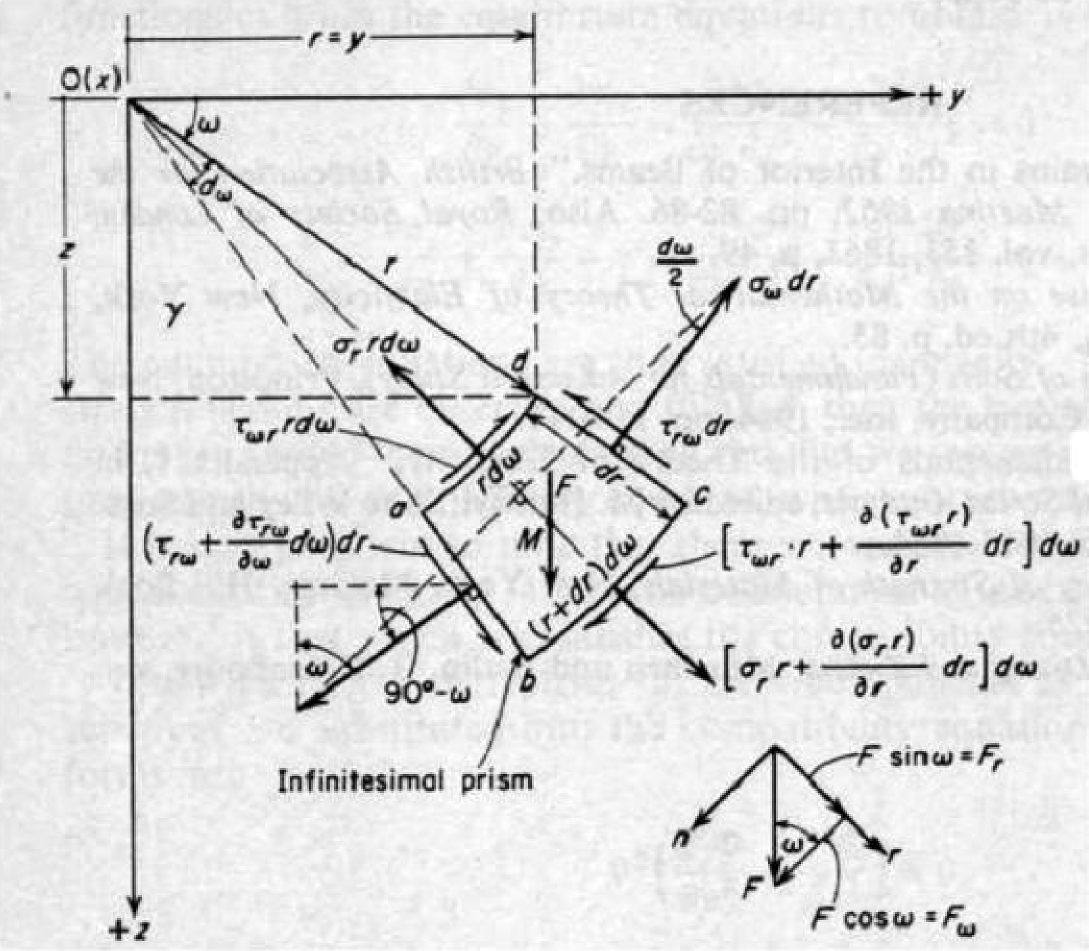
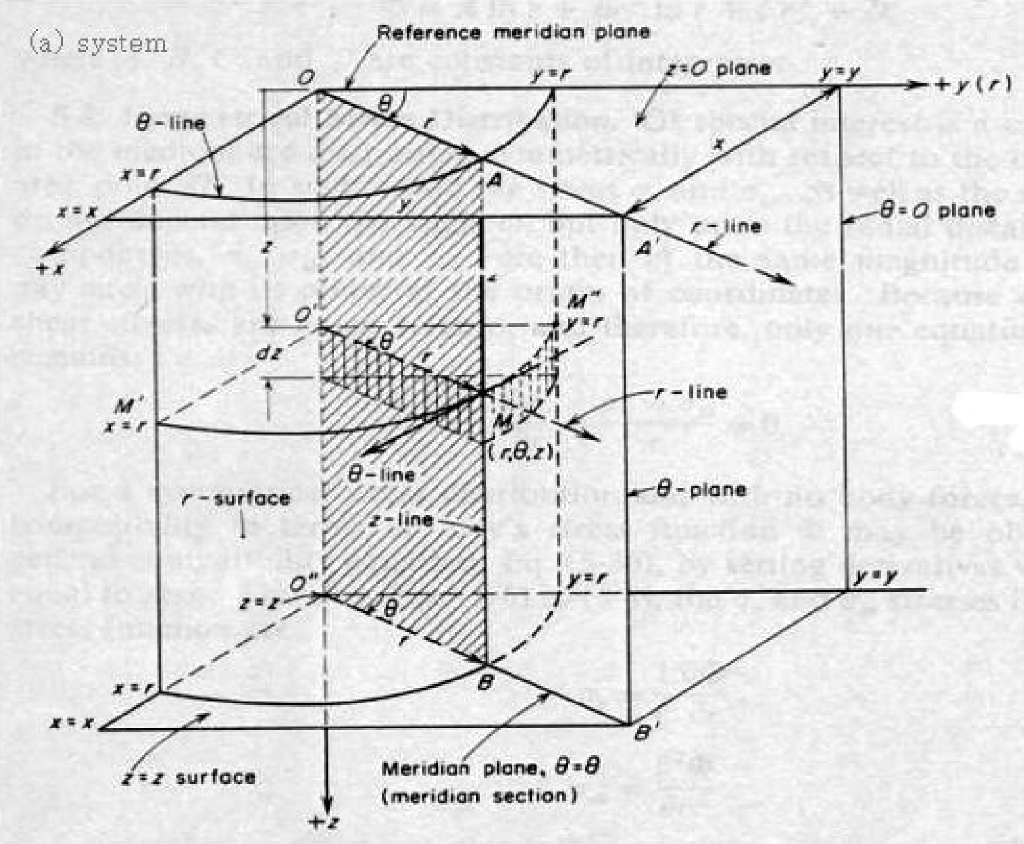
Lecture 6 보충자료 *#1*

2-D/3-D coordinate systems

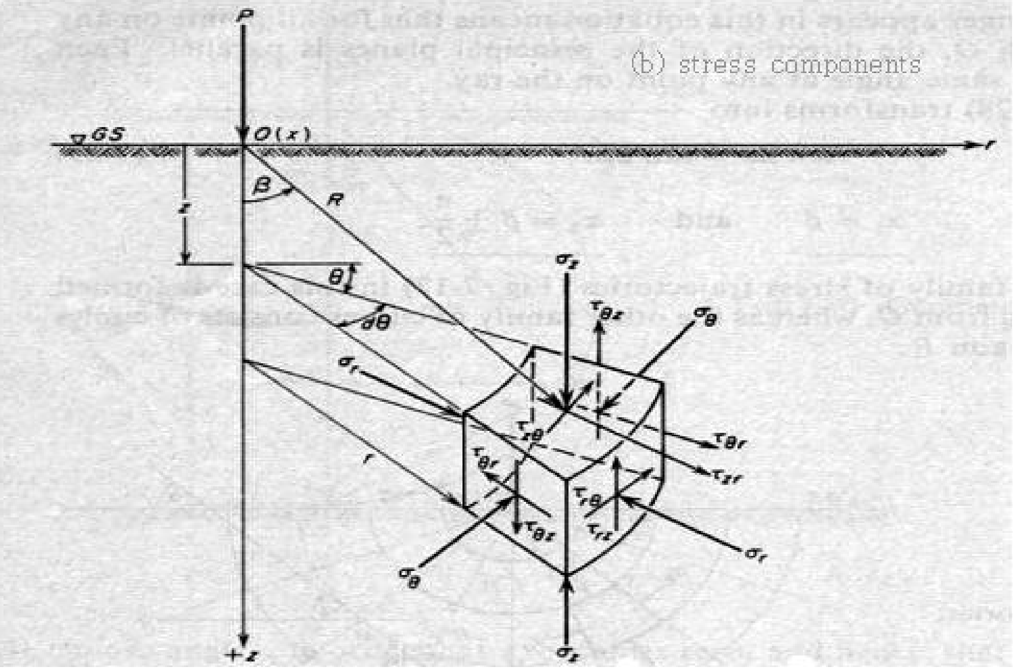
1. Stresses in polar coordinates.



2. Cylindrical coordinate system.



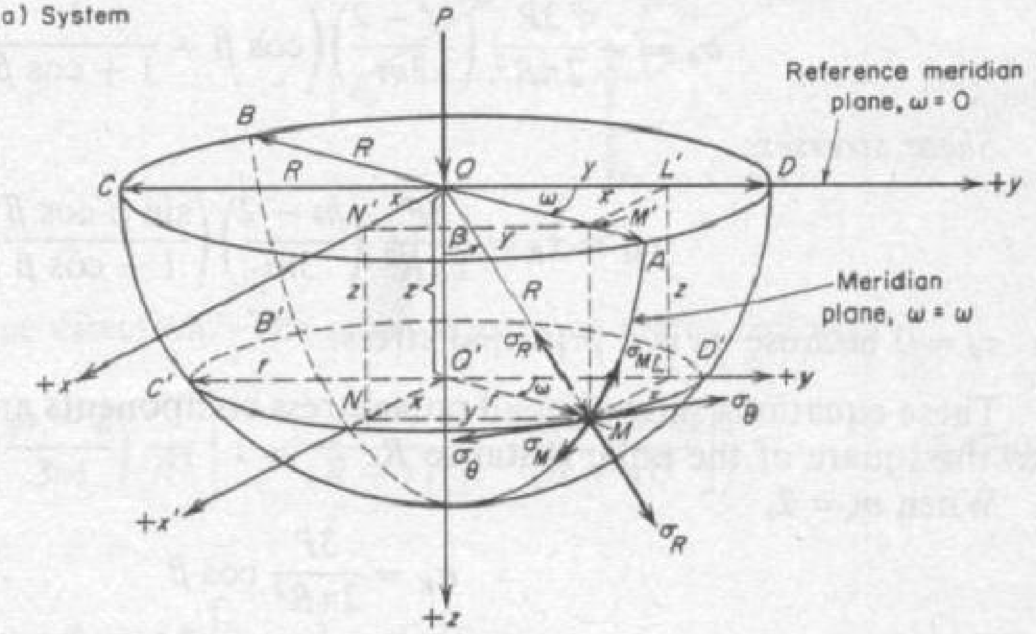
(a) system



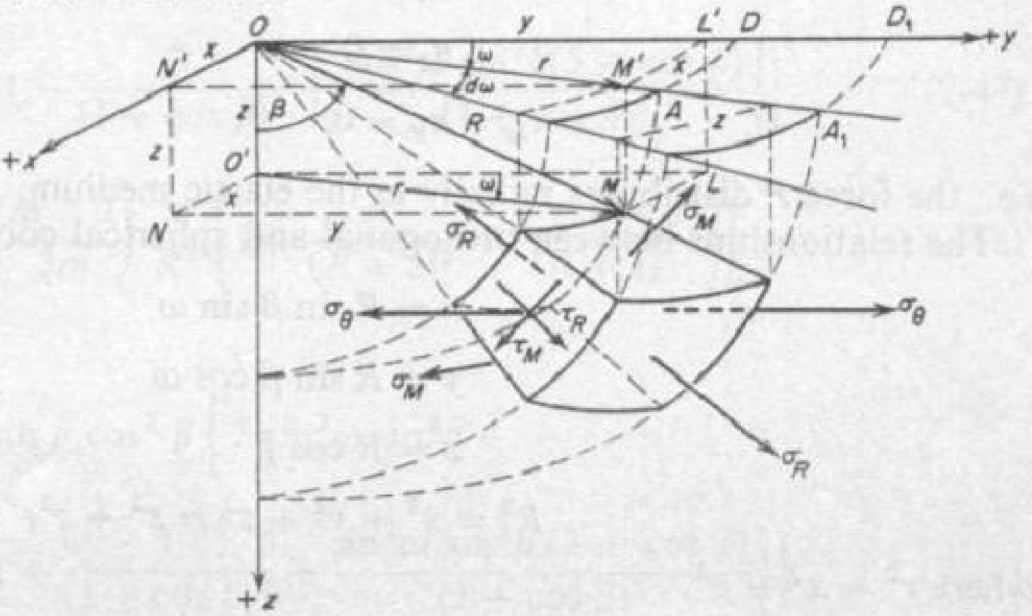
(b) stress components

3. Spherical coordinate system.

(a) System



(b) Stress components



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To incorporate the effect of strain relief due to embedment and yet retain simplicity for practical design purposes, the method assumes that the $2B$–0.6 distribution of the strain influence factor is unchanged but its maximum value is modified. The suggested factor is

$$C_1 = 1 - 0.5\left(\frac{\sigma'_{v0}}{\Delta q}\right) \geqslant 0.5 \tag{5.7}$$

where

σ'_{v0} = effective in-situ overburden stress at the foundation depth
Δq = net foundation pressure

In all cases, however, it is suggested that this correction factor not be less than 0.5.

Schmertmann (1970) also included a second correction factor, C_2, to account for some time-independent increase in settlement that was observed even for foundations on presumably cohesionless soils. In the cases studied by Schmertmann, time-dependent settlements probably occurred as a result of the consolidation of thin strata of silts and clays within the sands. Consequently, because the elastic distribution is inappropriate for cohesive soils and the method uses the Dutch cone penetration test (CPT) to estimate modulus, which is questionable for cohesive soils, the use of the correction factor C_2 is not recommended; therefore, use C_2 equal to 1.0 in Equation 5.6c.

No account was taken in the original procedure of the influence of foundation shape on the strain distribution, because as a foundation shape changes from approximately axisymmetric to approximately plane strain conditions, the angle of shearing resistance increases and the stresses at a given depth also increase. These two effects were thought to cancel each other, giving a strain distribution that is, perhaps, not very different for a wide range of length-to-width ratios.

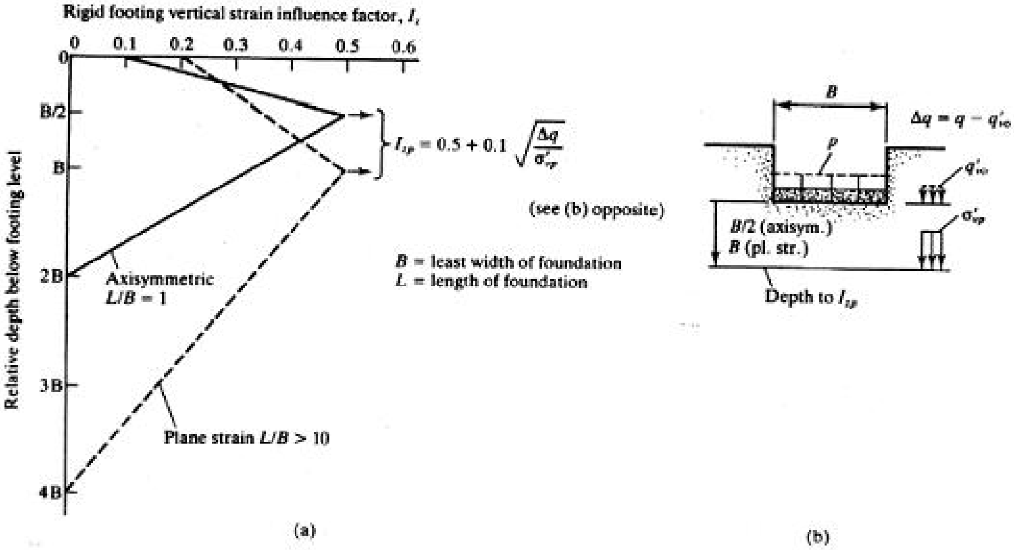
Model test results suggest that when a rigid boundary lies within the $2B$–0.6 distribution, the distribution of the strain influence factor will be simply truncated at the depth, with the slopes of the distribution remaining as for the homogeneous case.

Modifications of 1978 A number of modifications have been made by Schmertmann et al. (1978) and Schmertmann (1978). The strain influence diagram was modified slightly on the basis of extensive analytical studies, and axisymmetric and plane strain loadings are now considered separately. The modified strain influence diagram is shown in Figure 5.14. Note that the depth of the strain influence factor goes to $2B$ for the axisymmetric case and to $4B$ for plane strain conditions. The maximum value of the influence factor is at least 0.5 plus an incremental increase relative to the effective vertical overburden pressure at the depth of the maximum value. An explanation of the pressure terms in I_{zp} is shown in Figure 5.14b. Schmertmann (1978) recommends that if L/B is greater than 1 and less than 10, both the axisymmetric and plane strain cases can be calculated and interpolated for the actual L/B ratio.

As before, this method is only appropriate for normally loaded sands where the bearing capacity of the sand is adequate. If the sand has been prestrained by previous loading, then the real settlements will, as explained earlier, be greatly overpredicted by this method. Schmertmann (1978) recommends that a tentative reduction in settlement after preloading or other means of compaction of half the predicted settlement be used, and this is probably still conservative. There may also be some additional settlement effect due to dynamic, cyclic, or vibratory loads. This of course is a very serious potential problem for loose sands below the water table. Some type of densification or prestressing is an easy and effective way of reducing the potential for liquefaction or other undesirable behavior.

The correction factors C_1 (Eq. 5.7) and C_2 are unchanged. Also, as before, the correction factor C_2 is subject to question.

The use of this method to estimate the settlement of a shallow foundation on sand is illustrated by an example later in this section.



(a) (b)

Fig. 5.14 Modified strain influence factor diagrams for use in Schmertmann method for estimating settlement over sand. (a) Simplified strain influence factor distributions. (b) Explanation of pressure terms in equation for I_{zp}. (*Schmertmann, 1978.*)

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TABLE 3.1

Ultimate values of the settlement of foundations (according to ČSN 73 1001)

Type of building	The foundation soil consolidates			
	very quickly (for example, sands)		slowly (for example, clays)	
	difference of settlement	total settlement	difference of settlement	total settlement
	$\Delta s/L$	s [cm]	$\Delta s/L$	s [cm]
1. Buildings:				
panels[1]	0.0005 (0.002)	6 (7)	0.0007 (0.002)	8 (5)
bricks and blocks	0.0007	6	0.001	8
bricks, block reinforced with concrete strips	0.001	8	0.0013	10
reinforced concrete skeleton	0.0007	6	0.001	8
	$\Delta s/l$	s [cm]	$\Delta s/l$	s [cm]
2. Structures:				
statically determinate	0.003	10	0.003	10
statically indeterminate steel	0.0015	6	0.002	8
statically indeterminate reinforced concrete	0.001	4	0.0015	6
	$\Delta s/B$	s [cm]	$\Delta s/B$	s [cm]
rigid and massive				
massive foundation to a height of 20 m	0.005	20	0.005	20
higher than 20 m (chimneys)	0.002	10	0.002	10
	$\Delta s/l$	s [cm]	$\Delta s/l$	s [cm]
3. Crane tracks with bridge crane longitudinally and laterally	0.0015	—	0.0015	—

[1] Values in brackets are according to Professor Šimek, mentioned in the Proposed Code for the Foundations of Panel Housing. Difference of settlement values are used when there is strong no connection between adjacent vertical structures.

TABLE 5-7

Tolerable differential settlement of buildings, mm*

Recommended maximum values in parentheses

Criterion	Isolated foundations	Rafts
Angular distortion (cracking)	1/300	
Greatest differential settlement		
Clays	45 (35)	
Sands	32 (25)	
Maximum settlement		
Clays	75	75–125 (65–100)
Sands	50	50–75 (35–65)

*After MacDonald and Skempton (1955) but see also Wahls (1981).

TABLE 5-8

Permissible differential building slopes by the USSR code on both unfrozen and frozen ground

All values to be multiplied by L = length between two adjacent points under consideration. H = height of wall above foundation.*

Structure	On sand or hard clay	On plastic clay	Average max. settlement, mm
Crane runway	0.003	0.003	
Steel and concrete frames	0.002	0.002	100
End rows of brick-clad frame	0.0007	0.001	150
Where strain does not occur	0.005	0.005	
Multistory brick wall			25 $L/H \geq 2.5$
L/H to 3	0.0003	0.0004	100 $L/H \leq 1.5$
Multistory brick wall			
L/H over 5	0.0005	0.0007	
One-story mill buildings	0.001	0.001	
Smokestacks, water towers, ring foundations	0.004	0.004	300
Structures on permafrost			
Reinforced concrete	0.002–0.0015		150 at 40 mm/year†
Masonry, precast concrete	0.003–0.002		200 at 60 mm/year
Steel frames	0.004–0.0025		250 at 80 mm/year
Timber	0.007–0.005		400 at 129 mm/year

*From Mikhejev et al. (1961) and Polshin and Tokar (1957).

†Not to exceed this rate per year.

Construction and/or material	Maximum δ/L
Masonry (center sag)	1/250–1/700
(edge sag)	1/500–1/1000
Masonry and steel	1/500
Steel with metal siding	1/250
Tall structures	$< 1/300$ (so tilt not noticeable)
Storage tanks (center-to-edge)	$< 1/300$