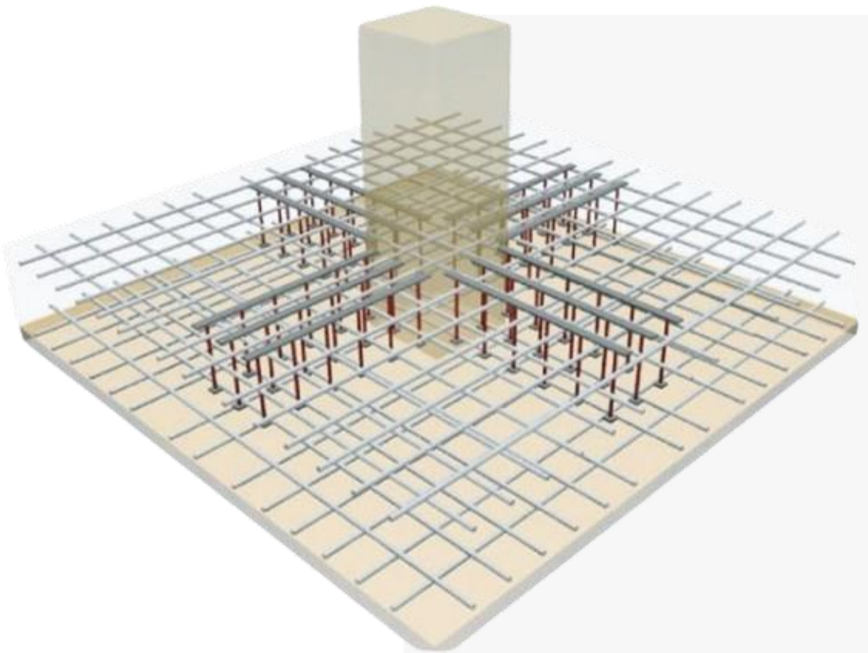
스터드스트립(옥타곤-SF)

STUDSTRIP



두꺼운 슬래브 | 기초 전단보강 공법

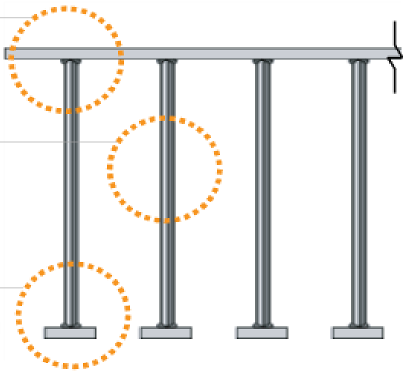
JINHOON ENGINEERING

충북 충주시 충주산단2로 106, 2층
043.724.3009
070.8611.3013

스터드스트립(옥타곤-SF) Studstrip

스터드스트립 공법 개요

시어스터드를 일정한 간격으로 스트립바에 용접하여 제작한 것으로 두께가 400m이상 두꺼운 슬래브 또는 기초매트 전단보강에 적용



[스터드스트립의 소재 물성치]

요구성능 Physical Requirements	시어스터드	시어정착헤드
항복강도 Yielding strength	400 MPa (min.)	275 MPa (min.)
인장강도 Tensile strength	540 MPa (min.)	410 MPa (min.)

[스터드스트립의 제품규격]

(단위 : mm, mm²)

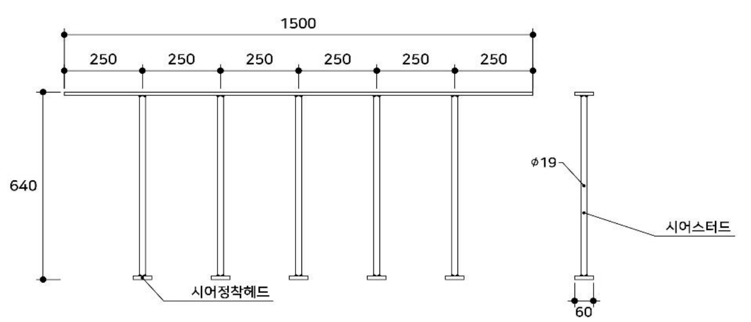
시어스터드			사각형 헤드		원형 헤드		시어정착헤드 형태
규격	지름	단면적	치수	두께(t)	지름	두께(t)	
R19	19.0	283.5	50(60)x60	12	60	15	
R18	18.0	254.4	50x55	12	60	15	사각형 원형

스터드스트립의 제품사양 표기방법

제품사양 스터드스트립, Ns ① - Rn ② - P ③ - H ④ - L ⑤

① Ns : 시어스터드 개수(q' ty)
② Rn : 시어스터드 호칭지름(mm)
③ P : 시어스터드 간격(mm)
④ H : 제품 높이(mm)
⑤ L : 제품 길이 (mm)

제품사양 표기 예

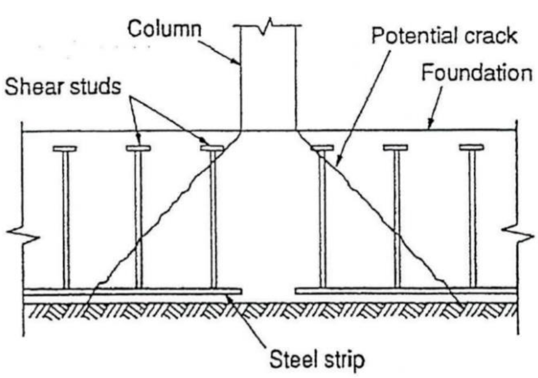


스터드스트립(옥타곤-SF)
5 - R19 - 250 - 640 - 1500

스터드스트립(옥타곤-SF) Studstrip

구조기준

+ 건축구조기준(KBC2016), 0507.12.5 확대머리 전단스터드 설계
+ ACI318-08 구조기준, 2-Way슬래브/매트 전단보강 설계방법 채택
+ ACI STRUCTURAL JOURNAL TECHNICAL PAPER (Title no. 96-S60) 기초 및 옹벽 전단보강,
  시어스터드 전단보강공법 적용 권장.



a) Vertical section in a raft foundation

Other applications of stud shear reinforcement

Stud shear reinforcement can be used and designed using the above equations to resist punching in raft foundations, footings, and in walls subjected to concentrated horizontal forces (e.g., offshore structures). Fig. 13(a) represents the arrangement of shear studs in the vicinity of a column in a raft foundation; the studs are mechanically anchored by heads at the top and by a steel strip at the bottom similar to Fig. 1(c).

Fig. 13(b) shows arrangement of shear studs with respect to other reinforcement in a wall. The figure can represent a vertical or a horizontal section. It is to be noted that the studs have double heads situated in the same plane as the outermost flexural reinforcement. Thus, the overall length of the studs, including the heads, should ideally be equal to the wall thickness minus the sum of the specified cover at the two wall faces.

ACI STRUCTURAL JOURNAL TECHNICAL PAPER (Title no. 96-S60)

ACI STRUCTURAL JOURNAL TECHNICAL PAPER
Title no. 96-S60

Design for Punching Shear Strength with ACI 318-95

by Amin Ghali and Sami Megally

Brittle punching failure of flat plates can occur due to the transfer of shearing forces and unbalanced moments between slabs and columns. Design of connections of columns to flat plates to insure safety against punching failure is presented. This paper covers the design procedure in most practical situations, including interior, edge, and corner columns; prestressed and nonprestressed slabs; slabs with openings; and slabs with shear reinforcement. The ACI 318-95 Building Code requirements are adhered to where applicable. Numerical examples are presented to demonstrate the design procedure. Seismic design considerations are not discussed in this paper.

Keywords: columns (supports); connections; flat concrete plates; prestressed concrete; punching shear; raft foundations; reinforced concrete; shear strength; slabs; structural design.

INTRODUCTION

The punching shear resistance of concrete flat plates frequently needs to be increased by the provision of drop panels or by shear reinforcement. The latter solution is more acceptable architecturally, and is often more economical. This paper gives the details of punching shear design of flat plates without drop panels, with or without shear reinforcement. Requirements of the ACI 318-95[1] Building Code for design of slabs against punching are reviewed. The design steps are presented, adhering to the code requirements when they apply. Most conditions that occur in practice are considered for slabs with or without prestressing, including slabs with openings in the column vicinity. Interior, edge, and corner column-slab connections subjected to shear and moment transfer are considered. The design steps are demonstrated by computed examples. This paper presents a complete design procedure for punching shear. Reference is made to an available computer program that can be used for the design. When drop panels are used, the design procedure for flat plates applies with an additional provision that is also discussed.

The ACI 318-95[1] Building Code allows the use of shear heads, in the form of steel I- or channel-shaped sections, as shear reinforcement in slabs. Because at present this type is rarely used, it will not be discussed here. The two most common types of shear reinforcement are shown in Fig. 1. To save space in this paper, the arrangements of the reinforcement with the two types are shown in a single top view in Fig. 1(a). Fig. 1(b) and (c) are a pictorial view and a cross section showing, respectively, details of conventional stirrups and stud shear reinforcement (SSR). The vertical legs of the stirrups or the stems of the studs intersect the shear cracks and prevent their widening (Fig. 2). Because the intersection can occur at any section of the stirrup leg or the stud stem, the leg or the stem should be as long as possible and must be anchored as closely as possible to the top and bottom surfaces of the slab (observing the cover requirements for corrosion and fire protection).

Effective anchorage is essential to develop the yield strength of the shear reinforcement of both types. With stirrups [Fig. 1(b)], the anchorage is provided by hooks, bends, and the longitudinal flexural reinforcing bar lodged at the corners. Before the force in a stirrup leg reaches its yield strength, the concrete inside the hooks or bends crushes or splits, causing slip, thus preventing development of the full strength of the stirrup,

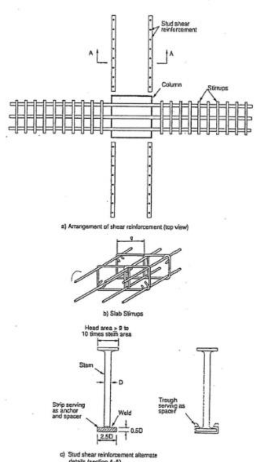


Fig. 1—Types of shear reinforcement considered: (a) shear reinforcements (top view); (b) stirrups; and (c) stud shear reinforcement alternate details (Section A-A).

ACI Structural Journal, V. 96, No. 4, July-August 1999.
Received October 13, 1997, and reviewed under Institute publication policies. Pertinent discussion will be published in the May-June 2000 *ACI Structural Journal* if received by January 1, 2000.

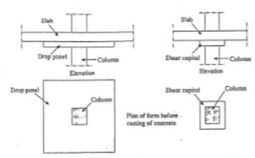


Fig. 12—Drop panels and shear capitals.

Step 4—Select 3/8-in.-diameter studs with the arrangement shown in Fig. 11(b).

$v_u/\phi = 355$ psi $< 6\sqrt{f'_c}$ (= 379 psi); $s_o \le 0.5d$; $s \le 0.75d$. Select $s_o = 2.25$ in.; $s = 4$ in.; $A_v = 1.104$ in.^{2}; $v_s = 180$ psi [Eq. (9)].

$v_c = 190$ psi [Eq. (13)].

$v_n = 190 + 180 = 370$ psi $< 8\sqrt{f'_c}$ (= 506 psi) [Eq. (12)].

$v_u < \phi v_n$ (= 315 psi); shear reinforcement is adequate.

Step 5—Properties of the critical section at $d/2$ from the outermost peripheral line of shear studs:

$b_o = 204.5$ in.; $I_x = 843.6 \times 10^3$ in.^{4}; $I_y = 635.0 \times 10^3$ in.^{4}; $I_{xy} = -80.99 \times 10^3$ in.^{4}.

The projections of critical section on principal axes x and y are 73.7 in. and 78.7 in., respectively. Eq. (16) and (17) give: $\gamma_{vx} = 0.408$; $\gamma_{vy} = 0.392$. The coordinates of column centroid are (-3.8, -2.2) in. Statical equivalent forces at critical section centroid are: $V_u = 110$ kip; $M_{ux} = 158$ kip-in.; and $M_{uy} = -168$ kip-in. Following the same procedure as for the critical section at $d/2$ from column face, the maximum shear stress $v_u = 98$ psi $< 2\phi\sqrt{f'_c}$ (= 108 psi). This indicates that the extension of the shear-reinforced zone is adequate [Fig. 11(b)].

Circular columns

The punching shear design steps described earlier in this paper are applicable for connections of slabs with circular columns. The circular column cross section is replaced by a square section so that the critical section at $d/2$ from the square column face will have the same perimeter length as for the critical section for the circular column.

Slabs with drop panels and shear capitals

A common solution used in practice to augment the punching shear strength of slab-column connections is to increase the slab thickness around the columns; this can be achieved by use of drop panels [Fig. 12(a)]. When drop panels are used, two critical sections must be investigated for punching shear strength, at $d_1/2$ from column face and at $d_2/2$ outside the drop panel, where d_1 and d_2 are effective depths of the slab inside and outside the drop panel, respectively. The two critical sections are checked following the design steps mentioned earlier. Plan dimensions are selected so that Eq. (1) is satisfied at the critical section outside the drop panel with v_c determined by Eq. (15) and $v_n = v_c = 2\sqrt{f'_c}$.

Fig. 12(b) shows what is known in practice as shear capital. It differs from drop panel in the plan dimensions. The shear capital is commonly small in size and is provided with no reinforcement other than the vertical bars of the column. The punching design is based on a critical section at $d/2$ outside the shear capital with the nominal shear stress v_n given by Eq. (4) to (6). Recent experiments[18] show that the punching failure with this type

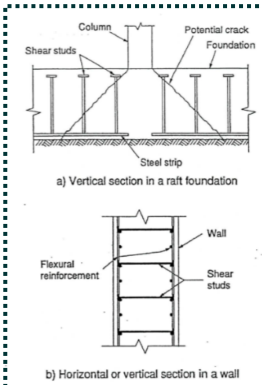


Fig. 13—Arrangement of shear studs in raft foundations and

of capitals can be extremely brittle; therefore, this practice is not recommended by the authors.

Other applications of stud shear reinforcement

Stud shear reinforcement can be used and designed using the above equations to resist punching in raft foundations, footings, and in walls subjected to concentrated horizontal forces (e.g., offshore structures). Fig. 13(a) represents the arrangement of shear studs in the vicinity of a column in a raft foundation; the studs are mechanically anchored by heads at the top and by a steel strip at the bottom similar to Fig. 1(c).

Fig. 13(b) shows arrangement of shear studs with respect to other reinforcement in a wall. The figure can represent a vertical or a horizontal section. It is to be noted that the studs have double heads situated in the same plane as the outermost flexural reinforcement. Thus, the overall length of the studs, including the heads, should ideally be equal to the wall thickness minus the sum of the specified cover at the two wall faces.

CONCLUSIONS

A complete design procedure for slab-column connections against punching shear is presented. This design procedure satisfies the requirements of the ACI 318-95 Building Code. Equations based on research are used in the design procedure of practical design situations not covered by the ACI 318-95 Code. Design examples are presented. The design can be simplified by use of an available computer program.

스터드스트립(옥타곤-SF) Studstrip

스터드스트립의 경제성 비교분석

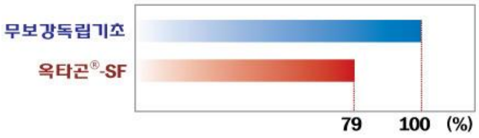
[설계 조건]

기둥 크기	기초 주근	q_a	f_{ck}	무보강 기초	스터드스트립 전단보강
500x700mm²	D22 (fy=400MPa)	200kN/㎡	24MPa	보강 전 두께 = 700mm	보강 후 두께 = 550mm

기초 두께 & 콘크리트량 & 터파기량

경제성 고려 시	21% 감소
기초 두께 최대 감소량	30% 감소

→ 스터드스트립 적용시 공사비 10% 이상 절감 가능



[경제성 고려 시 두께 감소 효과]

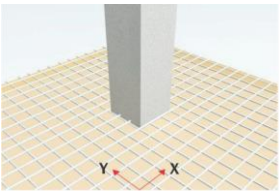
스터드스트립 공법의 장점 | 기초 두께 감소에 따른 친환경성 증대 및 기초 물량의 최적화 실현, 공사비 절감

터파기량 감소 → 기초공사 기간 감소 암반 파쇄량 감소 → 지하수 유출 최소화 소음 공해 최소화

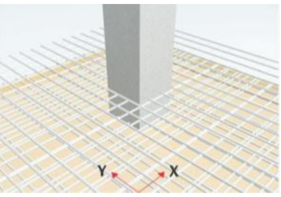
스터드스트립 시공방법

시공방법 A

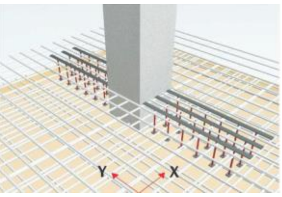
STEP ①
기초 하부철근 배근



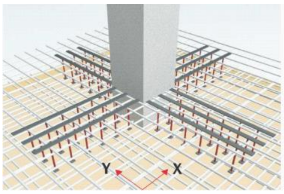
STEP ②
기초 상부철근 배근



STEP ③
옥타곤-SF
설치위치 확인 후,
뒤집어서 설치
(X, Y방향)

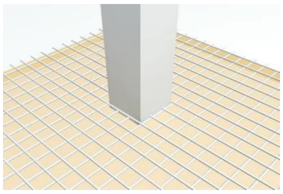


STEP ④
주 철근과
결속하여 설치완료

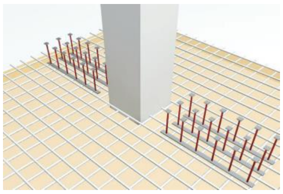


시공방법 B

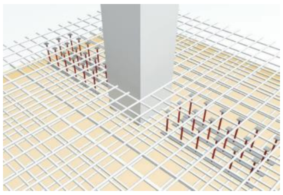
STEP ①
기초 하부철근 배근



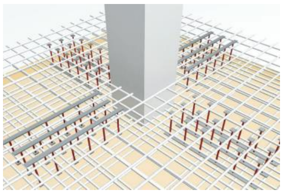
STEP ②
기초 하부철근 중
아래쪽 철근 위에
스터드스트립을
세워서 결속하여 설치



STEP ③
기초 상부철근 배근



STEP ④
하부철근에 설치한
스터드스트립과
직교하도록 상부철근
위에 뒤집어서
설치 후 결속



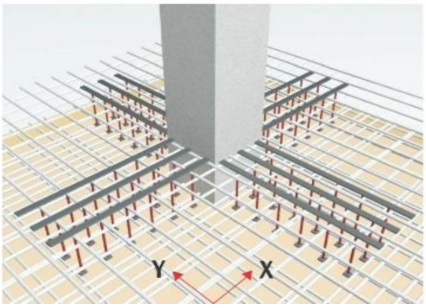
스터드스트립(옥타곤-SF) Studstrip

스터드스트립의 경제성 비교분석

- 기초 휨 철근 배근 완료 후 설치하므로 철근 공정과 간섭 없음
- 타워크레인 등 장비지원 없이 수작업 설치

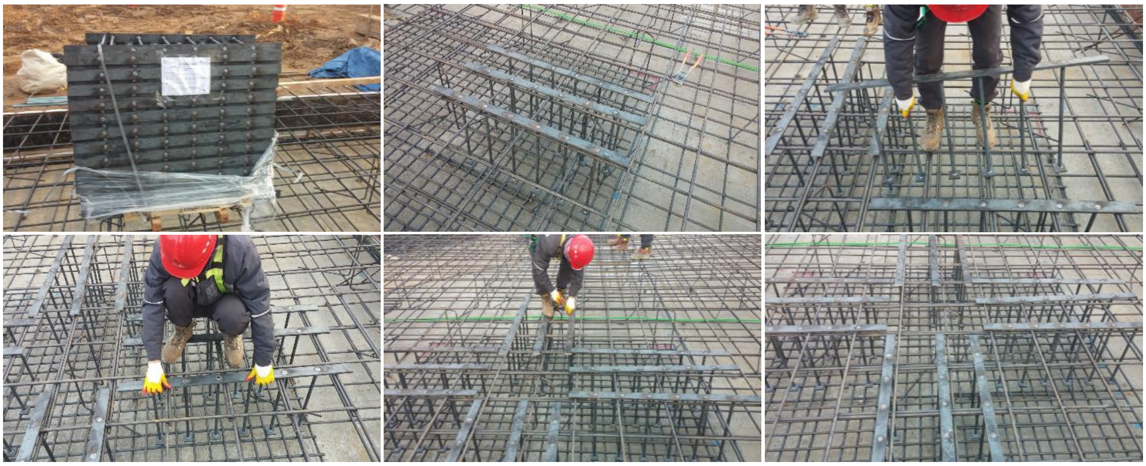
장비지원 없이 시공

수작업 설치 가능
제품 크기 및 무게



시공사례 | 판교엔스퀘어 (포스코건설)

시공사례 | 평택송담힐스테이트 (현대건설)



JINHOON ENGINEERING

전단보강재 제작 및 납품

충북 충주시 충주산단2로 106, 2층 (27326)
Tel. 043-724-3009
Fax. 070-8611-3013
www.jinhooneng.kr

옥타곤엔지니어링 OCTAGON ENGINEERING

전단보강재 엔지니어링서비스 및 기술지원

경기 성남시 중원구 상대원동 둔촌대로 484, 8층(13299)
Tel. 031-777-9707
Fax. 031-777-9708
www.octagon.kr