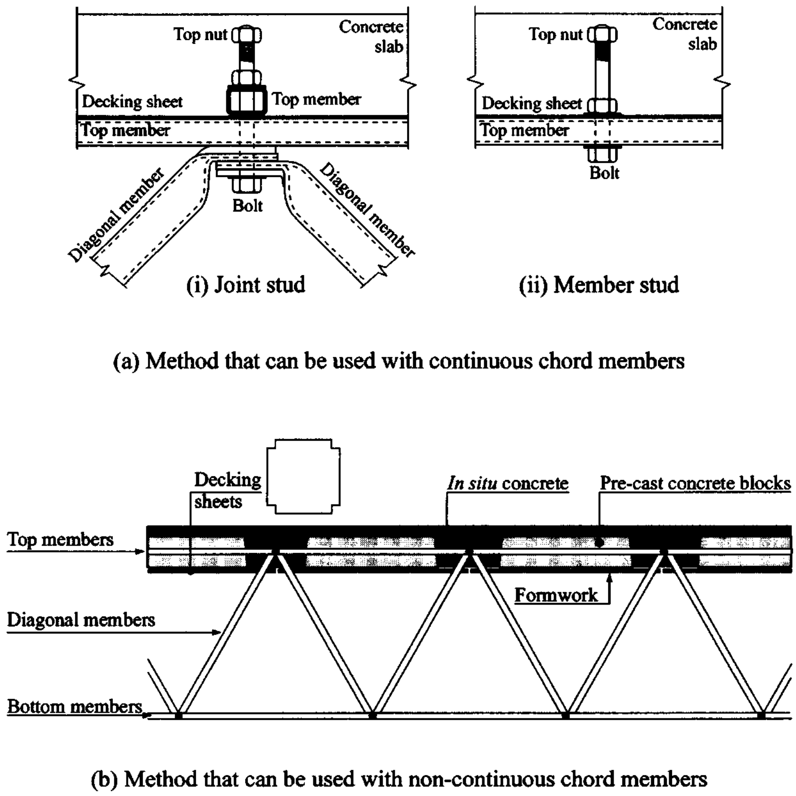


Fig. 1 Methods to create composite action

weight and the construction loads).

The adoption of the composite action has however added another step to the design procedure of space trusses. In addition to all the usual steps of layout design, designers of composite trusses need to choose a slab thickness. The work presented in this paper is intended to help the designer arrive quickly at the optimum slab thickness. The work is designed to study all factors that may influence the choice of slab thickness with the aim of identifying those factors with the maximum effect. Other factors, which could be considered as having a secondary effect, could therefore be safely ignored in the layout design stage.

The factors considered in this study to have some notable effect on slab design are: composite action between the concrete slab and steel truss, flexural and shear effects of lateral slab loading, and the constructional considerations. The study uses both computer-based finite element (FE) analyses and manual theoretical methods, and takes fully into consideration the specifications of British Standards, BS8110, Part 1 (1985). The focus in this study is on space trusses subjected to sagging moments. In other cases under hogging moments (e.g., in regions around internal supports), the tensile stresses expected to develop in the concrete slabs of composite trusses would certainly lead to a different stress distribution (and hence behaviour) from that assumed herein.

2. Finite element analyses

Several composite space trusses have been designed and non-linearly analysed in this study

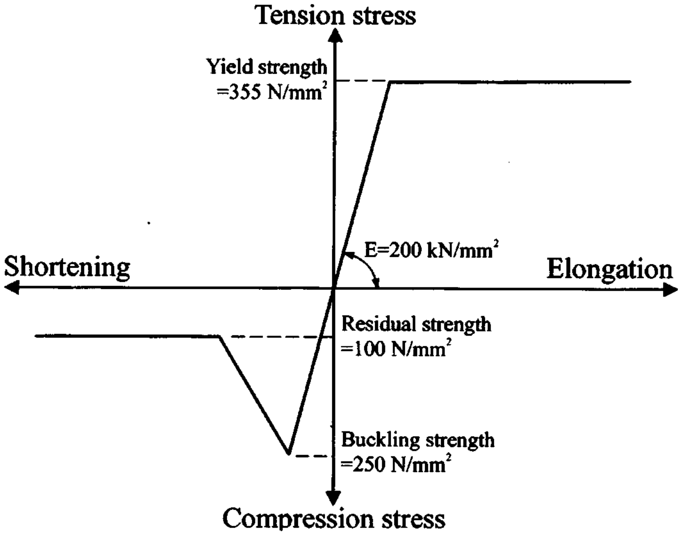


Fig. 2 Member characteristics

using ABAQUS, a finite element software package. In the analyses, truss members are modelled as two-noded elements with no end flexural stiffness, while the concrete slab is modelled with four-noded plate elements with six degrees of freedom per node. The analyses consider both material and geometric non-linearities due to member yielding and buckling, and change of joint co-ordinates. Member characteristics in tension and compression, as found in an earlier work for members with steel grade S355J2H, and slenderness ratio ≈ 75, are adopted in the analyses (El-Sheikh and McConnel 1991), see Fig. 2.

3. Effect of composite action forces on slab design

Due to the composite action, the concrete slab is expected to carry a large percentage of the top chord forces. These primarily compressive forces are transmitted to the slab through the truss top joints.

In the following, a theoretical study conducted to determine the slab thickness required for a specific truss loading (whilst considering only the effect of composite action) is presented. From the axial force and moment equilibrium of the section depicted in Fig. 3, we obtain:

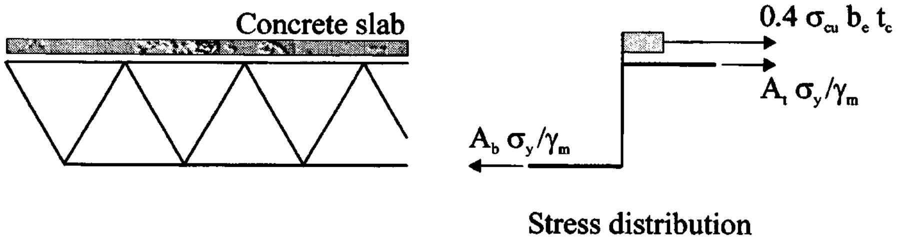


Fig. 3 Internal forces on a space truss cross section

$$0.4\,\sigma_{cu}\, b_e\, t_c + A_t\, \sigma_y/\gamma_m = A_b\, \sigma_y/\gamma_m \tag{1}$$

and

$$M_u = A_b\, \frac{\sigma_y}{\gamma_m}\left(d_s + \frac{t_t}{2} + \frac{t_c}{2}\right) - A_t\, \frac{\sigma_y}{\gamma_m}\left(\frac{t_t}{2} + \frac{t_c}{2}\right) \tag{2}$$

where

A_b and A_t = cross-sectional area of bottom and top chord members
b_e = effective width of concrete slab
d_s = effective depth of steel truss
t_c = thickness of concrete slab
t_t = depth of top chord members
γ_m = material partial safety factor (given in BS8110, Part 1)
σ_{cu} = cube crushing strength of concrete
σ_y = yield stress of steel
M_u = ultimate moment capacity of truss section

Due to the typically small cross-sectional area of top members in composite space trusses and their small contribution to M_u, let:

$$0.4\,\sigma_{cu}\, b_e\, t_c = A_b\, \sigma_y/\gamma_m \tag{3}$$

and

$$M_u = A_b\, \frac{\sigma_y}{\gamma_m}\left(d_s + \frac{t_t}{2} + \frac{t_c}{2}\right) = 0.4\,\sigma_{cu}\, b_e\, t_c\left(d_s + \frac{t_t}{2} + \frac{t_c}{2}\right) \tag{4}$$

Note also that the externally applied moment, M_{ex}, is obtained as

$$M_{ex} = \frac{(W_{slab} + W_{truss} + W_{cover} + W_{L.L.})\, b\, L^2}{D} \tag{5}$$

where

b = total width of truss section
D = factor that corresponds to the truss boundary conditions. For example, in a one-way space truss, D=8 (Schodek 1980)
L = truss span
$W_{L.L.}$ = factored live load
W_{slab}, W_{truss}, W_{cover} = unit factored weight of concrete slab, steel truss and covering material

Notice that $W_{slab}=\gamma_f\, t_c\, \gamma_c$ (where γ_f is the load factor – normally taken as 1.4 according to BS8110, Part 1, and γ_c is the density of concrete), therefore, by equating M_u to M_{ex}:

$$\frac{\gamma_f\, t_c\, \gamma_c\, b\, L^2}{D} + \frac{(W_{truss} + W_{cover} + W_{L.L.})\, b\, L^2}{D} = 0.4\,\sigma_{cu}\, b_e\, t_c\left(d_s + \frac{t_t}{2} + \frac{t_c}{2}\right) \tag{6}$$

therefore

$$(0.2\,\sigma_{cu}\, b_e)\, t_c^2 + \left[0.2\,\sigma_{cu}\, b_e\,(2\,d_s + t_t) - \frac{\gamma_f\, b\, L^2\, \gamma_c}{D}\right] t_c - \frac{(W_{truss} + W_{cover} + W_{L.L.})\, b\, L^2}{D} = 0,$$

and finally let:

$$t_c = \frac{-B \pm \sqrt{B^2 - 4A\,C}}{2A} \tag{7}$$

where

$$A = 0.2\,\sigma_{cu}\,b_e,\; B = 0.2\,\sigma_{cu}\,b_e\,(2d_s + t_t) - \frac{\gamma_f\,b\,L^2\gamma_c}{D},\ \text{and}\ C = -\frac{(W_{truss} + W_{cover} + W_{L.L.})\,b\,L^2}{D}.$$

The value of t_c obtained from Eq. (7) is the concrete slab thickness required to create a balanced composite section. It is also the optimum thickness that can be used in association with W_{truss}, W_{cover} and $W_{L.L.}$, while making the best possible use of material.

3.1. Parametric study 1

In order to evaluate the slab thickness requirements in composite one-way space trusses, a number of space truss pedestrian bridges were designed in this parametric study. The trusses had the following details:
b=2.5m, t_t=0.025m, D=8, factored $(W_{truss}+W_{cover}+W_{L.L.})$=9 kN/m^2, σ_{cu}=30 N/mm^2 and γ_c=25 kN/m^3. The trusses also ranged in span, L, between 5m and 50m with the effective depth d_s being equal to $L/20$ in every case. Using the theoretical analysis presented above, the thicknesses needed to fulfil the requirements of the global composite action are calculated for two cases; with $b_e=b$ and $b_e=3/4b$, respectively, see Fig. 4a. This figure shows clearly that while the slab thickness required grew steadily with the truss span, it remained below 220 mm in all cases.

3.2. Parametric study 2

This study was conducted to determine the slab thicknesses required in composite two-way space trusses with edge supports. For this purpose, a number of square two-way edge-supported

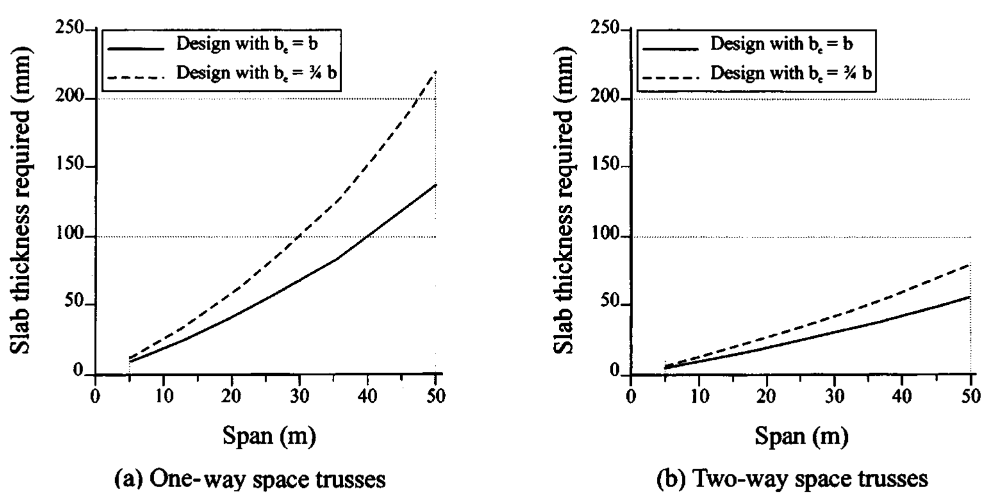


Fig. 4 Slab thicknesses required in composite one- and two-way space trusses involved in Parametric studies 1 and 2

space trusses with the same t_t, W_{truss}, W_{cover}, $W_{L.L.}$, σ_{cu} and γ_c as above, were designed. The trusses ranged in size, $L \times L$, between 5m×5m and 50m×50m. In each case, the effective depth d_s was equal to $L/20$. Further, D was taken in this study as 16 according to the findings of the earlier research carried out by El-Sheikh (1996b).

The slab thicknesses required for all trusses involved are plotted in Fig. 4b for two cases; with $b_e=b$ and $b_e=3/4b$. The figure shows that the maximum slab thickness needed was 80 mm for a truss span of 50m. The thickness requirements also reduced progressively with decreases in truss span, as would be expected.

3.3. Parametric study 3

While the theoretical analysis presented above is quite useful in determining the slab thickness required for one-way trusses and two-way trusses with edge supports, it cannot be used in situations involving corner supports or where truss serviceability is to be considered. For this reason, a third parametric study based on the finite element method was conducted to cover these areas. The study was non-linear and involved twenty seven space trusses designed to cover three main parameters, namely:

(1) Boundary conditions; with corner and edge supports
(2) Structural action; with one-way and two-way structures
(3) Slab thickness; from 25 mm to 200 mm.

While one-way trusses were 40m×5m×2m and supported along their two short edges, the two-way trusses were 40m×40m×2m, and were either corner- or edge-supported. All trusses were composed of panels of 2.5m×2.5m.

All trusses were designed under the following externally applied factored loads: $W_{truss}=1.4\times0.35$ kN/m^2, $W_{cover}=1.4\times0.35$ kN/m^2 and $W_{L.L.}=1.6\times5.0$ kN/m^2, in addition to the factored weight of the concrete slab which varied according to its thickness. In each case, the truss initial stiffness and strength were recorded as shown in Tables 1 to 3. Also, the sum of the weight of steel truss and concrete slab was calculated and subtracted from the truss strength to obtain the effective load carrying capacity of the truss. The tables also give the deflections under the truss working loads

Table 1 Strength and stiffness of one-way space trusses with 40m span, 5m width and 2m depth

Slab thickness (mm)	Strength (kN/m^2)	Initial stiffness (kN/mm)	Factored load (kN/m^2)		Strength-unfactored (W_{truss}+W_{slab}) kN/m^2	deflection under working load (mm) (Propped construction)
			Factored W_{truss}+W_{slab}	Factored $W_{L.L.}$+W_{cover}		
25	7.920	8.925	1.4×(0.350+0.625)	1.6×5.000+1.4×0.350	6.945	141.7
50	12.427	11.459	1.4×(0.350+1.250)	1.6×5.000+1.4×0.350	**10.827**⁺	121.3
75	12.478	12.832	1.4×(0.350+1.875)	1.6×5.000+1.4×0.350	10.253	**118.1**⁺
100	12.525	13.686	1.4×(0.350+2.500)	1.6×5.000+1.4×0.350	9.675	119.8
125	12.539	14.257	1.4×(0.350+3.125)	1.6×5.000+1.4×0.350	9.064	123.8
150	12.553	14.649	1.4×(0.350+3.750)	1.6×5.000+1.4×0.350	8.453	129.0
175	12.563	14.980	1.4×(0.350+4.375)	1.6×5.000+1.4×0.350	7.838	134.5
200	**12.576**⁺	**15.209**⁺	1.4×(0.350+5.000)	1.6×5.000+1.4×0.350	7.226	140.7

Note: + Optimum values in strength and stiffness columns are shown in bold style.

Table 2 Strength and stiffness of two-way corner-supported space trusses with size 40m×40m×2m

Slab thickness (mm)	Strength (kN/m^2)	Initial stiffness (kN/mm)	Factored load (kN/m^2)		Strength-unfactored (W_{truss}+W_{slab}) kN/m^2	Deflection under working load (mm) (Propped construction)
			Factored $W_{truss}+W_{slab}$	Factored $W_{L.L.}+W_{cover}$		
25	7.762	45.080	1.4×(0.350+0.625)	1.6×5.000+1.4×0.350	6.787	224.5
50	11.438	60.530	1.4×(0.350+1.250)	1.6×5.000+1.4×0.350	9.838	183.7
75	13.136	69.836	1.4×(0.350+1.875)	1.6×5.000+1.4×0.350	10.911	173.6
100	13.800	76.083	1.4×(0.350+2.500)	1.6×5.000+1.4×0.350	10.950	**172.4⁺**
125	14.445	80.349	1.4×(0.350+3.125)	1.6×5.000+1.4×0.350	**10.970⁺**	175.7
150	14.877	83.738	1.4×(0.350+3.750)	1.6×5.000+1.4×0.350	10.777	180.6
175	15.337	86.215	1.4×(0.350+4.375)	1.6×5.000+1.4×0.350	10.612	187.0
200	**15.680⁺**	**88.246⁺**	1.4×(0.350+5.000)	1.6×5.000+1.4×0.350	10.330	194.0

Note: + Optimum values in strength and stiffness columns are shown in bold style.

Table 3 Strength and stiffness of two-way edge-supported space trusses with size 40m×40m×2m

Slab thickness (mm)	Strength (kN/m^2)	Initial stiffness (kN/mm)	Factored load (kN/m^2)		Strength-unfactored (W_{truss}+W_{slab}) kN/m^2	Deflection under working load (mm) (Propped construction)
			Factored $W_{truss}+W_{slab}$	Factored $W_{L.L.}+W_{cover}$		
25	13.331	83.989	1.4×(0.350+0.625)	1.6×5.000+1.4×0.350	**12.356⁺**	120.5
50	13.717	94.929	1.4×(0.350+1.250)	1.6×5.000+1.4×0.350	12.117	**117.1⁺**
75	13.773	99.397	1.4×(0.350+1.875)	1.6×5.000+1.4×0.350	11.548	121.9
100	13.875	101.763	1.4×(0.350+2.500)	1.6×5.000+1.4×0.350	11.025	128.9
125	13.910	103.416	1.4×(0.350+3.125)	1.6×5.000+1.4×0.350	10.435	136.5
150	13.940	104.435	1.4×(0.350+3.750)	1.6×5.000+1.4×0.350	9.840	144.8
175	14.127	105.127	1.4×(0.350+4.375)	1.6×5.000+1.4×0.350	9.402	153.3
200	**14.272⁺**	**105.751⁺**	1.4×(0.350+5.000)	1.6×5.000+1.4×0.350	8.922	161.9

Note: + Optimum values in strength and stiffness columns are shown in bold style.

for the propped construction case.

The results presented in Tables 1 to 3 show clearly that while truss strength increased progressively with thicker slabs, the effective load carrying capacity started to degrade beyond a small thickness in the range of 25 to 125 mm according to the truss boundary conditions. Beyond this range, the additions to truss weight caused by the larger slab thicknesses outweighed the corresponding strength increases. Note also must be made that with more supports, the slab thickness requirements decreased due to the better distribution of truss internal forces.

The results also show that while truss stiffness improved with thicker slabs, the central deflections recorded under the truss working load (including the weight of the slab) was lowest when the slab thickness was between 50 and 100 mm. With thicker slabs, the truss stiffness increased progressively, but the associated increase in truss total load was more significant, and led to an overall adverse effect on truss deformations. For instance, the central deflection of a truss with a 200 mm concrete slab under the total working load exceeded that of a truss with a

75 mm slab by 19%, 12% and 32% in the three cases studied, respectively.

4. Flexural effects of lateral slab loading

The top concrete slabs of composite space trusses also come under the flexural effects of direct lateral loads. In this case, the slab is treated as a series of individual rectangular panels, supported along all four edges by truss top chord members, and continuous across all supports. The loads applied directly on slab panels include the slab self weight in addition to the weight of any covering material and the live load.

The maximum flexural moments produced by the slab lateral loads can be calculated as follows (according to Young 1989):

$$M_{max}^{-ve} \text{ at centre of long edge} = \frac{-\beta_1 q\, b_p^2}{6},$$

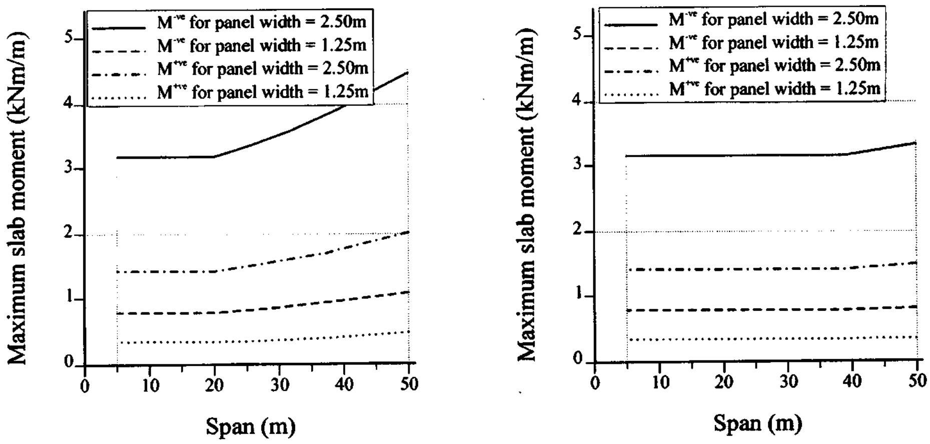
$$M_{max}^{+ve} \text{ at centre of slab panels} = \frac{+\beta_2 q\, b_p^2}{6} \qquad (8)$$

where q=factored (W_{slab}+W_{cover}+$W_{L.L.}$), and b_p=the largest side length of the slab panel. The values of constants β_1 and β_2 (which depend only on the aspect ratio of the slab panel) can be found in Young (1989).

4.1. Parametric study 4

In order to evaluate the flexural effects of lateral slab loading, attention is given in this study to the space trusses designed in Parametric studies 1 and 2. In this case, q= factored (W_{cover}=1.4×0.35 kN/m^2)+($W_{L.L.}$=1.6×5.0 kN/m^2) in addition to the factored slab weight which depended on its thickness. Two panel sizes were considered: 1.25m×1.25m and 2.5m×2.5m.

For every span considered between 5m and 50m, the thickness required by the composite action



(a) One-way space trusses (b) Two-way space trusses

Fig. 5 Flexural moments due to slab lateral loading in composite space trusses

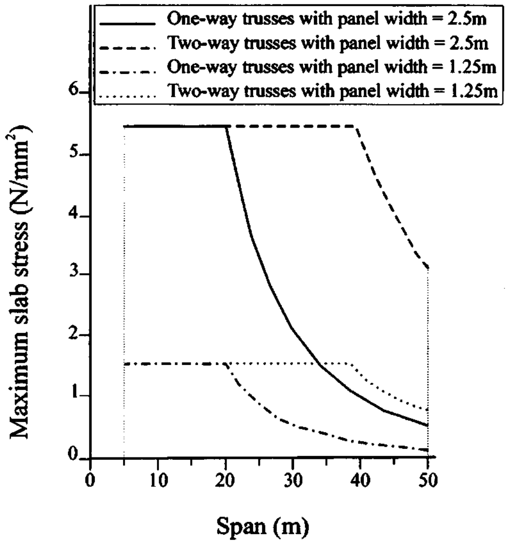


Fig. 6 Maximum stresses due to slab lateral loading in composite space trusses

(and shown in Fig. 4) for b_e=3/4 b, was used to determine the value of q, and hence the maximum moments using Eqs. (8). Note however that in cases involving a slab thickness below 60 mm, the thickness was increased to this value for practical reasons.

The results of this study are plotted in Fig. 5, which illustrates a number of findings:

1. Slabs with larger panel sizes had larger values of maximum moments.
2. As the truss span increased, the slab thickness required increased, and hence the total slab load grew, leading to higher slab moments.
3. The hogging moments along the edges of slab panels were higher than the sagging moments acting at the slab central regions.

Further, in an attempt to determine whether the maximum moments depicted in Fig. 5 can cause cracking in the slab, the maximum tensile stresses in the slab arising from an assumed linear distribution of stress were calculated and plotted in Fig. 6. It can be seen from this figure that in trusses with a panel width of 1.25m, the stresses were quite low ($\leq$ 1.6 N/mm^2), and would not be expected to cause cracking in the slab. However, the stresses associated with a panel width of 2.5m were high enough to cause cracking (and would therefore necessitate the use of reinforcement), but nevertheless, they were by no means serious. Also note that the highest stresses recorded were associated with a slab thickness of 60 mm. With a 2.5m-panel width, a much larger thickness would be necessary to accommodate the two meshes of reinforcement needed (to control cracking), and it is expected that the stresses will be reduced considerably.

5. Shear effects of lateral slab loading

Slab lateral loads also produce shear effects that may need to be considered. In the majority of cases involving a uniformly distributed slab load, the shear effects at the slab-support interface are typically much less critical than the load flexural effects. (For instance, the maximum shear stresses caused by the lateral load on the slabs of all trusses designed in Parametric studies 1 and 2 are between 0.05 and 0.16 N/mm^2) It is only when the slab is subjected to heavy concentrated loads that shear (and in particular punching shear) becomes a possible failure mode that must be considered. This type of load is most likely to develop in bridge structures subjected to vehicle wheel loads.

According to BS8110, Part 1, the maximum punching shear stress, v_{max} (due to a concentrated shear force, V) which can be determined as:

$$v_{max} = \frac{V}{(u_o = \text{perimeter of loaded area})\ (d_c = \text{effective depth of slab})} \tag{9}$$

should not exceed $0.8\sqrt{\sigma_{cu}}$ or 5 N/mm^2.

The value of v_{max} should not also exceed $v_c = \dfrac{0{,}79}{\gamma_m}\left(\dfrac{100A_s}{b_v\, d_c}\right)^{1/3}\left(\dfrac{400}{d_c}\right)^{1/4}$ in order to avoid using expensive slab shear reinforcement. Notice that A_s is the cross-sectional area of steel reinforcement crossing the failure surface, b_v is the breadth of punching shear failure surface, and $(100A_s/b_v d_c)$ should not be taken greater than 3 according to BS8110, Part 1.

The worst case of a slab under a heavy concentrated load is probably in a bridge carrying 40-ton vehicles. In this case, the slab needs to be designed for individual wheel loads of 100 kN acting on an area of 300 mm$\times$300 mm (Scottish Office 1984). If concrete with grade 40 is used, the minimum slab thickness required would be about 110 mm, such that the average slab effective depth $\approx$ 70 mm. Therefore:

$$v_{max} = \frac{100\times 10^3}{4\times 300\times 70} = 1.19\ \text{N/mm}^2,$$

which is less than $0.8\ \sqrt{40}$=5.06 N/mm^2 and 5 N/mm^2, and is almost equal to v_c=1.17 N/mm^2 (based on a value of $\dfrac{100A_s}{b_v\, d_c} = 3$).

Further, punching shear stresses become much less critical if the slab is covered with an adequate surfacing layer (usually made of Asphalt) which normally allows an internal load distribution at a slope of 1 vertical to 2 horizontal. Therefore, for the same slab studied earlier, if a surfacing layer of 100mm thickness is to be used, the effective loading area on the slab would grow to 400$\times$400 mm. This loading area would subsequently lead to a smaller required effective depth of 50 mm which produces a v_{max} of 1.25 N/mm^2 (note that v_c in this case=1.27 N/mm^2).

6. Overall discussion

The work presented above shows clearly that in composite space truss applications involving only UD loading (e.g., in floors and roofs of buildings), the slab thickness requirements due to global composite action much outweigh the requirements due to the effects of direct lateral slab load. In such circumstances, it is reasonable to assume that the slab thickness will be entirely in compression, or at least safe from tensile cracking, especially if the truss top panels are relatively small ($\approx$ 1.25m or less). This assumption could simplify the design procedure of the top slabs in two ways: (1) the design could be focused (at least initially) on the global composite action analysis stage, and (2) a small slab thickness could be used with only one middle mesh of reinforcement needed to resist shrinkage and creep cracking.

However, in trusses involving a panel size larger than 1.25-1.5m, considerable tensile stresses could arise due to the flexural effects of lateral slab loading, leading to a requirement to use two meshes of reinforcement. Even in such situations, the thickness requirements due to the effect of composite action are still predominant, but the thickness used ought to be at least large enough to accommodate the two meshes of reinforcement needed.

Overall, it appears that the constructional requirement (that a slab thickness should accommodate the steel meshes and their cover) outweigh the structural requirements in many situations. For instance, in trusses with a panel width=1.25m, and where one mesh of reinforcement could be sufficient, the minimum slab thickness needed would be about 60mm, which is above the structural requirements of one- and two-way trusses up to spans of 20m and 39m, respectively. If, however, the trusses were to adopt a panel width of 2.5m, two meshes of reinforcement would be necessary, leading to a minimum slab thickness of about 125 mm (to accommodate four layers of bars of diameter $\geq$10 mm and two layers of cover of thickness $\geq$20 mm), which exceeds the structural requirements of all two-way trusses covered herein, and those of one-way trusses up to a span of 35m.

Finally, if the truss top slab is to be subjected to heavy concentrated loads, as in bridge applications, two meshes of reinforcement must be used to help prevent punching and the almost inevitable high tensile stresses at the slab outer fibres. The slab thickness requirements in this case (whether or not a surfacing layer is used), are, however, still below the minimum needed to accommodate the necessary reinforcement meshes, and therefore the focus in these situations should again be on the global composite action and the constructional requirements.

7. Conclusions

From the work presented in this paper, the following conclusions can be drawn:

(1) In composite space trusses under UDL, the slab thickness requirements due to the composite action outweigh those due to the effects of slab lateral loading.

(2) In applications involving only a UDL and a small panel size ($\leq$1.25m), a slab with one intermediate steel mesh could be sufficient, otherwise, two steel meshes would be necessary with larger panel sizes.

(3) The normal stresses caused by the flexural effects of direct lateral slab loading are so low that, when combined with the effects of global composite action, they may not be sufficient to produce any tensile cracking in the slab.

(4) The slab shear stresses resulting from UDL in composite space trusses are usually negligible.

(5) The design of top slabs of composite space trusses is best conducted along the following sequential steps:

- The number of reinforcement layers is chosen according to the panel size and type of loading. If the panel width exceeds 1.25-1.5m and/or heavy concentrated loads are expected, two meshes of reinforcement would be needed, otherwise, one would be sufficient.
- The number of reinforcement meshes is then used to determine the minimum slab thickness required to accommodate them. Note that the thickness of cover is controlled only by the severity of the truss working environment, and is determined according to BS8110, Part 1 (1985).
- This thickness is finally used in a full truss analysis, and could be increased according to the requirements of the truss global composite action.

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