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PREFACE

Purpose of this project :
It is about illumination around some part of the Famagusta Castle which is called St.- NICHOLAS in the project.
My opinion is that by means of this lighting system the castle will look more attractive and beautiful to everyone than it had been before. The most of the tourists visiting our country will be able to see how this fantastic castle appear at nights. And it will also help to the whole shops which exist in that area, remain open even until midnights. So, it will not only be useful for tourism but also for our own people living in Famagusta. They will have chance to do shopping for the things they are urgently in need. I think this may be a good step for development.

I also would like to thank to my Professor Mr. Haldun Gurmen for his assists in the preparation of this project. He had been always ready for us. And I am certain he did his best for being helpful.

F.CIVISILLI

INTRODUCTION

There is no doubt that floodlighting a bul- is one of the most spectacular achievements in lighting engineering. A floodlit building is a focal point in a town, where it is dark and colours are blurred.

Formerly it was mostly buildings of historic interest that were floodlit.

Floodlighting of these old buildings, which often boast rich, ornate facades and beautiful architecture, i s still very effective. Such wonderful results can be achieved that often these buildings are reinvested in this way with some of their former glory.

In addition to being used for aesthetic purpose, floodlighting nowadays can be simply functional This is especialy true of industrial and commerical buildings were floodlighting is used for advertising and security reasons. In generaly, floodlighting of industrial and commerical buildings can be said to have a threefold purpose.

* As a relatively inexpensive means of advertising

A building which at night would otherwise be completly invisible or incospicuous, will immediatly attract attention when it is floodlit.

If the name of the firm or the trade mark is floodlit on the facade, advertising is possibly made even more effective.

* Prestige..

In many cases the reasons for wanting a building to be as spectacular as posssible is that it is of focal or national importance or has particular architectural qualities. After sunset, floodlighting is consequetly an effective means of impressing visitors.

* Increased security around buildings.

Nowadays it is unfortunently necessary to take elaborate precautions in order to prevent illegal entery, theft or wilful destruction of factory and other industrial buildings. Floodlighting in the areas around buildings enables night watchmen and police to have a clear view of the scene.

The diffeent used to which floodlight is put whether they are primarly aesthetic or purely functional to achieve commerical ends, does not alter the fact that quality of the end product should be as high as possible. Even a modern office block with bare frontage can be made attractive by means of artivical lighting However, it must be said that, whether the reason, it is better to abandon the idea of a floodlighting installation that to be satisfied with a mediocre result.

CHAPTER 1

PLANNING

A floodlighting installlation project can only be carried out succesfully if a thorough study has been made of the building concerned. The lighting engineering should become familar with all factors relating to lighting installat-ions for the building. It is esssential he sh-ould first study the features of the facade under various conditions and with the sunlight falling upon it at different angles in order to decide which are the most attractive features.

If an on the spot survey is impossible, daylight photos, drawings or a scale model can be useful aids. An informative part of the "day-light study" is the analysis of how given ef-fects arise. Althoug this project is about the floodlighting of castles by means of artifical light, it will none the less be useful first of all to go into certain features of the effects of daylight upon them.

In the past, an architect only thought in terms of a building being viewed in daylight when he was drawing up his plans. The archit-ecture of the facade was therefor designed in those days with the idea in mind that it wo-uld be lit from above, by the sun and the sky. Today, however, there is a greater tendency to think that a building should also be attractive after dusk, when the various surface may be ill-uminated by a floodlighting installation. The app-earence of the building at night is therefore taken in to account when designing the building and it is most important that if this is the case, there shoud already be good cooperation, at this stage, between the lighting engineering and the architec, in order to avoid any risk of the architect's conception being misinterpreted.

CHARACTERISTICS OF LARGE FLOODLIGHTING EQUIQMENT

An important factor to be considered in sel-cting floodlights is beam spread - i.e., the ang-le between the points on a candlepower distri-bution curve that are 10 per cent of the mx. candlepower. A large, low area to be lighted from a relatively short distance dictates wide - beam floodlights, while greater distance suggests na-rrower - beam equiqment. A tall building lighted from close in floodlights will, on the other hand, call for narrow beam equiqment for lighting the upper part, mainly becouse of the grazing angle of the light. Four factors determine beam

spread of the luminaire:

1 - Dimensions of the light source and the reflector. As the ratio of the light source dimension to the reflector size increases, the beam spread increases.

2 - Surface texture of the reflector. Polihsed is used for narrow beams, etched for wide beams (sometimes a polished surface is used with phospor - coated high - intensity - discharge lamps to achieve similar beam spreads, while allowing a choice of color rendition).

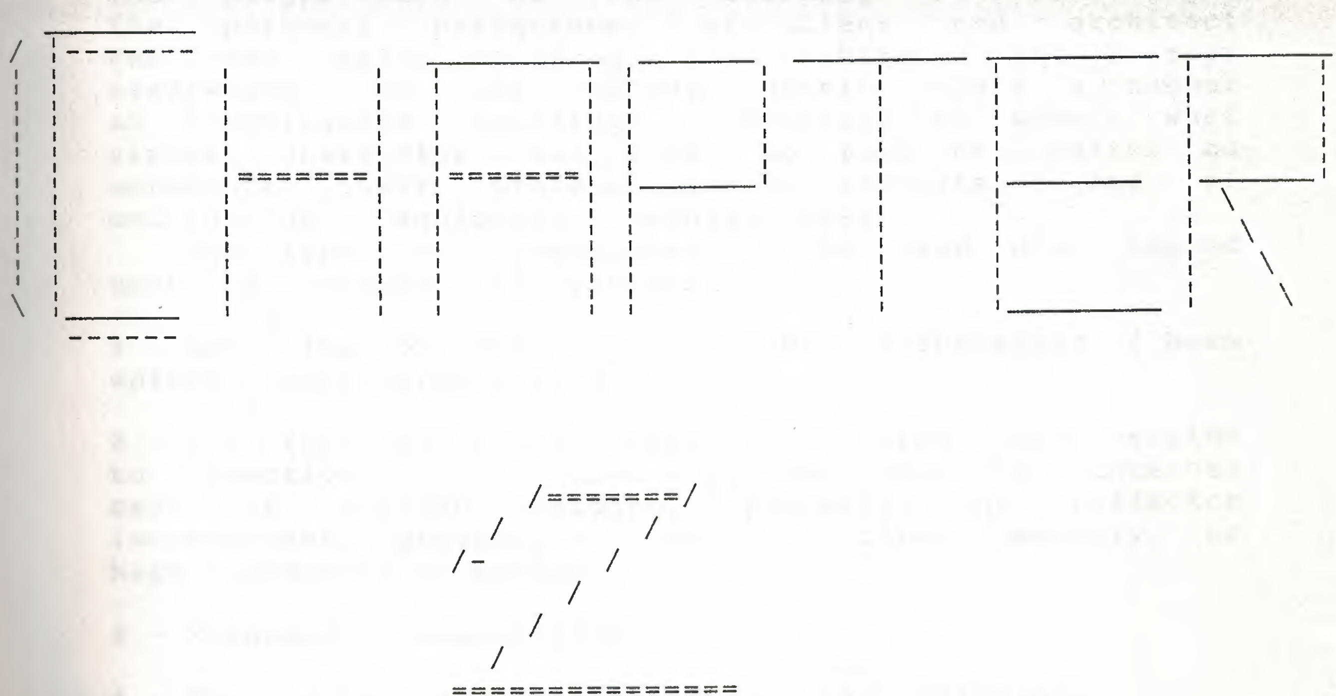
3 - The diffusing or refracting characteristic of the glass cover.

4 - Focal lenght of the reflector. The spherical elliptical, parabolodial, cylindrical, or a combination of these. The shorter the focal lenght, the larger the beam spread. The conventional general service - type incandescent lamp placed inside a polished reflector covered by clear glass a gives a beam spread of 25 degrees by 25 degrees. Changing the reflecting surface from polishe to etched enlarges the beam spread to 65 degrees by 65 degrees. If the glass is stippled the beam spread is reduced to about 40 degrees. But then a frensnel lens can produce a nonsymmetrical beam pattern of 25 degrees vertical and 45 degrees horizontal.

ARCHTECTURAL CHARACTER DETERMINES TYPE OF LIGHTING

A significant aspect of the more recent examples of the floodlighting buildings is that in very many cases the architectural character of buildings pretty much suggests the type of lighting that is most appropriate. In other words, engineering factors, thoug important, are subservient to aesthetic demands. The lighting approch and the equiqment are geared to emphasize architectural features in a natural sort of way.

To illustrate: The celluar grid and horizontal sunshaded facade of a tall building is crosslighted by two banks of floodlights shining up from ground or near ground level. The result is a building that is uniformly lighted but with strong accents on the undersides of the horizontal sunshades and modeling effects on the grid elements. The buildins has punch as well as brillance.
Another building has filagreed precast concrete screens between tall concrete columns topped by



a cornice. Single rows of floodlights at ground level highlight the screens and graze the columns with even illumination. The floodlights are close to the building, and with their high aiming angle they brightly illuminate the cornice.

How bright the building should be depends not only upon the general ambience of illumination in the neighborhood of the building but also upon the personal preferences of client and architect For any major building, the architec and a repr- esentative of the calient should visit a number of floodlighted buildings - building of some - what similar characrter and size - so they can better co- mmunicate their preferences to consultants and fl- oodlighting equiqment manufacturers.

The type of floodlights to be used will depend upon a number of factors:

1 - How the building is to be illuminated (beam spread considerations, etc.)

2 - The type of lamps that are used as related to function, color, cost - general - service incandes- cent or tungten - halogen, projector or reflector incandescent, phosphor - coated or clear mercury, or high - pressure - sodium.

3 - Economic consideration.

4 - The size and character of the building.

Price determination of lighting levels and bright- ness can be a tedious arithmetic process, parti- cularly when floodlights are aimed at all sorts of angles toward a facade. For precision, calcu- lations have to be done by the point - by - point method ; for a building any size and a fair number of fixtures, the process can be exceedingly time consuming. To explain the point by point method The illumination level can be calculated for one luminaire at a series of grid points on a fac- ade, assuming that the luminaire's location and aiming point are known. But if there are, say 10 lines each way on the grid, there are 100 points and if there are 50 luminers, there are 5000 se- perated calculations. Thus for particularly important of difficult floodlighting jobs, it may be advi- sable to consider the use of a compiter ; prog- rams have been developed to this chore.

Selection of light source :

Selection of light source depends upon a co- mbination of factor, among which are size, shape,

and type of building, desired lighting effect, colour preference, extend of beam control required from the floodlighting, and relative economics (first cost versus owning cost).

For overal lighting of building facates, the number of floodlight generally can be determined by deciding what footcadle level is desired and then using the beam - lumen method to find out how many floodlight are reqired. Floodlight selection for overall lighting as regards beam angle is governed primarily by floodlight location. (floodlights are divided into seven types by the National Electrical Manufacturers Association, on the bases of beam spread. Beam efficiencies (ratio of luminaire output lumens to lamp lumens) For example, for a low building, a wide - beam floodlight would be indicated if the luminaires must be mounted close to the building ; narrow beam if they are far back. But with a tall building, on the other hand, narrow - beam floodlights may be needed if the luminaires must be mounted close in. The reason is that otherwise there would be too great a difference in illumination between top and bottom of the building as result of the building and the grazing angle. But with a low height building, the floodlights can be strung out in a row and overlap of beams will produce the desired uniformity.

The beam - lumen formula is ;

$$N = (A * fc) / (BL * CBU * MF)$$

N is the number of luminaires.
A is the area to be floodlighted.
fc is the footcandle level.
BL is the beam lumens of the luminaire.
CBU is the coefficient of beam utiolization.
MF is the maintenance factor.

The footcandle of illumination to be used will depend upon just how bright the building is to appear against its surroundings. Of course, the darker the colour of surface of the building, the more light will be needed to achive a given brightness. Typical footcandle values for exposed concret facades might be between 5 and 10 fc, provided that there is not too much competing brightness in the surroundings. A figure sometimes given as to how much brighter a building should be than the competing surround is in the range of 4/1 to 5/1.

Another way of helping to make a building stand out against its surroundings is through the use of colour

Phychologically, the difference in colour may

attract attention. The illuminating engineering society has recommandetions for illumination levels depending upon the reflectance of surface material and the competing brightness. These values, of course, are not absolute but should be used with judgment based upon experience.

The coefficient of beam utilization is that fraction of the beam lumens intercepted by the building surface. Beam lumens of a luminaire are the total lumens within the beam spread of the luminaire. Designers try to select a floodlight so that the CBU is at least between 75 and 80 per cent. If half, or more than half, of the floodlights are aimed so that all their lumens fall on the lighted surface, the overall utilization factor will be about 0.75 ;if one quarter to one - half of the floodlights are aimd in that manner, 0.60 ; less than one quarter, not 0.40 (with towers and steeples the utilization factor may be less than 0.25).

Maintenance factor is equal to the lamp lumen depreciation factor multiplied by the luminaire dirt depreciation factor. This factor compensates for reduce illumination as the installation becomes older the loss of illumination results from the combined effects of gradual reduction of lumen output during lamp life and the loss caused by collection o dirt. A reasonable maintenance factor to be assumed for enclosed equipment is 0.75.

It has been mentioned how location of equipment affects the selection of floodlights. As a general rule, it is desirable to have floodlights located a distance out from the building equal to at least one - fourth to one - third the height of the building. The farther back the floolights are from the building, generally speaking, the wider the choice possible in floodlight and lamp selection.

Whether the floodlights are concentrated in banks or lined up in rows depends upon severals factors. They may be arranged in rows if;

1 - illimination is to be even and modeling need not to be too strong.

2 - There is a series of tall columns each of which is to be accented.

3 - Space availability is no problem and the luminaires can be easily concealed.

Floodlights may be arranged in banks if:

1 - Space availabily is a problem.

2 - Concealment is difficult.

3 - Fairly strong modeling effects are desired.

For lower buildings, floodlights mounted at grouond or near ground level will be aimed with the center of their beams striking the building near

the top - a typical aiming point might be 2/3 of the height. Even with a building of, say, eight to ten stories, the floodlights might be aimed near the top to accent a cornice and still illluminate the facade fairly evenly. A very tall building, on the other hand, if lighted from floodlights close to the base of the building may have to be illuminated in segment in order to achiev reasonable uniformity.

Obviously there can be no exact rules for location or aiming of floodlights becouse of the many variables. Nature of building facade (materials and design) available areas for mounting floodlights, desired effect, etc.. It may be that the architect does not want uniformity of illumination but rather a graded wash or even bright accents. But " accidental " lighting effects and unintentional spottiness surely should be avoided. In the point by point method, the most exact method for determining footcandle levels produced by a single or over lapping foodlight beams. A point is selected on the building surface; then, knowing the candlepower of the floodlight beam aimed at that point, the designer can determine the footcandle contribution by a combination of the cosine law and the inverse - square law.

A more visual method of getting a picture of the amount of illumination on various portions of the building facade is to used the isocandle curves presented in manufacturers photo metric data, and to draw this curves on the building facade by projection. To get and accurate trace of the curves on the facade by this method can be a quite time - consuming process. However and experienced floodlighting designer can sketch the projected isocandle curve by projecting a few points, and with these projected curves he can predict with sufficient accuracy what footcandle levels can be expected. Through experience, the lighting designer will be able to establish trial aiming points , once he has determined the number of floodlights necessary. Then he can check his results to see whether " re - aiming " on paper might be necessary.

If the building floodlighting situation is such that PAR or R lamps seem indicated, the footcandle levels can easily be calculated by tracing footcandle patterns of these lamps, which are provided in the literature, at the given angle of projection (0, 30, 45, 60, 70 degrees) on a scale drawing of the area to be lighted.

It must be recognized that no matter what type of floodlighting design approch has been used no calculation method anticipate small areas of sharp gradiation in brightness where beams may overlap too much or not enough. These may show up

as light or dark streaks or striations. This means that there always will be some adjustments required in the field for final aiming of the floodlights to obtain the efffect desired by the architect and his lighting consultant.

SURFACE MATERIAL OF THE FACADE

In determining the illumination level needed for a facade, in order to obtain the required brightness the reflection factor and the way the building surface material reflects the light are important factors to be borne in mind. The table below indicates the reflection factors of the number of different materials.

MATERIAL	STATE	REFLECTION FACTOR
White marble	fairly clean	0.60 - 0.65
Granite	fairly clear	0.10 - 0.15
Light concrete or stone	fairly clear	0.40 - 0.50
Dark concrete or stone	fairly clear very dirty	0.25 0.05 - 0.10
Imitation concrete	clean	0.50
White brick	clean	0.80
Yellow brick	new	0.35
Red brick	dirty	0.05

The total reflection from a facade depends on following points :

* The material of the facade
* The incident angle of the light
* The position of the observer in relation to the reflecting material (specular reflectuions).

The colour of the material is also an important factor.
The colour of the surface material is accentuated if light of the same colour is used.

A distinction can be made between the diffuse reflection and specular reflection and of variations between the extremes. These different types of reflection are due to the particular surface textures of the different materials. Four classes of surface may be distinguished are below.

Very smooth surface

A very smooth surface acts more or less as a mirror, with the result that most of the reflected light is direct upward, away from the observer (see fig. 1).

Smooth surface

Light is reflected somewhat diffusely from a smooth surface; a small amount of this light reaches the observer (see fig. 2).

Dull surface

Incident light reflected from a dull surface is even more diffused, so that a large part of the light is directed towards the viewer (fig.3).

Very dull surface

Light reflected from a very dull surface is diffused to a large degree, and therefor a great part of the light is directed towards the observer (fig. 4).

It is obvious that these different reflection properties of surface material necessitate a different illumination of the facade, in each case, in order to achieve the required brightness.

Even the mount of grime on a building is important ; the reflection factor of an clean facade can sometime be more than twice that of a grimy facade. This was clearly illustrated recently when certain historic buildins were cleaned.

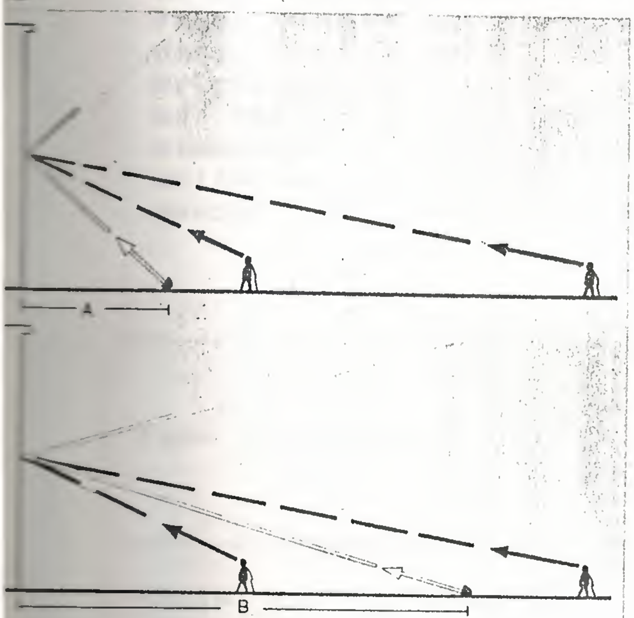
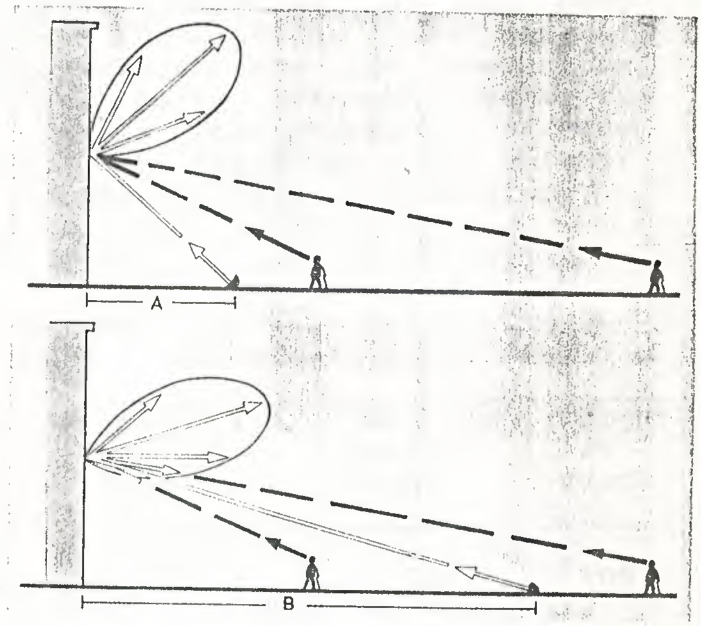


Fig. 5~~3~~ 2



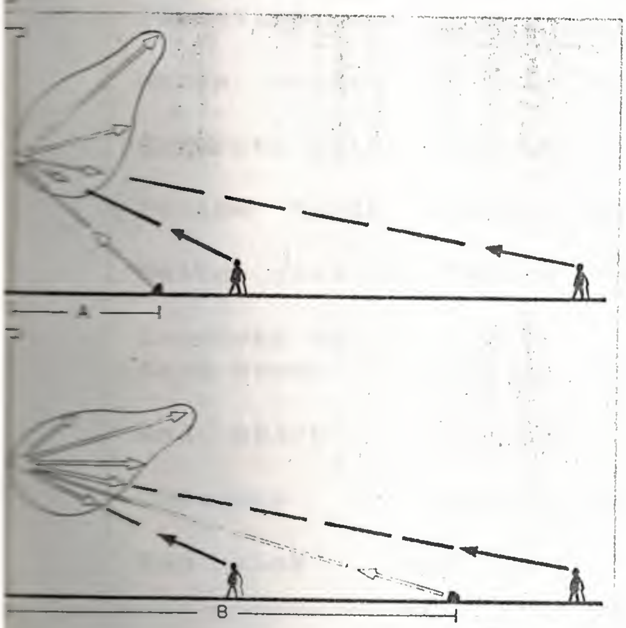
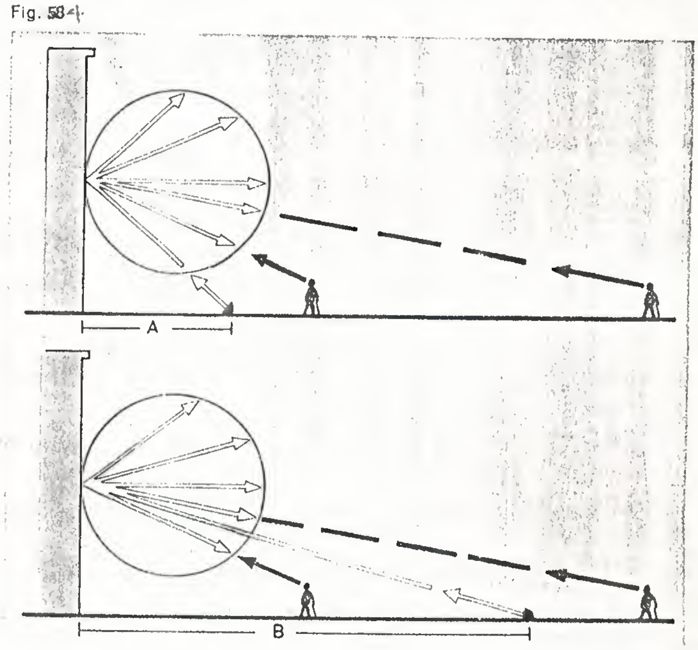


Fig. 5~~8~~ 4



SELECTION OF THE LEVEL OF ILLUMINATION

The lighting level needed on a facade to effect a certain brightness contrast depends upon such factors as the reflection factor of the surface building material, the location of the building in relation to its surroundings, the general brightness of these surroundings and the dimensions of the building. The table below present some recommended illumination levels for various surface building materials used on buildings in either poorly lit, well it or brightly lit sorroundings.

Type of surface	state	illumination in lux		
		poorly lit surrounding	well lit surrounding	bright lit surd.
White marble	fairly clean	25	50	100
light concrete imitation	fairly clean	50	100	200
White brick	fairly clean	20	40	80
Concrete paint	fairly clean	100	250	400
Yellow brick	fairly clean	50	100	200
White granite	fairly clean	150	300	600
Concrete or dark stone	fairly clean	75	150	300
Red brick	fairly clean	75	150	300
Concrete	very dirty	-- requires at least 150-300		
Red brick	dirty	-- requires at least 150-300		

EXTERIOR LIGHTING

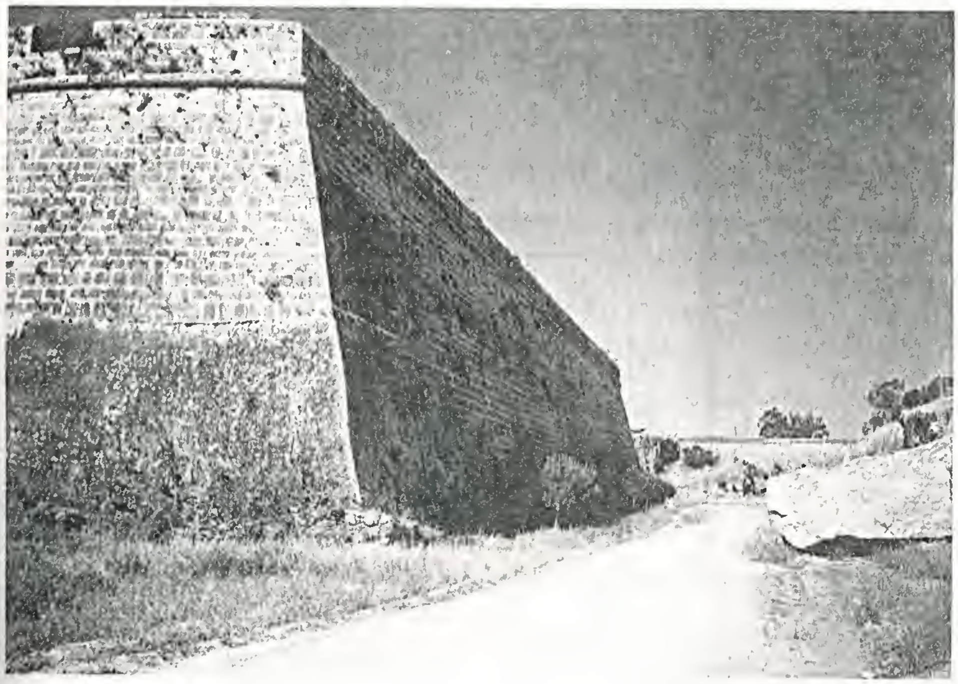
Exterior lighting requires an architect's attention if it is to suit his architectural concept and not seem merely appliqued. This understanding of the situation is becoming increasingly accepted.

Architects are paying increasing attention to how buildings look at night. Now, however, not only are manufactures offering architects much more in the way of hardware but, beyond this, the architects have developed a more personal and vital interest in exterior lighting.

Of course, it must be recognized that building exteriors themselves have changed very often a facade is texture by bold patterns of exposed structural elements or by the missing of a series of volumes, both of which lend themselves to strongly accented patterns of light. But even when the exterior is flat, such as a sheer glass facade, the client still may want his building to stand out at night. Then the architect may want to concider some sort of internal lighting that will make the building glow from within, a technique that has grown to be more commonly used with glass - walled structures.

It is important for the architect to realize that lighting cannot possibly make a building look the same at night as it does during the day. What is important is that the night - lighted building create a favorable visual impression, not merely be an idenfinite blob of brightness.

Although building floodlighting demands care from the architect in decicing upon lighting approach and in technical execution, there are some basic design parameters that help determine the appproach. Even though the daytime apppearance can not be duplicated, ity should be remembered that daylighting on clear, pleasant day is a combination of derectional sunlight and diffuse skylight. Thus it usually is desirable to locate the main floodlighting so that, similarly, there will be some modeling effect. If floolights are aimed head on to the building, the effect will tend to be flat and it may be uninterseting. This does not mean that the main lighting must be limited to a point source ; modeling also can be achieved by aiming each of a line of floodlights at the proper angle. Deep shadows can be softened by low levels of diffuse floodlighting at an angle to the main floodlighting.



CHAPTER 7

Possible locations for mounting lighting equigment may limit the type of lighting possible. In general four locations may be considered :

1 - on the building itself,
2 - on adjacent ground,
3 - on poles,
4 - on adjacent buildings.

Floodlighting located close to a surface and aimed at a grazing angle will emphasize the texture of the surface ; however, defects such as dimples or waviness tend to be emphasized when viewed from nearby. The farther away the floodlights are located, the lesss bold the texture brought out by the lighting.

Major viewing locations also will affect the floodlighting approach. If the building is to be seen primarly from automobiles, then lighting of the upper major elements of the building may be most important. For pedesrtrians, however, the ground level facade, sidewalk, landscaping, buildings materials, and construction details will deserve emphasis.

Obviously, the viewer should not be aware of the location of floodlights, or should he see reflected images of lampss or reflectors. Therefore floodlights should be louvered or shielded if necessary so that they will not be seen from normal viewing locations. Direct glare near building entrances, which might make steps and curbs difficult to see, particularly should be avoided. Landscaping, walls, or wells can help to minimize direct glare as well as conceal the equigment in the daytime. Sight lines should be checked to make sure there are no bright reflected images of lamps or reflectors showing in specular surfaces.

DESING PROCEDURE FOR FLOODLIGHTING :

The general desing procudure for floodlighting consists of four basic steps :
1 - Determining the desired effect.
2 - Determining the level of illumination.
3 - Determining the location of lighting equipment.
4 - Determining the fixetures and lamps to be used, from the standpoints of engineering performance and the economics of maintenance.

Lighting engineer Robert Faset has suggested the following checklist for selecting larger types of outdoor area - lighting equipment. He points out that selecting lighting equipment requires a combination of common sense, good engineering economic evaluation and a feel for the aesthetics of lighting effects.

1 - For 10000 burning hours per year or less, use filament lamps. Otherwise use high - intensity -discharge sources or fluorscent fixtures in the largest practical size.

2 - Use the largest wattage fixtures and the fewest locations that will deliver amount of light wanted. With area - type luminaires spacing generally should exceed two to four times distance from the surface being lighted to the lighting equipments.

3 - Consider the cost of relamping and cleaning fixtures.

4 - Keep in mind the styling of the lighting equipment.

5 - Buy top - quality fixtures, lamps, and poles, in order to achieve lowest total owning cost.

If uniformity is desired with large area outdoor lighting, these steps will help obtain it, provided that the floodlights are spaced at recommended distances from the building :

1 - Beams should overlap so that any given area receives as much light from the floodlight on either side as from the one directly in front of it.

2 - The widest beam spread available should be used consistent with reasonable utilization

3 - The largest lamp available should be used, consistent with acceptable uniformity. Obviously, proper aiming of floodlights is important. Approximate aiming can be determined by scaled sketches showing beam overlap. Exact aiming, however, must be adjusted in the field regardless of how carefully it was planned and laid out.

When the floodlighting equipment is aimed upword from a low level, the shadows that exist in daylight will be reversed or perhaps even eliminated While flat, head on illumination destroys depth and perspective large brightness contrasts may not produce desirable effects either. The resons is that bright areas appear closer and dark ares appear farther away to distance observers. For very tall structures apparent uniformity is achived if the top portions are illuminated so that they are from two to four times as bright as the lower portions. Greater illumination at the top also accentuates apparent height. Illuminating the lower portion of the building at a somewhat lesser level also minimies possible annoyance to pedestrians

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2 - Surface texture of the reflector. Polihsed is used for narrow beams, etched for wide beams (sometimes a polished surface is used with phospor - coated high - intensity - discharge lamps to achieve similar beam spreads, while allowing a choice of color rendition).

3 - The diffusing or refracting characteristic of the glass cover.

4 - Focal lenght of the reflector. The spherical elliptical, parabolodial, cylindrical, or a combination of these. The shorter the focal lenght, the larger the beam spread. The conventional general service - type incandescent lamp placed inside a polished reflector covered by clear glass a gives a beam spread of 25 degrees by 25 degrees. Changing the reflecting surface from polishe to etched enlarges the beam spread to 65 degrees by 65 degrees. If the glass is stippled the beam spread is reduced to about 40 degrees. But then a frensnel lens can produce a nonsymmetrical beam pattern of 25 degrees vertical and 45 degrees horizontal.

ARCHTECTURAL CHARACTER DETERMINES TYPE OF LIGHTING

A significant aspect of the more recent examples of the floodlighting buildings is that in very many cases the architectural character of buildings pretty much suggests the type of lighting that is most appropriate. In other words, engineering factors, thoug important, are subservient to aesthetic demands. The lighting approch and the equiqment are geared to emphasize architectural features in a natural sort of way.

To illustrate: The celluar grid and horizontal sunshaded facade of a tall building is crosslighted by two banks of floodlights shining up from ground or near ground level. The result is a building that is uniformly lighted but with strong accents on the undersides of the horizontal sunshades and modeling effects on the grid elements. The buildins has punch as well as brillance.
Another building has filagreed precast concrete screens between tall concrete columns topped by

CHAPTER 2

a cornice. Single rows of floodlights at ground level highlight the screens and graze the columns with even illumination. The floodlights are close to the building, and with their high aiming angle they brightly illuminate the cornice.

How bright the building should be depends not only upon the general ambience of illumination in the neighborhood of the building but also upon the personal preferences of client and architect For any major building, the architec and a repr-esentative of the calient should visit a number of floodlighted buildings - building of some - what similar characrter and size - so they can better co-mmunicate their preferences to consultants and fl-oodlighting equiqment manufacturers.

The type of floodlights to be used will depend upon a number of factors:

1 - How the building is to be illuminated (beam spread considerations, etc.)

2 - The type of lamps that are used as related to function, color, cost - general - service incandes-cent or tungten - halogen, projector or reflector incandescent, phosphor - coated or clear mercury, or high - pressure - sodium.

3 - Economic consideration.

4 - The size and character of the building.

Price determination of lighting levels and bright-ness can be a tedious arithmetic process, parti-cularly when floodlights are aimed at all sorts of angles toward a facade. For precision, calcu-lations have to be done by the point - by - point method ; for a building any size and a fair number of fixtures, the process can be exceedingly time consuming. To explain the point by point method The illumination level can be calculated for one luminaire at a series of grid points on a fac-ade, assuming that the luminaire's location and aiming point are known. But if there are, say 10 lines each way on the grid, there are 100 points and if there are 50 luminers, there are 5000 se-perated calculations. Thus for particularly important of difficult floodlighting jobs, it may be advi-sable to consider the use of a compiter ; prog-rams have been developed to this chore.

Selection of light source :

Selection of light source depends upon a co-mbination of factor, among which are size, shape,

and type of building, desired lighting effect, colour preference, extend of beam control required from the floodlighting, and relative economics (first cost versus owning cost).

For overal lighting of building facates, the number of floodlight generally can be determined by deciding what footcadle level is desired and then using the beam - lumen method to find out how many floodlight are reqired. Floodlight selection for overall lighting as regards beam angle is governed primarily by floodlight location. (floodlights are divided into seven types by the National Electrical Manufacturers Association, on the bases of beam spread. Beam efficiencies (ratio of luminaire output lumens to lamp lumens) For example, for a low building, a wide - beam floodlight would be indicated if the luminaires must be mounted close to the building ; narrow beam if they are far back. But with a tall building, on the other hand, narrow - beam floodlights may be needed if the luminaires must be mounted close in. The reason is that otherwise there would be too great a difference in illumination between top and bottom of the building as result of the building and the grazing angle. But with a low height building, the floodlights can be strung out in a row and overlap of beams will produce the desired uniformity.

The beam - lumen formula is ;

$$N = (A * fc) / (BL * CBU * MF)$$

N is the number of luminaires.
A is the area to be floodlighted.
fc is the footcandle level.
BL is the beam lumens of the luminaire.
CBU is the coefficient of beam utiolization.
MF is the maintenance factor.

The footcandle of illumination to be used will depend upon just how bright the building is to appear against its surroundings. Of course, the darker the colour of surface of the building, the more light will be needed to achive a given brightness. Typical footcandle values for exposed concret facades might be between 5 and 10 fc, provided that there is not too much competing brightness in the surroundings. A figure sometimes given as to how much brighter a building should be than the competing surround is in the range of 4/1 to 5/1.

Another way of helping to make a building stand out against its surroundings is through the use of colour

Phychologically, the difference in colour may

attract attention. The illuminating engineering society has recommandetions for illumination levels depending upon the reflectance of surface material and the competing brightness. These values, of course, are not absolute but should be used with judgment based upon experience.

The coefficient of beam utilization is that fraction of the beam lumens intercepted by the building surface. Beam lumens of a luminaire are the total lumens within the beam spread of the luminaire. Designers try to select a floodlight so that the CBU is at least between 75 and 80 per cent. If half, or more than half, of the floodlights are aimed so that all their lumens fall on the lighted surface, the overall utilization factor will be about 0.75 ;if one quarter to one - half of the floodlights are aimd in that manner, 0.60 ; less than one quarter, not 0.40 (with towers and steeples the utilization factor may be less than 0.25).

Maintenance factor is equal to the lamp lumen depreciation factor multiplied by the luminaire dirt depreciation factor. This factor compensates for reduce illumination as the installation becomes older the loss of illumination results from the combined effects of gradual reduction of lumen output during lamp life and the loss caused by collection o dirt. A reasonable maintenance factor to be assumed for enclosed equipment is 0.75.

It has been mentioned how location of equipment affects the selection of floodlights. As a general rule, it is desirable to have floodlights located a distance out from the building equal to at least one - fourth to one - third the height of the building. The farther back the floolights are from the building, generally speaking, the wider the choice possible in floodlight and lamp selection.

Whether the floodlights are concentrated in banks or lined up in rows depends upon severals factors. They may be arranged in rows if;

1 - illimination is to be even and modeling need not to be too strong.

2 - There is a series of tall columns each of which is to be accented.

3 - Space availability is no problem and the luminaires can be easily concealed.

Floodlights may be arranged in banks if:

1 - Space availabily is a problem.

2 - Concealment is difficult.

3 - Fairly strong modeling effects are desired.

For lower buildings, floodlights mounted at grouond or near ground level will be aimed with the center of their beams striking the building near

the top - a typical aiming point might be 2/3 of the height. Even with a building of, say, eight to ten stories, the floodlights might be aimed near the top to accent a cornice and still illluminate the facade fairly evenly. A very tall building, on the other hand, if lighted from floodlights close to the base of the building may have to be illuminated in segment in order to achiev reasonable uniformity.

Obviously there can be no exact rules for location or aiming of floodlights becouse of the many variables. Nature of building facade (materials and design) available areas for mounting floodlights, desired effect, etc.. It may be that the architect does not want uniformity of illumination but rather a graded wash or even bright accents. But " accidental " lighting effects and unintentional spottiness surely should be avoided. In the point by point method, the most exact method for determining footcandle levels produced by a single or over lapping foodlight beams. A point is selected on the building surface; then, knowing the candlepower of the floodlight beam aimed at that point, the designer can determine the footcandle contribution by a combination of the cosine law and the inverse - square law.

A more visual method of getting a picture of the amount of illumination on various portions of the building facade is to used the isocandle curves presented in manufacturers photo metric data, and to draw this curves on the building facade by projection. To get and accurate trace of the curves on the facade by this method can be a quite time - consuming process. However and experienced floodlighting designer can sketch the projected isocandle curve by projecting a few points, and with these projected curves he can predict with sufficient accuracy what footcandle levels can be expected. Through experience, the lighting designer will be able to establish trial aiming points , once he has determined the number of floodlights necessary. Then he can check his results to see whether " re - aiming " on paper might be necessary.

If the building floodlighting situation is such that PAR or R lamps seem indicated, the footcandle levels can easily be calculated by tracing footcandle patterns of these lamps, which are provided in the literature, at the given angle of projection (0, 30, 45, 60, 70 degrees) on a scale drawing of the area to be lighted.

It must be recognized that no matter what type of floodlighting design approch has been used no calculation method anticipate small areas of sharp gradiation in brightness where beams may overlap too much or not enough. These may show up

as light or dark streaks or striations. This means that there always will be some adjustments required in the field for final aiming of the floodlights to obtain the efffect desired by the architect and his lighting consultant.

SURFACE MATERIAL OF THE FACADE

In determining the illumination level needed for a facade, in order to obtain the required brightness the reflection factor and the way the building surface material reflects the light are important factors to be borne in mind. The table below indicates the reflection factors of the number of different materials.

MATERIAL	STATE	REFLECTION FACTOR
White marble	fairly clean	0.60 - 0.65
Granite	fairly clear	0.10 - 0.15
Light concrete or stone	fairly clear	0.40 - 0.50
Dark concrete or stone	fairly clear very dirty	0.25 0.05 - 0.10
Imitation concrete	clean	0.50
White brick	clean	0.80
Yellow brick	new	0.35
Red brick	dirty	0.05

The total reflection from a facade depends on following points :

* The material of the facade
* The incident angle of the light
* The position of the observer in relation to the reflecting material (specular reflectuions).

The colour of the material is also an important factor.
The colour of the surface material is accentuated if light of the same colour is used.

A distinction can be made between the diffuse reflection and specular reflection and of variations between the extremes. These different types of reflection are due to the particular surface textures of the different materials. Four classes of surface may be distinguished are below.

Very smooth surface

A very smooth surface acts more or less as a mirror, with the result that most of the reflected light is direct upward, away from the observer (see fig. 1).

Smooth surface

Light is reflected somewhat diffusely from a smooth surface; a small amount of this light reaches the observer (see fig. 2).

Dull surface

Incident light reflected from a dull surface is even more diffused, so that a large part of the light is directed towards the viewer (fig.3).

Very dull surface

Light reflected from a very dull surface is diffused to a large degree, and therefor a great part of the light is directed towards the observer (fig. 4).

It is obvious that these different reflection properties of surface material necessitate a different illumination of the facade, in each case, in order to achieve the required brightness.

Even the mount of grime on a building is important ; the reflection factor of an clean facade can sometime be more than twice that of a grimy facade. This was clearly illustrated recently when certain historic buildins were cleaned.

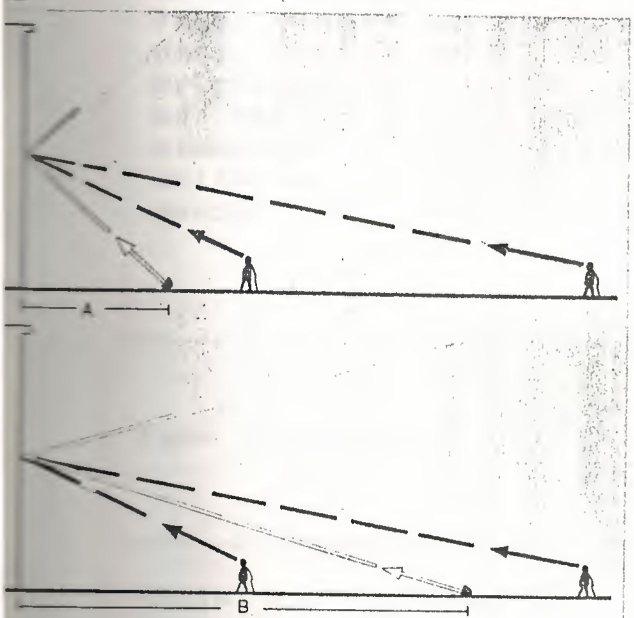
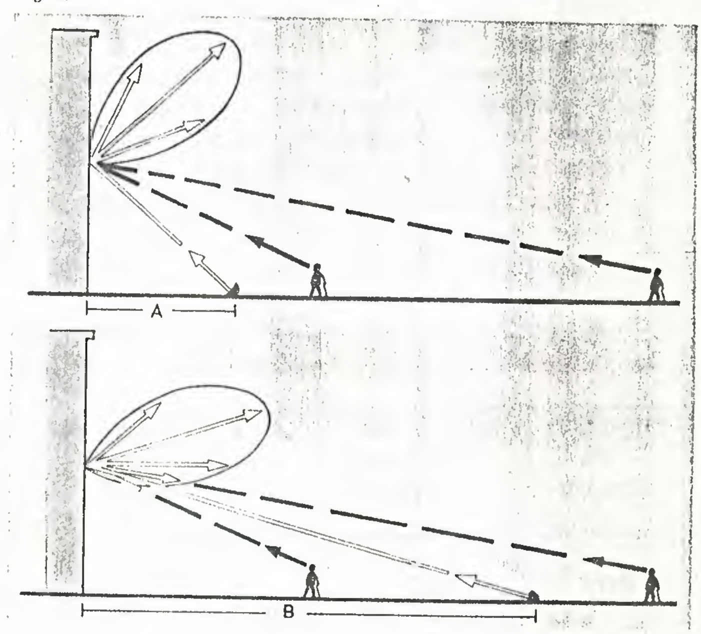


Fig. 58 2



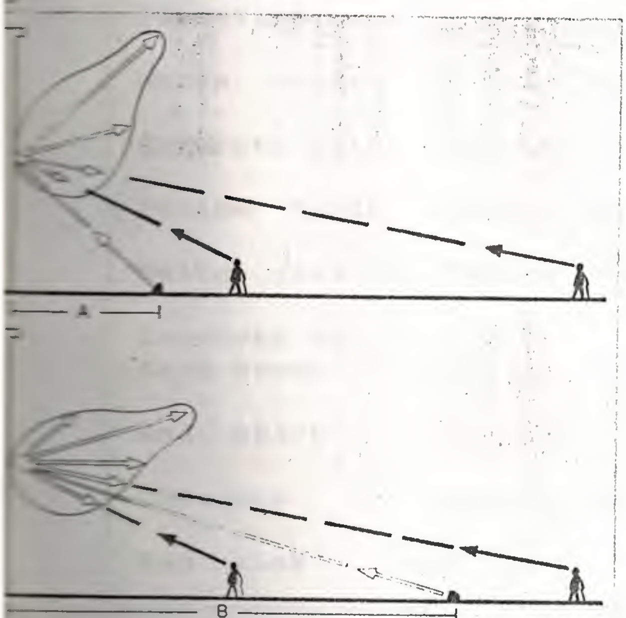
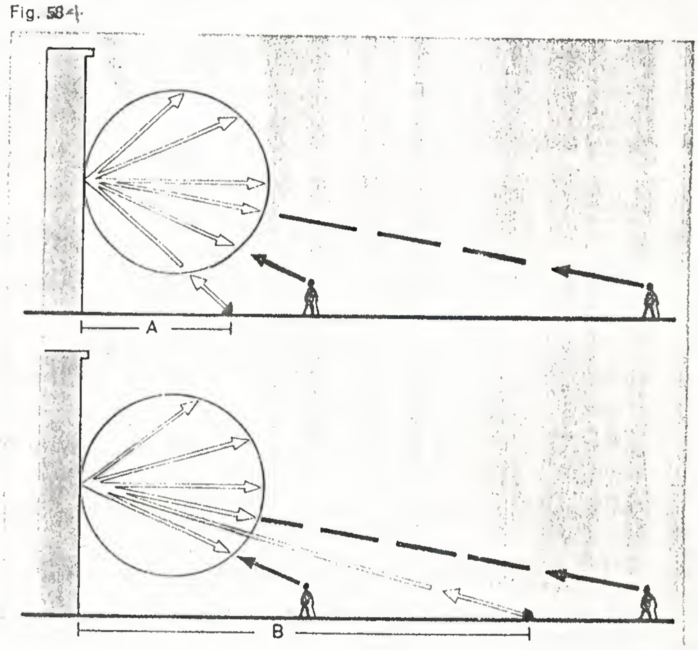


Fig. 58 4



SELECTION OF THE LEVEL OF ILLUMINATION

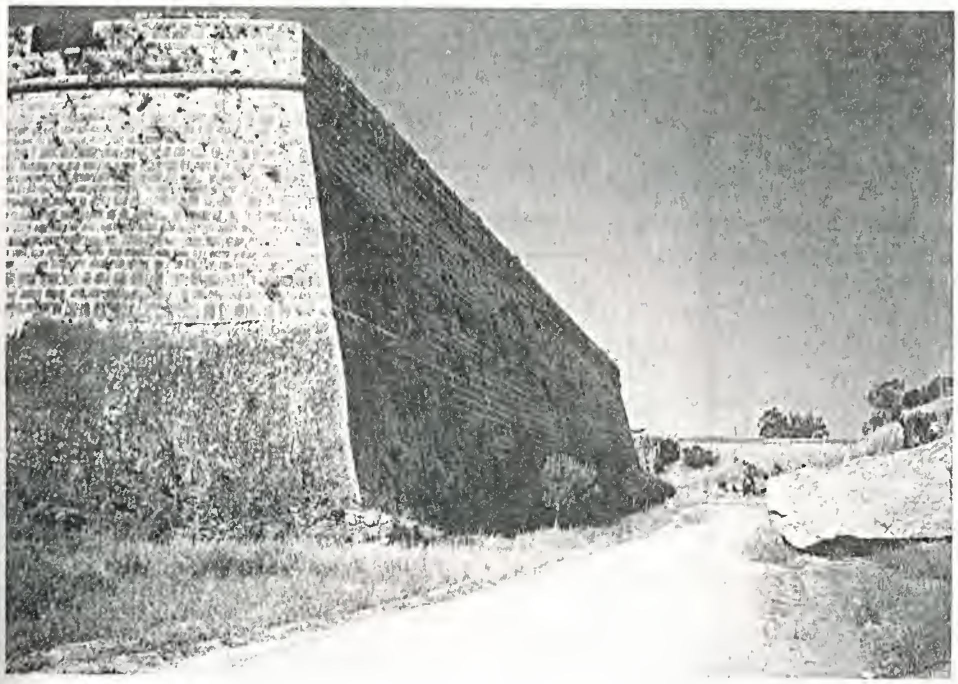
The lighting level needed on a facade to effect a certain brightness contrast depends upon such factors as the reflection factor of the surface building material, the location of the building in relation to its surroundings, the general brightness of these surroundings and the dimensions of the building. The table below present some recommended illumination levels for various surface building materials used on buildings in either poorly lit, well it or brightly lit sorroundings.

Type of surface	state	illumination in lux		
		poorly lit surrounding	well lit surrounding	bright lit surd.
White marble	fairly clean	25	50	100
light concrete imitation	fairly clean	50	100	200
White brick	fairly clean	20	40	80
Concrete paint	fairly clean	100	250	400
Yellow brick	fairly clean	50	100	200
White granite	fairly clean	150	300	600
Concrete or dark stone	fairly clean	75	150	300
Red brick	fairly clean	75	150	300
Concrete	very dirty	-- requires at least 150-300		
Red brick	dirty	-- requires at least 150-300		

EXTERIOR LIGHTING

Exterior lighting requires an architect's attention if it is to suit his architectural concept and not seem merely appliqued. This understanding of the situation is becoming increasingly accepted.
Architects are paying increasing attention to how buildings look at night. Now, however, not only are manufactures offering architects much more in the way of hardware but, beyond this, the architects have developed a more personal and vital interest in exterior lighting.
Of course, it must be recognized that building exteriors themselves have changed very often a facade is texture by bold patterns of exposed structural elements or by the missing of a series of volumes, both of which lend themselves to strongly accented patterns of light. But even when the exterior is flat, such as a sheer glass facade, the client still may want his building to stand out at night. Then the architect may want to concider some sort of internal lighting that will make the building glow from within, a technique that has grown to be more commonly used with glass - walled structures.

It is important for the architect to realize that lighting cannot possibly make a building look the same at night as it does during the day. What is important is that the night - lighted building create a favorable visual impression, not merely be an idenfinite blob of brightness.
Although building floodlighting demands care from the architect in decicing upon lighting approach and in technical execution, there are some basic design parameters that help determine the appproach. Even though the daytime apppearance can not be duplicated, ity should be remembered that daylighting on clear, pleasant day is a combination of derectional sunlight and diffuse skylight. Thus it usually is desirable to locate the main floodlighting so that, similarly, there will be some modeling effect. If floolights are aimed head on to the building, the effect will tend to be flat and it may be uninterseting. This does not mean that the main lighting must be limited to a point source ; modeling also can be achieved by aiming each of a line of floodlights at the proper angle. Deep shadows can be softened by low levels of diffuse floodlighting at an angle to the main floodlighting.



CHAPTER 7

Possible locations for mounting lighting equigment may limit the type of lighting possible. In general four locations may be considered :

1 - on the building itself,
2 - on adjacent ground,
3 - on poles,
4 - on adjacent buildings.

Floodlighting located close to a surface and aimed at a grazing angle will emphasize the texture of the surface ; however, defects such as dimples or waviness tend to be emphasized when viewed from nearby. The farther away the floodlights are located, the lesss bold the texture brought out by the lighting.

Major viewing locations also will affect the floodlighting approach. If the building is to be seen primarly from automobiles, then lighting of the upper major elements of the building may be most important. For pedesrtrians, however, the ground level facade, sidewalk, landscaping, buildings materials, and construction details will deserve emphasis.

Obviously, the viewer should not be aware of the location of floodlights, or should he see reflected images of lampss or reflectors. Therefore floodlights should be louvered or shielded if necessary so that they will not be seen from normal viewing locations. Direct glare near building entrances, which might make steps and curbs difficult to see, particularly should be avoided. Landscaping, walls, or wells can help to minimize direct glare as well as conceal the equigment in the daytime. Sight lines should be checked to make sure there are no bright reflected images of lamps or reflectors showing in specular surfaces.

DESING PROCEDURE FOR FLOODLIGHTING :

The general desing procudure for floodlighting consists of four basic steps :

1 - Determining the desired effect.
2 - Determining the level of illumination.
3 - Determining the location of lighting equipment.
4 - Determining the fixetures and lamps to be used, from the standpoints of engineering performance and the economics of maintenance.

Lighting engineer Robert Faset has suggested the following checklist for selecting larger types of outdoor area - lighting equipment. He points out that selecting lighting equipment requires a combination of common sense, good engineering economic evaluation and a feel for the aesthetics of lighting effects.

1 - For 10000 burning hours per year or less, use filament lamps. Otherwise use high - intensity -discharge sources or fluorscent fixtures in the largest practical size.

2 - Use the largest wattage fixtures and the fewest locations that will deliver amount of light wanted. With area - type luminaires spacing generally should exceed two to four times distance from the surface being lighted to the lighting equipments.

3 - Consider the cost of relamping and cleaning fixtures.

4 - Keep in mind the styling of the lighting equipment.

5 - Buy top - quality fixtures, lamps, and poles, in order to achieve lowest total owning cost.

If uniformity is desired with large area outdoor lighting, these steps will help obtain it, provided that the floodlights are spaced at recommended distances from the building :

1 - Beams should overlap so that any given area receives as much light from the floodlight on either side as from the one directly in front of it.

2 - The widest beam spread available should be used consistent with reasonable utilization

3 - The largest lamp available should be used, consistent with acceptable uniformity. Obviously, proper aiming of floodlights is important. Approximate aiming can be determined by scaled sketches showing beam overlap. Exact aiming, however, must be adjusted in the field regardless of how carefully it was planned and laid out.

When the floodlighting equipment is aimed upword from a low level, the shadows that exist in daylight will be reversed or perhaps even eliminated While flat, head on illumination destroys depth and perspective large brightness contrasts may not produce desirable effects either. The resons is that bright areas appear closer and dark ares appear farther away to distance observers. For very tall structures apparent uniformity is achived if the top portions are illuminated so that they are from two to four times as bright as the lower portions. Greater illumination at the top also accentuates apparent height. Illuminating the lower portion of the building at a somewhat lesser level also minimies possible annoyance to pedestrians

Most lighting designers feel that shadows should appear as natural as practical. That is to say, if duplication of the type of shadows produce by the sun is not feasible, the shadows should at least present an interesting pattern and not destroy the basic form and depth of the architecture

The basic floodlighting effects can be categorized as :

1 - Flat floodligfhting
2 - Grazing floodlighting
3 - Interior floodlighting
4 - Accent or outline floodlighting

The type of equipment used, for the most part, will depend upon the size of the building. Monumental buildings will most generally be floodlighted by large units, except for interior lighting effects when fluorscent or quartz (tungsten - halogen) lamps may be used at the windows to illuminate draperies or window surrounds. Buildings of lesser size often employ projector (PAR) and reflector (R) lamps, particularly for grazing floodlighting and accent floodlighting ; outline lihghting may be accomplished using generalservice incandesent lamps or sign lamps

Grazing Floodlighting :

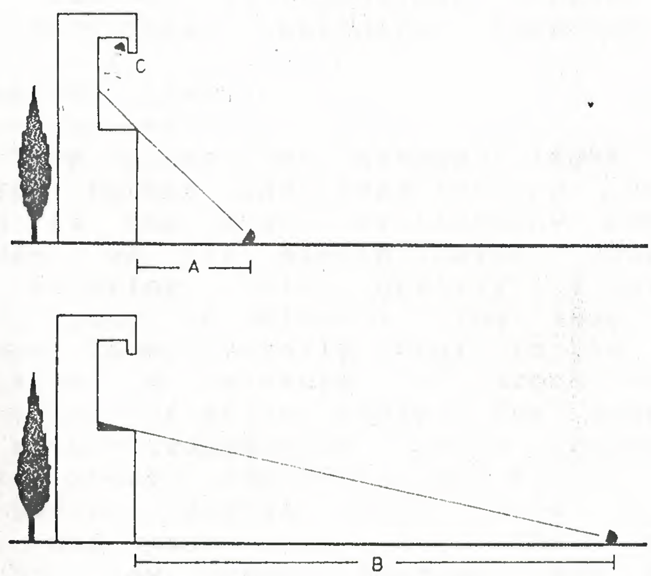
Grazing floodlighting often produces strong high lights and shadows, particularly when the floodlights are mounted very close to the facade. In addition to being desirable aesthetically, the grazing technique will be suitable functionally where lack of space, appearance considerations, or other restrictions prevent mounting floodlights in front of the building. Incandecent, fluorescent, and high - intensity discharge lamps have all been used for grazing floodlighting. Equipment may consist of spread - lens and fresnel - lens incandescent units, fluorescent floodlights with large specular reflectors, or tungsten - halogen and high intensity discharge lamps in reflector type fixtures with clear glass covers. In some cases, even small, single lamp fluorescent units with white reflectors can be used effectively for low buildings.

Facades with recessed parts ;

These may be balconies which are set back or galleries with railings at the front. Obviously a large part of the built - in space will be in shadow if the floodlights are placed only a short distance from the facade.
In such a case supplementary lighting will be required in the balcony and for this light of onther color

may be used. If this done, a particularly striking effect can be achieved, at the same time creating a greater impression of depth.

Floodlighting from a larger distance, however, reduces shadow, making it less visible to the viewer, thus obviating the need for extra lighting. The figure shown below.



LAMPS TYPES :

Three types of lamps are in common use for exterior lighting ;

a) Tungsten filament
b) Sodium
c) Mercury

Tungsten - filament lamps are available up to 1500 W loading. They render all colors satisfactorily, red in particular. Nowadays, tungsten - halogen lamps have become very popular for floodlighting applications. In general they provide some 15 per cent more light and twice the life of ordinary filament lamps used for floodlighting applications are of linear double - ended construction and therefore give a fan - shape beam, which is narro w in vertical plane. Reflector lamps using the sealed - beam prin- cple are useful in confined space or for high lighting particular building features.

SODIUM - VAPOUR LAMP :

This lamp gives an orange light and is used mainly for street and roadlighting, and on airfields. The lamp is the most effficiency produce of light but becouse of its single color characteristic it gives an inferior color quality (everyting looks) yellow or grey to black). The lamp consist of a long glass tube, usually bent in to U - shape. The tube contains a mixture of argon and neon gases, with particles of solid sodium. The lamps is operated from an auto - transformer which raises the mains voltage to about 350 V to 400 V.

Low pressure sodium lamps have a high luminous efficiency and poor life, but their predominantly ye- llow light, low powder loading and poor color -re- nding limit their application in floodligting. Th- eir prime use in to produce yellow light. The high - pressure sodium lamp provides a source of high light output with exceptionaly good golden color appearance and color rending almost like the warmth of the setting sun

Sodium lamps are classified by means of a three or four - letter designation. The first letter is al- ways " S ".

Type SO/H : This lamp has an arc tube enclosed in an outer jacket and is removable. The "H" indicates that the lamp is designed for horizontal operation.

Type SLI/H : In this type, the arc tube is linear instead of U -shaped arc tube of the other sodium types.

Type SOX : This type is broadly similar in construction to the SOI/H lamp exect that it has a heat reflecting coating on the inner surface of the enclosing jacket. Also designed for horizontal operation.

The average life of all sodium lamps is 6000 hours. The high pressure sodium lamp is a recet development. This discharge is contained in a pencil shape translucent ceramic tube which is housed in an enacuated outer jacket. With an efficiency of 100 lm/W and a light output of nearly 40,000 lumens, the 400 W type of lamp is the most efficincy light source yet developed. A high voltege source is necessary for starting and is provided by a thyristor ignitor. The lamp can be used in any burning position. There is a good color rendering.

It is used where color rending is not important Therefore it is not usefull for indoors. It is usful for outdoor lighting such as carpark, highway light etc. It is more economically , short recognization time and moving objects. The characteristics of high pressure sodium lamps which I used it in my project shown below table ;

Rating (watts)	type of envp.	Lighting design lumens	Op. Volts (V)	Op. Currt. (A)	cap	Mx. dimn. (mm)	
						ovral lenght	bulb dimt
150	tubu lar	19500	240	3.0	E40	227	91
250	tubu lar	27000	240	3.0	E40	257	53
400	tubu lar	47000	240	4.4	E40	292	122
1000	tubu	130000	240	4.4	E40	292	53

High pressure sodium lamps characteristics are show above table.

Definition : High - pressure sodium vapor lamps, for outdoor and indoor use, with sitered aluminium oxide discharge tube enclosed in a clear, tubular hard glass outer bulb.

Description :

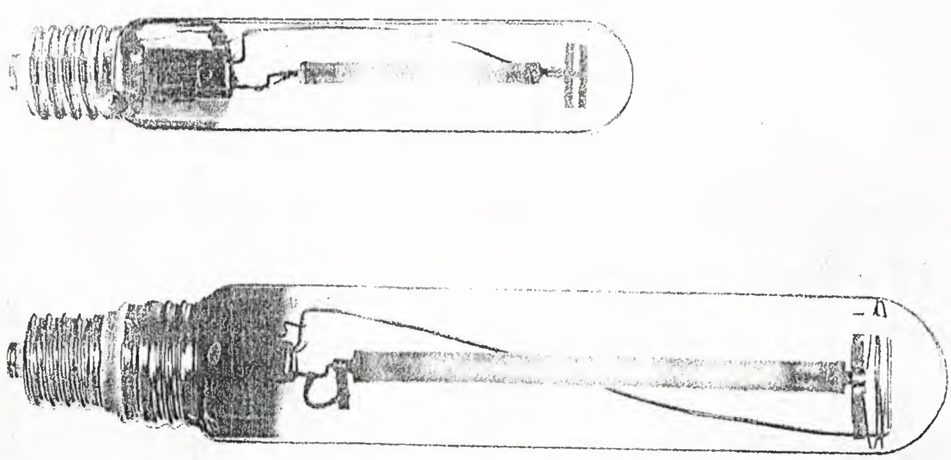
- Becouse of the high sodium pressure the lamp has a high luminous efficiency and a good color appearance.
- The clear, tubular outer bulb makes this light source highly suitable for use with specially designed optical systems.

- Additional assets :
  * Long economical life
  * Excelent lumen maintenance
  * Reliable, stable operation.

Applications :

- Public lighting
- Parking lost
- Airports
- Floodlighting
- Industrial lighting
- Plant irradiation
- Sports lighting

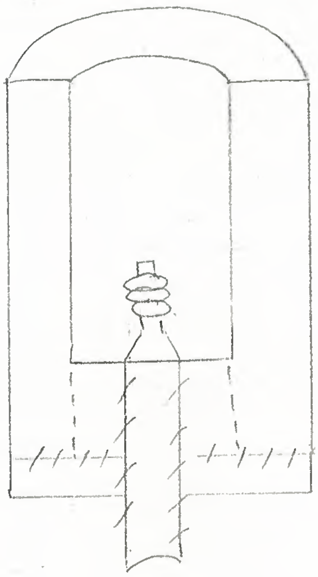
High-pressure sodium lamps



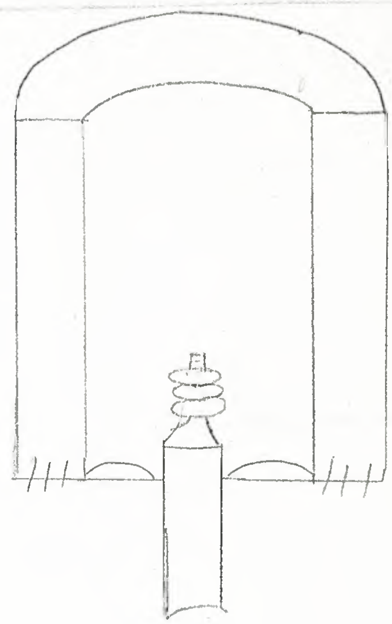
SON-T 150W
SON-T 250W
SON-T 400W
SON-T 1000W

SON-T lamps

Possible constraction for high pressure sodium lamp in seramic arc tube shown below figures.



(a)



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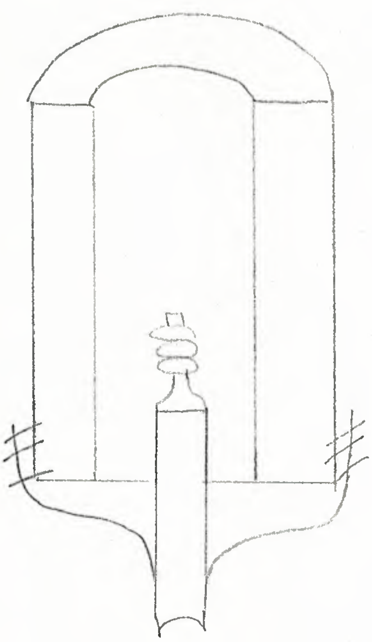

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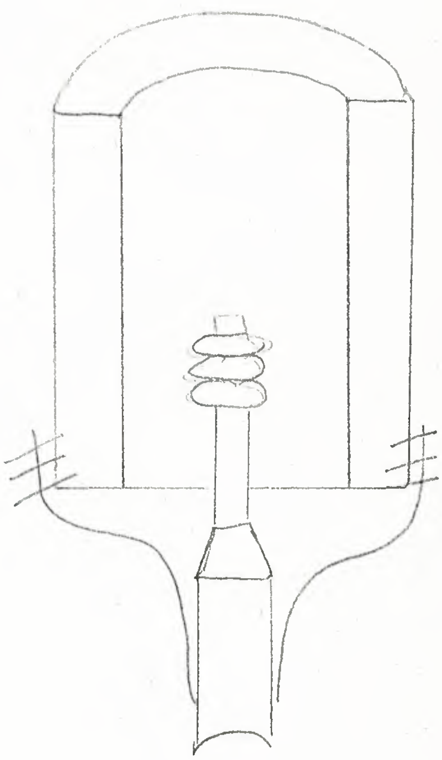


(d)

CHAPTER 4

HIGH - PRESSURE MERCURY - VAPOUR LAMP :

This type of lamp is used for street and road lighting, floodlighting and lighting industrial premises. The light emitted is bluish - green in color. There are several types of HPMV lamp. They are classed according to the loading per cantimetre if arc lenght. The lamp consists of an inner bulb or lamp proper made of special silicate glass bulb.

High - pressure mercury vapour lamps have a much longer life and a higher efficiency. The average life of this lamp is 5000 hours. It is relatively larger source size, the control of light distribution is not quite so precise as with tungsten lamps.

MERCURY LAMPS:

Mercury lamps as a general description covers a wide range of light sources. They are all based on the operation of an electric discharge tube generally made of fused silica and containing mercury vapour at a pressure of some atmospheres. In most cases no liquid mercury is present in the lamp when it is full opeation.

The color and luminous efficacy of mercury lamps primarily depend on the vapour density within the lamp. They can be modified by the use of phosphors by the addition of other elements to the discharge and by adding light from an incandescent filament. Lamps within the range are used in general lighting light projection and special applications.

CALCULATION TECHNIQUES:

Once the lighting requipments have been decided, floodlighting design falls into three stages. Firstly a partical assessment is made of where to locate the floodlights, the light distribution required, and the light source characteristics which suit the particular application.

Secondly, a " Lumen calculation " is carried out to establish the number and the loading of the luminaires to achieve the design objectives.

Thirtly, " point -by - point calculations " are performed to determine the precise aiming of the floodlights to give a stated illuminance diversity : this in turn may necessiate slight modifications to the preliminary calculation.

For a large facade the lumen method should be used. This based upon a certain average luminous efficiency. For high and small objects, castle steeples chimneys, minaret, etc, the luminous intensity method should be used. This is based on the luminous itensity radiation in a certain direction.

LUMEN METHOD :

As the name suggests, this method consists in calculating the number of lumens to be directed on to a facade in order to obtain a certain illumination level.

The number of lumens cab be calculated by means of the formula :

Q = (F * E)/n

Where Q is the total number of lamp - lumens, i.e. the total luminous flux produced by all lamps.

Where F is the surface of the facade to be illuminated in meter square.

Where E is the desired illumination in lux on that facade.

Where n is a factor which takes into account the efficiency of the fitting and the light losses (luminous efficiency).

```
                                      |
         I              E             |
@ >-  -  -  -  >  -  -  ->            |        E = I / D*D
                                      |
/-  -  -  -  D  -  -  -  -/           |
______________________________________|        fig. 5
```

The percence of a utilization factor in this formula indicates that not all the lamp lumens contribute to the illumination level on the facade. The lumen produce by the lamps are concentrated by reflectors in which process some loss is in volved. If the initial output is 100 % lamp lumens, 60 to 75 % are projected through the lighting eqipment and 40 to 25 % are lost in the fitting itself through inter-reflection in the reflector and absorption by other parts of the fitting.

After the floodlighting has been in operation for some time, a further percentage of the actual number of lamp lumens is lost becouse of the decrease in luminous flux due to the ageing of the lamp and dirt which collects on the lamp and fitting.

Finally a percentage of the losses is account for by wasted light, that is light not incident to the building facade. In practice an average utilization factor varying between 0.25 and 0.35 may be reckoned with. Using this figure in the formula given page 23. The total luminous flux needed, Qt ca be calculated. Once the total number of lumens is known, the number of fitting (N) needed can be calculated by dividing this amount by the number of lumens installed per fitting :

N = Qt / Qf

Note : If fitting are eqipped with two lamps, Q fitting is twice Q lamp.

LUMINOUS INTENSITY METHOD :

In this method the starting point is the luminous intensity, in candela, radiated by a light source in a particular direction. This luminous intensity may be derived from the limunous intensity diagram or from a table. This data can usually be found in the appropriate catalogue and brochures.
The calculation is made with the formula (fig.4 and 5).

```
                                   |
                          E    /|  /
                            /   |  |
                      I   /     |
                        /       |  |
                      /         |  h
                    /           |
                  /             |  |
---------@----------------         /
        / -  -  D  -  - /
```

The formula is ;

E = $(1 / h)\ \sin^{2}\theta * a\ \cos^{1}\theta a$ tan a = h / D

Where E is the vertical illumination on the facade,
I is the luminous intensity at the angle a,
h is the height of the object above the level on which the fittings are arranged,
a is the angle at which the light beam strikes the normal on the plane to be illuminated.

LIGHTING UNITS AND DEFINITIONS :

Luminance : (L)
The luminous intensity in a given direction divided by the area of the surface pe-pendicular to taht direction.

Candela : (cd)
Units of luminuos intensity. Also called the new international candela. Equal to the lum-nous intensity of a surface of black -body radiator operated at the temperature of soli-difying platinum.

Candela - Power :
Units of luminous intensity. Orginally the luminous intensity of a specified candle burning at a specified rate.

Illuminance : (E)
Luminous flux on a surface element divided by the area of the element ; in lumens per square meter or lux.

Lumen : (lm)
The flux emitted in unit solid angle by a uniform point source of one candela. It is unit of luminous flux.

Lux : (lx)
Unit of illuminations, the illumination pro-duced on the surface of a sphere, having a radius of one meter, by a uniform point source of one candela situated at its cen-tre. It correspond to a flux density of one lumen per square meter.

Flux, radiant : (Qe)
Power emitted, transsferred or received as radiation : in watts.

Luminous flux : (Q , F, unit : lumen)
The rated of passage of radiant energy evalu-ated by refference to the luminous sensation produced thereby.

Luminance intensity :(symbol ;I , unit: candela)
The quantity which describes the light - giving power of a source in any parti-cular direction . If F is the luminous flux emitted within a cone of very small angle w, having its apex at the source and its axis.

Objective brightness :

This is a luminous intensity of a light source. It is the light output divided by the projected area of the kight source in the particular direction, measured in candela per unit area.

The ratio of reflection factor :

$$\frac{\text{Lumens reflected from a source}}{\text{Lumens received by the surface}}$$

Coefficient of utilization :

New called the utilization factor, is a factor used in planning schemes, which allows for loss of light by absoption in reflectors, ceilings, walls, etc. It is the ratio ;

$$\frac{\text{Lumens received at the working plane}}{\text{Lumens generated by the light source}}$$

Reflection factor :

The reflection factor describes the relationship between the incident luminous flux and the reflected luminous flux. This factor depends upon the reflection properties of the surface of the material to be illuminated.

Maximum intensity :

The maximum intensity of the beam is the maximum intensity in candela per 1000 lumen of the lamp flux (fig. 1 a)

Beam spread :

This is the deviation in degrees between the lines indicating the direction where the luminous intensity is 1 /2 Imax (Europe).

Beam lumens :

The terms beam lumens refers to the quantity of light (figs. 1-c and 1-d) contained within the beam for I = 0.5 I max (Europe).

Beam efficiency :

It is the ratio between the luminous flux in the beam and total luminous flux of the lamps.

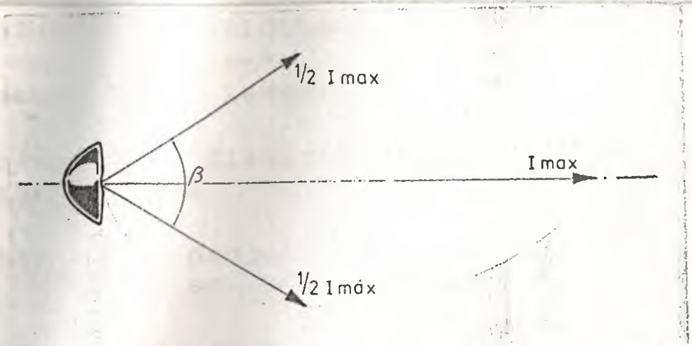


Fig. 66

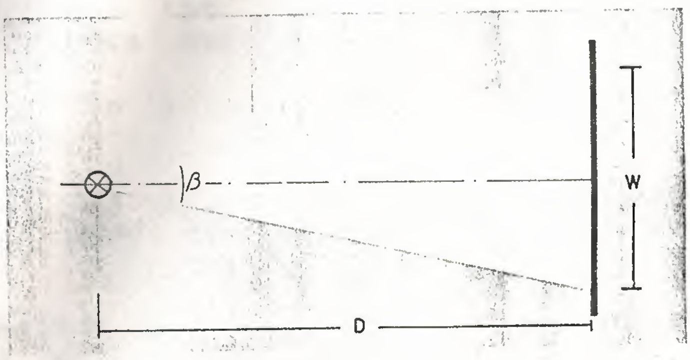


Fig. 67

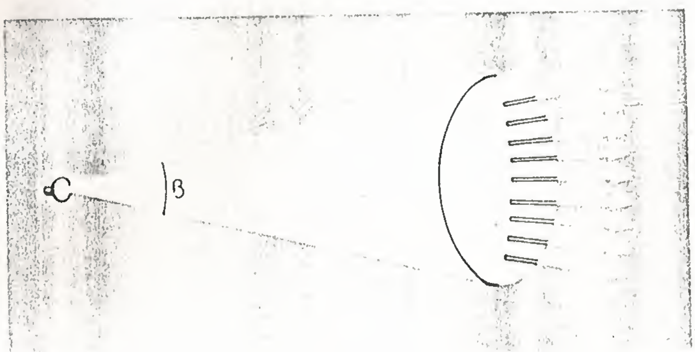


Fig. 68

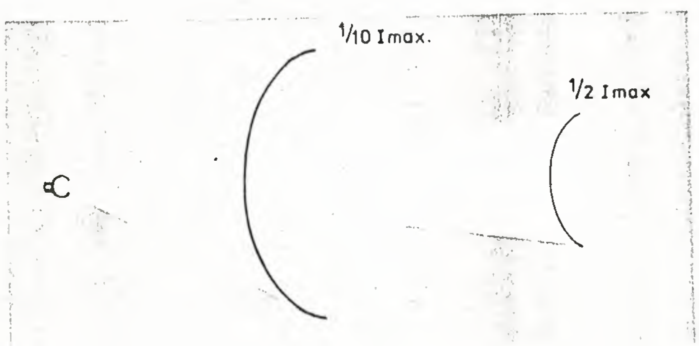
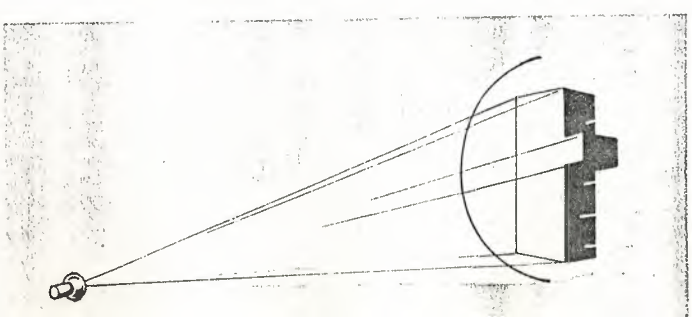


Fig. 69



PROCEDURE OF CALCULATIN :

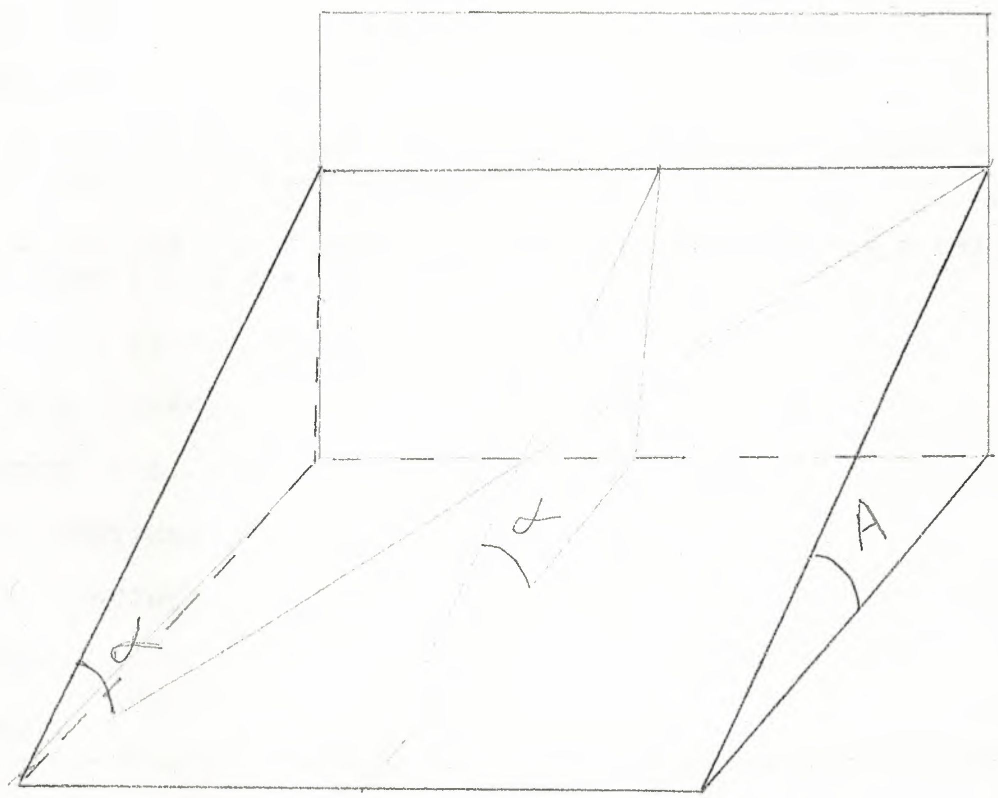
- Measure the lenght and the wide of castle,
- Chose the distance between the projector and the light source,
- Chose the projectors and its isocandela curves which is narrow or wide beam.
- Chose, what type of projector will you use.
- Calculate the light intensity in each point on the isocandela curves
- Find the illuminance at each point on the isocandela curves.
- Draw its figure on the white paper and thin paper for find the distance between the two projectors.
- Used " A and alfa (α) "projectors, calculate "A" and alfa (α) respectively.

The formulas which used our project shown below.

$$A = \tan^{-1} \frac{Y'\sqrt{1+X_0'^2}}{1+X'X_0'} - \tan^{-1} \frac{Y_0'}{\sqrt{1+X_0'^2}}$$

$$\alpha = \cos^{-1}\left[\frac{1+X'X_0'+Y'^2\,\frac{1+X_0'^2}{1+X'X_0'}}{\sqrt{(1+X'^2+Y'^2)\left(1+X_0'^2+Y'^2 * \left(\frac{1+X_0'^2}{1+X'X_0'}\right)^2\right.}}\right]$$

$$\cos^3\Theta = \frac{1}{(1+X'^2+Y'^2)^{1.5}}$$



A, α projector.

COMPUTER PROGRAMING FOR CALULATION "A" AND "alfa" :

```
READ  ( 5,*)  C , D

Z = 0

B = 0

DO  10  Z = 0 , 2 , 0.1

DO  20  B = 0 , 2 , 0.1

S = INV COS [ 1/SQRT ( 1 + C**2 + D**2) * ( 1+ D**2 + C*Z) /
    SQRT ( 1 + D**2 + Z**2)]

A = INV COS [ 1 / SQRT ( 1 + C**2 + D**2 ) * (1 + C**2 +D*B)/
   SQRT ( 1 + C**2 + B**2)]

G = 1 / [( 1+ Z**2 + B**2)**1.5)]

H = G / (h**2)

WRITE  ( 5, * ) , C , D , Z , B, E, F, G, H,

20  CONTINUE

10  CONTINUE

STOP

END
```

```
LET :     Z = X`        E = H * I  ,      Xo`= Xo / h
          B = Y`
          C = Xo`       X` = X / h        Yo`= Yo / h
          S = alfa
          G = COS³Θ     Y` = Y / h        E = I* cos³Θ  / h**2
```

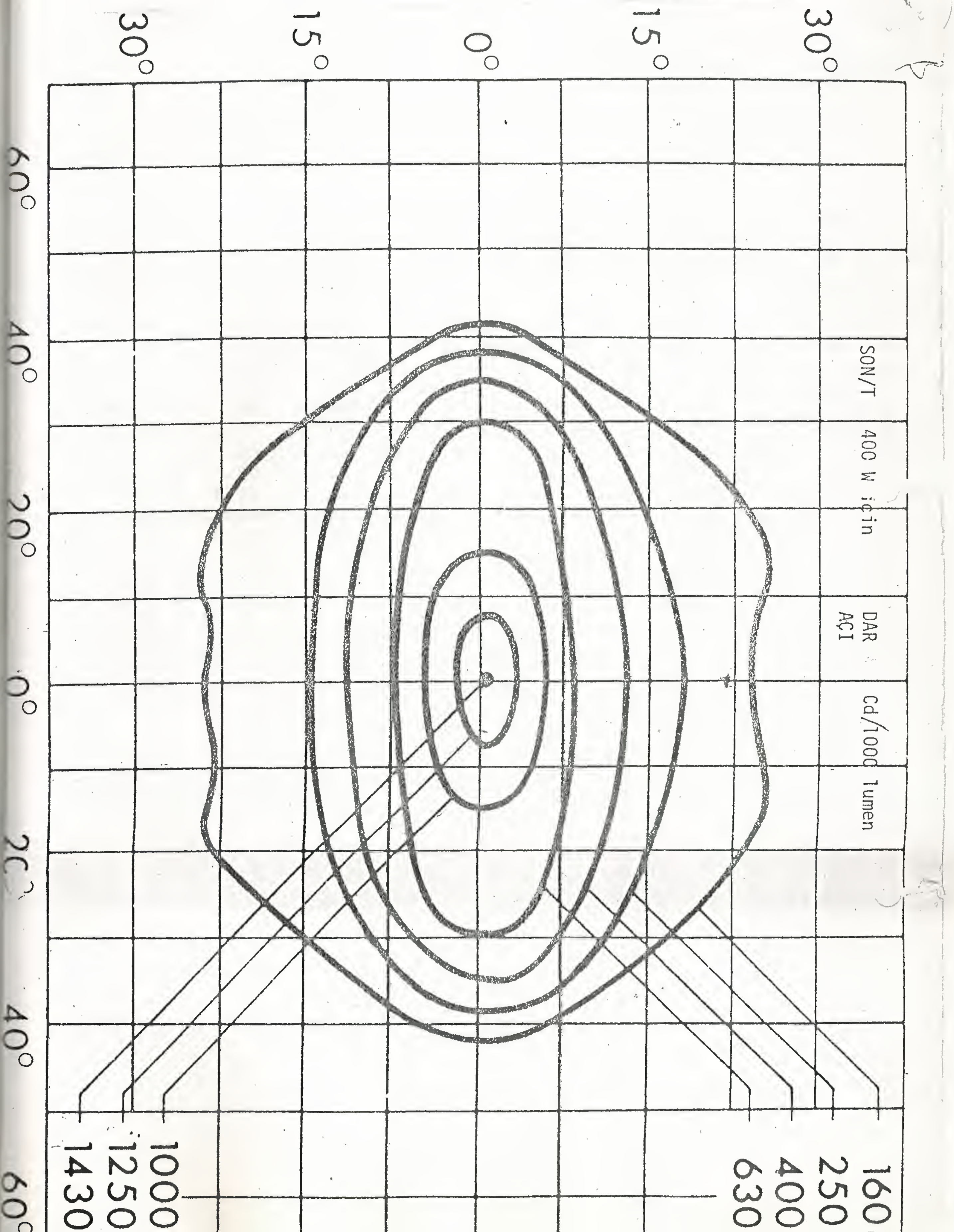
The table shown below is the result of high pressure sodium vapour lamps (SON -T 400 W).

X`	Y`	α	A	I	Cos$^3\theta$	E
0	0	0	0	38610	1.0000000	167.94
0	0.1	0	5.71	34965	0.9851854	149.83
0	0.2	0	11.30	29700	0.9428662	121.8
0	0.3	0	16.69	25795	0.8787398	98.58
0	0.4	0	21.80	22404	0.8000411	78.00
0	0.5	0	26.56	19107.9	0.7155418	59.47
0	0.6	0	30.90	15974.8	0.6305096	43.81
0	0.7	0	34.99	10800	0.5498201	25.82
0	0.8	0	41.98	6750	0.4761395	14.00
0.1	0	5.71	0.00	27000	0.9851854	115.71
0.1	0.1	5.71	5.71	26190	0.9707331	110.57
0.1	0.2	5.71	11.30	23028.3	0.9294288	93.09
0.1	0.3	5.71	16.69	19560.4	0.8667842	73.74
0.1	0.4	5.71	21.80	17280	0.7901714	59.38
0.1	0.5	5.71	26.56	15457.5	0.7070404	47.53
0.1	0.6	5.71	30.90	12042	0.6236188	32.57
0.1	0.7	5.71	34.99	8775	0.5443311	20.77
0.1	0.8	5.71	41.98	6238.4	0.4719176	12.78
0.2	0.0	11.30	0.00	12278.8	0.9428662	50.35
0.2	0.1	11.30	5.71	12042.7	0.9294288	48.68
0.2	0.2	11.30	11.30	11259	0.8909722	43.62
0.2	0.3	11.30	16.69	10395	0.8324965	37.65
0.2	0.4	11.30	21.80	9307.9	0.7607259	30.8
0.2	0.5	11.30	26.56	7256.5	0.6825201	21.54
0.2	0.6	11.30	30.90	6264	0.6036817	16.45
0.2	0.7	11.30	34.99	4320	0.5284001	9.93
0.2	0.8	11.30	41.98	0.00	0.4592362	0.00
0.3	0.0	16.69	0.00	8100	0.8787398	31.0
0.3	0.1	16.69	5.71	7832.7	0.8667842	29.52
0.3	0.2	16.69	11.30	7236	0.8324965	26.18
0.3	0.3	16.69	16.69	6596.5	0.7801480	22.37
0.3	0.4	16.69	21.80	5291	0.7155418	19.28
0.3	0.5	16.69	26.56	4320	0.6446780	14.83
0.3	0.6	16.69	30.90	0.0	0.5727275	0.0
0.3	0.7	16.69	34.99	0.0	0.5035173	0.0
0.3	0.8	16.69	41.98	0.0	0.4394716	0.0
0.4	0.0	21.80	0.00	5541.2	0.8001410	18.9
0.4	0.1	21.80	5.71	5211	0.7901714	17.8
0.4	0.2	21.80	11,30	5041.4	0.7607259	16.67
0.4	0.3	21.80	16.69	5019.7	0.7155418	15.59
0.4	0.4	21.80	21.80	4493.9	0.6593852	12.87
0.4	0.5	21.80	26.56	3354.7	0.5972710	9.80
0.4	0.6	21.80	30.90	0.0	0.5336232	0.00
0.4	0.7	21.80	34.99	0.0	0.4718176	0.00
0.4	0.8	21.80	41.98	0.0	0.4140867	0.00

```
  31---29.52---36-----33.5---34.1----34.1---33.5---36-----29.5---31-
   |     |      |       |      |       |      |      |      |      |
   |     |      |       |      |       |      |      |      |      |
50.35--48.68---53.55---54.1---52.2----52.2---54.1--53.5---48.62--50.3
   |     |      |       |      |       |      |      |      |      |
   |     |      |       |      |       |      |      |      |      |
115.7--123.4---114-----106----103-----103----106---114---123.4--115.7
   |  /  |      |       |      |       |      |      |      |      |
   | 2m  |      |       |      |       |      |      |      |      |
   |  /  | /2m /|       |      |       |      |      |      |      |
@ 167----164----142-----146.8---133.5---133.5--146.8--142----164---167
   |  0  |      |       |      |       |      |      |      |   0  |
   |     |      |       |      |       |      |      |      |      |
115.7--123.4---114-----106----103-----103----106---114---123.4--115.7
   |     |      |       |      |       |      |      |      |      |
   |     |      |       |      |       |      |      |      |      |
50.35--48.68---53.55---54.1---52.2----52.2---54.1--53.5---48.62--50.3
   |     |      |       |      |       |      |      |      |      |
   |     |      |       |      |       |      |      |      |      |
  31---29.52----36-----33.5----34.1----34.1---33.5---36-----29.52--31
   |     |      |       |      |       |      |      |      |      |
   |     |      |       |      |       |      |      |      |      |
  19----17.8----16.67---16-----12.87--12.87---16-----16.67--17.8---19
```

Final illuminance average values between two floodlights. The distance between two floodlights are 18 m. And the height of the floodlights are 8 meters from the ground.

Ioscandela curves figure



The results of SON-T 400 W which I set up on the ground.

X`	Y`	α	A	$\cos^3\theta$	I	E
0	0.0	20.37	20.37	1.000	56676.8	141.7
0	0.25	20.37	7.30	0.9411	55160.14	129.78
0	0.5	20.37	4.53	0.8	41565.62	83.13
0	0.75	20.37	14.48	0.63	36805.88	58.9
0	1.00	20.37	22.5	0.50	32922.47	41.15
0	1.25	20.37	22.28	0.39	27207.77	26.52
0.25	0.00	7.30	20.37	0.9411	42031.42	99.00
0.25	0.25	7.30	7.30	0.8888	40478.75	98.89
0.25	0.5	7.30	4.53	0.7619	39957.5	64.68
0.25	0.75	7.30	14.48	0.6153	29610	45.55
0.25	1.00	7.30	22.5	0.56	26907.5	35.81
0.25	1.25	7.30	22.28	0.4122	23844.66	24.58
0.5	0.00	4.53	20.37	0.8000	17573.91	35.14
0.5	0.25	4.53	7.30	0.7619	17390	33.12
0.5	0.5	4.53	4.53	0.6666	14883	24.8
0.5	0.75	4.53	14.48	0.5517	13868	19.24
0.5	1.00	4.53	22.5	0.44	11750	15.5
0.5	1.25	4.53	22.28	0.35	10058	8.88
0.75	0.00	14.48	20.37	0.64	10692.5	17.28
0.75	0.25	14.48	7.30	0.6153	10692	16.5
0.75	0.75	14.48	4.53	0.5517	10257	14.14
0.75	1.00	14.48	14.48	0.47	9261.7	10.87
0.75	1.25	14.48	22.5	0.3902	8930	8.71
0.75	1.75	14.48	22.8	0.32	0.00	0.00
1.00	0.00	22.5	20.37	0.5	8490.15	10.61
1.00	0.25	22.5	7.30	0.4848	8841.87	10.71
1.00	0.5	22.5	4.53	0.4444	8789	9.76
1.00	0.75	22.5	14.48	0.3902	7520	7.33
1.00	1.00	22.5	22.5	0.3333	0.00	0.00
1.00	1.25	22.5	22.8	0.2807	0.00	0.00

CONTENTS
****

CHAPTER - 1

CHAPTER - 2

CHAPTER - 3

E. E. 400 SPECIAL PROJECT

CHAPTER - 4

CONTENTS :

PREFACE

Purpose of this project :
It is about illumination around some part of the Famagusta Castle which is called St.- NICHOLAS in the project.
My opinion is that by means of this lighting system the castle will look more attractive and beautiful to everyone than it had been before. The most of the tourists visiting our country will be able to see how this fantastic castle appear at nights. And it will also help to the whole shops which exist in that area, remain open even until midnights. So, it will not only be useful for tourism but also for our own people living in Famagusta. They will have chance to do shopping for the things they are urgently in need. I think this may be a good step for development.

I also would like to thank to my Professor Mr. Haldun Gurmen for his assists in the preparation of this project. He had been always ready for us. And I am certain he did his best for being helpful.

F.CIVISILLI

INTRODUCTION

There is no doubt that floodlighting a bul- is one of the most spectacular achievements in lighting engineering. A floodlit building is a focal point in a town, where it is dark and colours are blurred.

Formerly it was mostly buildings of historic interest that were floodlit.

Floodlighting of these old buildings, which often boast rich, ornate facades and beautiful architecture, i s still very effective. Such wonderful results can be achieved that often these buildings are reinvested in this way with some of their former glory.

In addition to being used for aesthetic purpose, floodlighting nowadays can be simply functional This is especialy true of industrial and commerical buildings were floodlighting is used for advertising and security reasons. In generaly, floodlighting of industrial and commerical buildings can be said to have a threefold purpose.

* As a relatively inexpensive means of advertising

A building which at night would otherwise be completly invisible or incospicuous, will immediatly attract attention when it is floodlit.

If the name of the firm or the trade mark is floodlit on the facade, advertising is possibly made even more effective.

* Prestige..

In many cases the reasons for wanting a building to be as spectacular as posssible is that it is of focal or national importance or has particular architectural qualities. After sunset, floodlighting is consequetly an effective means of impressing visitors.

* Increased security around buildings.

Nowadays it is unfortunently necessary to take elaborate precautions in order to prevent illegal entery, theft or wilful destruction of factory and other industrial buildings. Floodlighting in the areas around buildings enables night watchmen and police to have a clear view of the scene.

The diffeent used to which floodlight is put whether they are primarly aesthetic or purely functional to achieve commerical ends, does not alter the fact that quality of the end product should be as high as possible. Even a modern office block with bare frontage can be made attractive by means of artivical lighting However, it must be said that, whether the reason, it is better to abandon the idea of a floodlighting installation that to be satisfied with a mediocre result.

CHAPTER 1

PLANNING

A floodlighting installlation project can only be carried out succesfully if a thorough study has been made of the building concerned. The lighting engineering should become familar with all factors relating to lighting installat-ions for the building. It is esssential he sh-ould first study the features of the facade under various conditions and with the sunlight falling upon it at different angles in order to decide which are the most attractive features.

If an on the spot survey is impossible, daylight photos, drawings or a scale model can be useful aids. An informative part of the "day-light study" is the analysis of how given ef-fects arise. Althoug this project is about the floodlighting of castles by means of artifical light, it will none the less be useful first of all to go into certain features of the effects of daylight upon them.

In the past, an architect only thought in terms of a building being viewed in daylight when he was drawing up his plans. The archit-ecture of the facade was therefor designed in those days with the idea in mind that it wo-uld be lit from above, by the sun and the sky. Today, however, there is a greater tendency to think that a building should also be attractive after dusk, when the various surface may be ill-uminated by a floodlighting installation. The app-earence of the building at night is therefore taken in to account when designing the building and it is most important that if this is the case, there shoud already be good cooperation, at this stage, between the lighting engineering and the architec, in order to avoid any risk of the architect's conception being misinterpreted.

CHARACTERISTICS OF LARGE FLOODLIGHTING EQUIQMENT

An important factor to be considered in sel-cting floodlights is beam spread - i.e., the ang-le between the points on a candlepower distri-bution curve that are 10 per cent of the mx. candlepower. A large, low area to be lighted from a relatively short distance dictates wide - beam floodlights, while greater distance suggests na-rrower - beam equiqment. A tall building lighted from close in floodlights will, on the other hand, call for narrow beam equiqment for lighting the upper part, mainly becouse of the grazing angle of the light. Four factors determine beam

spread of the luminaire:

1 - Dimensions of the light source and the reflector. As the ratio of the light source dimension to the reflector size increases, the beam spread increases.

2 - Surface texture of the reflector. Polihsed is used for narrow beams, etched for wide beams (sometimes a polished surface is used with phospor - coated high - intensity - discharge lamps to achieve similar beam spreads, while allowing a choice of color rendition).

3 - The diffusing or refracting characteristic of the glass cover.

4 - Focal lenght of the reflector. The spherical elliptical, parabolodial, cylindrical, or a combination of these. The shorter the focal lenght, the larger the beam spread. The conventional general service - type incandescent lamp placed inside a polished reflector covered by clear glass a gives a beam spread of 25 degrees by 25 degrees. Changing the reflecting surface from polishe to etched enlarges the beam spread to 65 degrees by 65 degrees. If the glass is stippled the beam spread is reduced to about 40 degrees. But then a frensnel lens can produce a nonsymmetrical beam pattern of 25 degrees vertical and 45 degrees horizontal.

ARCHTECTURAL CHARACTER DETERMINES TYPE OF LIGHTING

A significant aspect of the more recent examples of the floodlighting buildings is that in very many cases the architectural character of buildings pretty much suggests the type of lighting that is most appropriate. In other words, engineering factors, thoug important, are subservient to aesthetic demands. The lighting approch and the equiqment are geared to emphasize architectural features in a natural sort of way.

To illustrate: The celluar grid and horizontal sunshaded facade of a tall building is cross-lighted by two banks of floodlights shining up from ground or near ground level. The result is a building that is uniformly lighted but with strong accents on the undersides of the horizontal sunshades and modeling effects on the grid elements. The buildins has punch as well as brillance.
Another building has filagreed precast concrete screens between tall concrete columns topped by

CHAPTER 7

a cornice. Single rows of floodlights at ground level highlight the screens and graze the columns with even illumination. The floodlights are close to the building, and with their high aiming angle they brightly illuminate the cornice.

How bright the building should be depends not only upon the general ambience of illumination in the neighborhood of the building but also upon the personal preferences of client and architect For any major building, the architec and a repr-esentative of the calient should visit a number of floodlighted buildings - building of some - what similar characrter and size - so they can better co-mmunicate their preferences to consultants and fl-oodlighting equiqment manufacturers.

The type of floodlights to be used will depend upon a number of factors:

1 - How the building is to be illuminated (beam spread considerations, etc.)

2 - The type of lamps that are used as related to function, color, cost - general - service incandes-cent or tungten - halogen, projector or reflector incandescent, phosphor - coated or clear mercury, or high - pressure - sodium.

3 - Economic consideration.

4 - The size and character of the building.

Price determination of lighting levels and bright-ness can be a tedious arithmetic process, parti-cularly when floodlights are aimed at all sorts of angles toward a facade. For precision, calcu-lations have to be done by the point - by - point method ; for a building any size and a fair number of fixtures, the process can be exceedingly time consuming. To explain the point by point method The illumination level can be calculated for one luminaire at a series of grid points on a fac-ade, assuming that the luminaire's location and aiming point are known. But if there are, say 10 lines each way on the grid, there are 100 points and if there are 50 luminers, there are 5000 se-perated calculations. Thus for particularly important of difficult floodlighting jobs, it may be advi-sable to consider the use of a compiter ; prog-rams have been developed to this chore.

Selection of light source :

Selection of light source depends upon a co-mbination of factor, among which are size, shape,

and type of building, desired lighting effect, colour preference, extend of beam control required from the floodlighting, and relative economics (first cost versus owning cost).

For overal lighting of building facates, the number of floodlight generally can be determined by deciding what footcadle level is desired and then using the beam - lumen method to find out how many floodlight are reqired. Floodlight selection for overall lighting as regards beam angle is governed primarily by floodlight location. (floodlights are divided into seven types by the National Electrical Manufacturers Association, on the bases of beam spread. Beam efficiencies (ratio of luminaire output lumens to lamp lumens) For example, for a low building, a wide - beam floodlight would be indicated if the luminaires must be mounted close to the building ; narrow beam if they are far back. But with a tall building, on the other hand, narrow - beam floodlights may be needed if the luminaires must be mounted close in. The reason is that otherwise there would be too great a difference in illumination between top and bottom of the building as result of the building and the grazing angle. But with a low height building, the floodlights can be strung out in a row and overlap of beams will produce the desired uniformity.

The beam - lumen formula is ;

$$N = (A * fc) / (BL * CBU * MF)$$

N is the number of luminaires.
A is the area to be floodlighted.
fc is the footcandle level.
BL is the beam lumens of the luminaire.
CBU is the coefficient of beam utiolization.
MF is the maintenance factor.

The footcandle of illumination to be used will depend upon just how bright the building is to appear against its surroundings. Of course, the darker the colour of surface of the building, the more light will be needed to achive a given brightness. Typical footcandle values for exposed concret facades might be between 5 and 10 fc, provided that there is not too much competing brightness in the surroundings. A figure sometimes given as to how much brighter a building should be than the competing surround is in the range of 4/1 to 5/1.

Another way of helping to make a building stand out against its surroundings is through the use of colour

Phychologically, the difference in colour may

attract attention. The illuminating engineering society has recommandetions for illumination levels depending upon the reflectance of surface material and the competing brightness. These values, of course, are not absolute but should be used with judgment based upon experience.

The coefficient of beam utilization is that fraction of the beam lumens intercepted by the building surface. Beam lumens of a luminaire are the total lumens within the beam spread of the luminaire. Designers try to select a floodlight so that the CBU is at least between 75 and 80 per cent. If half, or more than half, of the floodlights are aimed so that all their lumens fall on the lighted surface, the overall utilization factor will be about 0.75 ;if one quarter to one - half of the floodlights are aimd in that manner, 0.60 ; less than one quarter, not 0.40 (with towers and steeples the utilization factor may be less than 0.25).

Maintenance factor is equal to the lamp lumen depreciation factor multiplied by the luminaire dirt depreciation factor. This factor compensates for reduce illumination as the installation becomes older the loss of illumination results from the combined effects of gradual reduction of lumen output during lamp life and the loss caused by collection o dirt. A reasonable maintenance factor to be assumed for enclosed equipment is 0.75.

It has been mentioned how location of equipment affects the selection of floodlights. As a general rule, it is desirable to have floodlights located a distance out from the building equal to at least one - fourth to one - third the height of the building. The farther back the floolights are from the building, generally speaking, the wider the choice possible in floodlight and lamp selection.

Whether the floodlights are concentrated in banks or lined up in rows depends upon severals factors. They may be arranged in rows if;

1 - illimination is to be even and modeling need not to be too strong.

2 - There is a series of tall columns each of which is to be accented.

3 - Space availability is no problem and the luminaires can be easily concealed.

Floodlights may be arranged in banks if:

1 - Space availabily is a problem.

2 - Concealment is difficult.

3 - Fairly strong modeling effects are desired.

For lower buildings, floodlights mounted at grouond or near ground level will be aimed with the center of their beams striking the building near

the top - a typical aiming point might be 2/3 of the height. Even with a building of, say, eight to ten stories, the floodlights might be aimed near the top to accent a cornice and still illluminate the facade fairly evenly. A very tall building, on the other hand, if lighted from floodlights close to the base of the building may have to be illuminated in segment in order to achiev reasonable uniformity.

Obviously there can be no exact rules for location or aiming of floodlights becouse of the many variables. Nature of building facade (materials and design) available areas for mounting floodlights, desired effect, etc.. It may be that the architect does not want uniformity of illumination but rather a graded wash or even bright accents. But " accidental " lighting effects and unintentional spottiness surely should be avoided. In the point by point method, the most exact method for determining footcandle levels produced by a single or over lapping foodlight beams. A point is selected on the building surface; then, knowing the candlepower of the floodlight beam aimed at that point, the designer can determine the footcandle contribution by a combination of the cosine law and the inverse - square law.

A more visual method of getting a picture of the amount of illumination on various portions of the building facade is to used the isocandle curves presented in manufacturers photo metric data, and to draw this curves on the building facade by projection. To get and accurate trace of the curves on the facade by this method can be a quite time - consuming process. However and experienced floodlighting designer can sketch the projected isocandle curve by projecting a few points, and with these projected curves he can predict with sufficient accuracy what footcandle levels can be expected. Through experience, the lighting designer will be able to establish trial aiming points , once he has determined the number of floodlights necessary. Then he can check his results to see whether " re - aiming " on paper might be necessary.

If the building floodlighting situation is such that PAR or R lamps seem indicated, the footcandle levels can easily be calculated by tracing footcandle patterns of these lamps, which are provided in the literature, at the given angle of projection (0, 30, 45, 60, 70 degrees) on a scale drawing of the area to be lighted.

It must be recognized that no matter what type of floodlighting design approch has been used no calculation method anticipate small areas of sharp gradiation in brightness where beams may overlap too much or not enough. These may show up

as light or dark streaks or striations. This means that there always will be some adjustments required in the field for final aiming of the floodlights to obtain the efffect desired by the architect and his lighting consultant.

SURFACE MATERIAL OF THE FACADE

In determining the illumination level needed for a facade, in order to obtain the required brightness the reflection factor and the way the building surface material reflects the light are important factors to be borne in mind. The table below indicates the reflection factors of the number of different materials.

MATERIAL	STATE	REFLECTION FACTOR
White marble	fairly clean	0.60 - 0.65
Granite	fairly clear	0.10 - 0.15
Light concrete or stone	fairly clear	0.40 - 0.50
Dark concrete or stone	fairly clear very dirty	0.25 0.05 - 0.10
Imitation concrete	clean	0.50
White brick	clean	0.80
Yellow brick	new	0.35
Red brick	dirty	0.05

The total reflection from a facade depends on following points :

* The material of the facade
* The incident angle of the light
* The position of the observer in relation to the reflecting material (specular reflectuions).

The colour of the material is also an important factor.
The colour of the surface material is accentuated if light of the same colour is used.

A distinction can be made between the diffuse reflection and specular reflection and of variations between the extremes. These different types of reflection are due to the particular surface textures of the different materials. Four classes of surface may be distinguished are below.

Very smooth surface

A very smooth surface acts more or less as a mirror, with the result that most of the reflected light is direct upward, away from the observer (see fig. 1).

Smooth surface

Light is reflected somewhat diffusely from a smooth surface; a small amount of this light reaches the observer (see fig. 2).

Dull surface

Incident light reflected from a dull surface is even more diffused, so that a large part of the light is directed towards the viewer (fig.3).

Very dull surface

Light reflected from a very dull surface is diffused to a large degree, and therefor a great part of the light is directed towards the observer (fig. 4).

It is obvious that these different reflection properties of surface material necessitate a different illumination of the facade, in each case, in order to achieve the required brightness.

Even the mount of grime on a building is important ; the reflection factor of an clean facade can sometime be more than twice that of a grimy facade. This was clearly illustrated recently when certain historic buildins were cleaned.

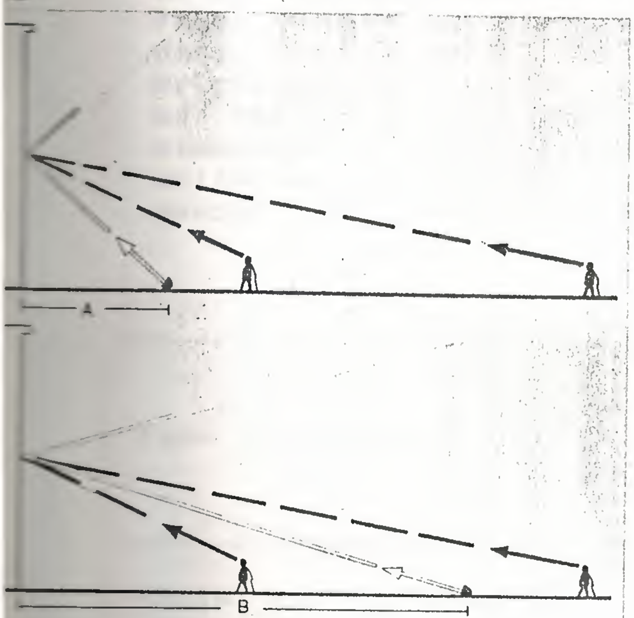
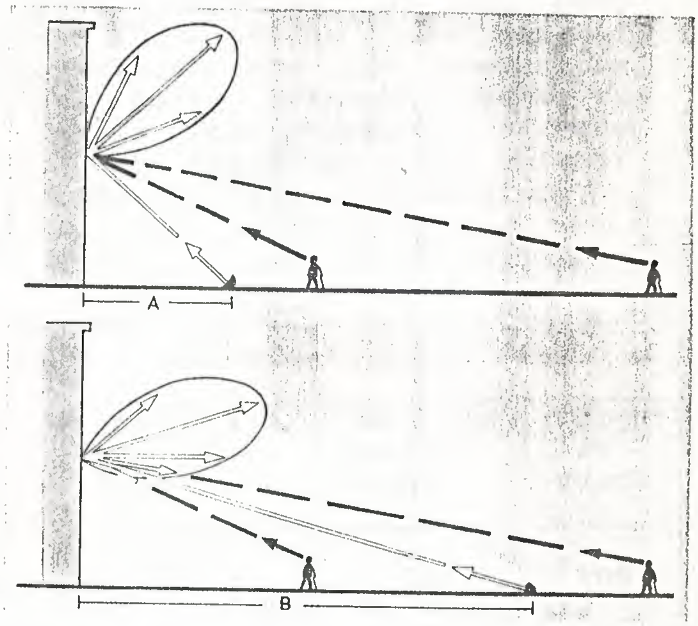


Fig. 2



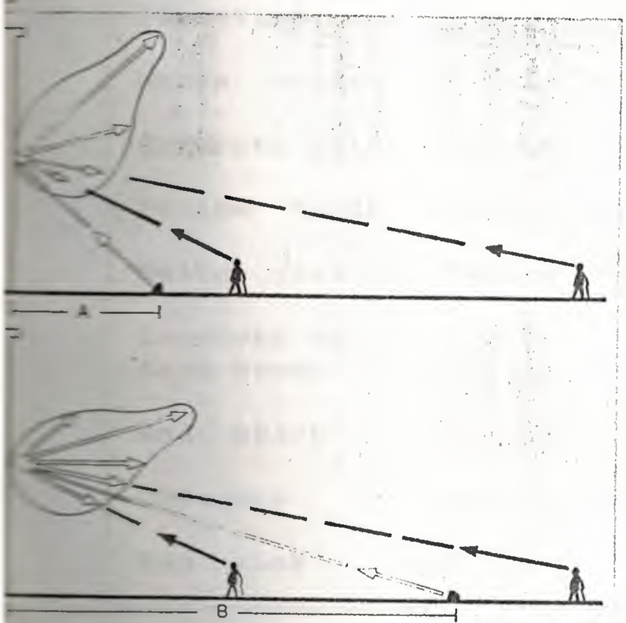
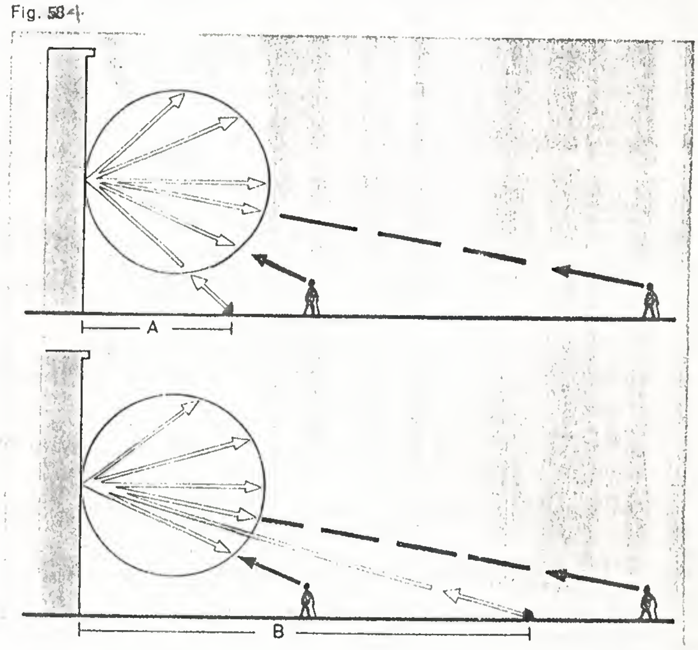


Fig. 4



SELECTION OF THE LEVEL OF ILLUMINATION

The lighting level needed on a facade to effect a certain brightness contrast depends upon such factors as the reflection factor of the surface building material, the location of the building in relation to its surroundings, the general brightness of these surroundings and the dimensions of the building. The table below present some recommended illumination levels for various surface building materials used on buildings in either poorly lit, well it or brightly lit sorroundings.

Type of surface	state	illumination in lux		
		poorly lit surrounding	well lit surrounding	bright lit surd.
White marble	fairly clean	25	50	100
light concrete imitation	fairly clean	50	100	200
White brick	fairly clean	20	40	80
Concrete paint	fairly clean	100	250	400
Yellow brick	fairly clean	50	100	200
White granite	fairly clean	150	300	600
Concrete or dark stone	fairly clean	75	150	300
Red brick	fairly clean	75	150	300
Concrete	very dirty	-- requires at least 150-300		
Red brick	dirty	-- requires at least 150-300		

EXTERIOR LIGHTING

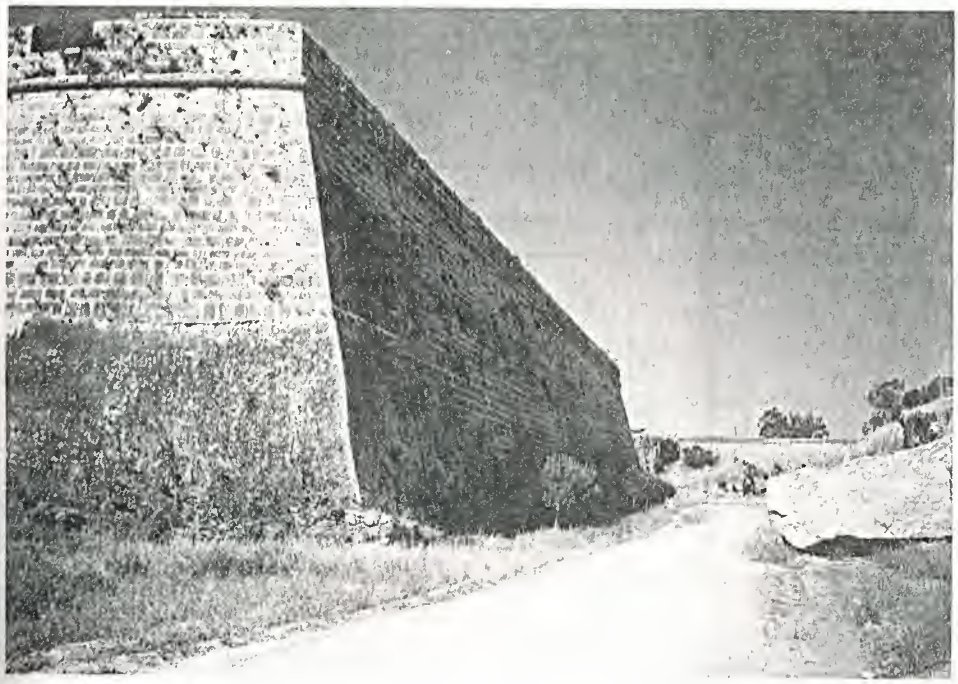
Exterior lighting requires an architect's attention if it is to suit his architectural concept and not seem merely appliqued. This understanding of the situation is becoming increasingly accepted.

Architects are paying increasing attention to how buildings look at night. Now, however, not only are manufactures offering architects much more in the way of hardware but, beyond this, the architects have developed a more personal and vital interest in exterior lighting.

Of course, it must be recognized that building exteriors themselves have changed very often a facade is texture by bold patterns of exposed structural elements or by the missing of a series of volumes, both of which lend themselves to strongly accented patterns of light. But even when the exterior is flat, such as a sheer glass facade, the client still may want his building to stand out at night. Then the architect may want to concider some sort of internal lighting that will make the building glow from within, a technique that has grown to be more commonly used with glass - walled structures.

It is important for the architect to realize that lighting cannot possibly make a building look the same at night as it does during the day. What is important is that the night - lighted building create a favorable visual impression, not merely be an idenfinite blob of brightness.

Although building floodlighting demands care from the architect in decicing upon lighting approach and in technical execution, there are some basic design parameters that help determine the appproach. Even though the daytime apppearance can not be duplicated, ity should be remembered that daylighting on clear, pleasant day is a combination of derectional sunlight and diffuse skylight. Thus it usually is desirable to locate the main floodlighting so that, similarly, there will be some modeling effect. If floolights are aimed head on to the building, the effect will tend to be flat and it may be uninterseting. This does not mean that the main lighting must be limited to a point source ; modeling also can be achieved by aiming each of a line of floodlights at the proper angle. Deep shadows can be softened by low levels of diffuse floodlighting at an angle to the main floodlighting.



CHAPTER 7

Possible locations for mounting lighting equigment may limit the type of lighting possible. In general four locations may be considered :

1 - on the building itself,
2 - on adjacent ground,
3 - on poles,
4 - on adjacent buildings.

Floodlighting located close to a surface and aimed at a grazing angle will emphasize the texture of the surface ; however, defects such as dimples or waviness tend to be emphasized when viewed from nearby. The farther away the floodlights are located, the lesss bold the texture brought out by the lighting.

Major viewing locations also will affect the floodlighting approach. If the building is to be seen primarly from automobiles, then lighting of the upper major elements of the building may be most important. For pedesrtrians, however, the ground level facade, sidewalk, landscaping, buildings materials, and construction details will deserve emphasis.

Obviously, the viewer should not be aware of the location of floodlights, or should he see reflected images of lampss or reflectors. Therefore floodlights should be louvered or shielded if necessary so that they will not be seen from normal viewing locations. Direct glare near building entrances, which might make steps and curbs difficult to see, particularly should be avoided. Landscaping, walls, or wells can help to minimize direct glare as well as conceal the equigment in the daytime. Sight lines should be checked to make sure there are no bright reflected images of lamps or reflectors showing in specular surfaces.

DESING PROCEDURE FOR FLOODLIGHTING :

The general desing procudure for floodlighting consists of four basic steps :
1 - Determining the desired effect.
2 - Determining the level of illumination.
3 - Determining the location of lighting equipment.
4 - Determining the fixetures and lamps to be used, from the standpoints of engineering performance and the economics of maintenance.

Lighting engineer Robert Faset has suggested the following checklist for selecting larger types of outdoor area - lighting equipment. He points out that selecting lighting equipment requires a combination of common sense, good engineering economic evaluation and a feel for the aesthetics of lighting effects.

1 - For 10000 burning hours per year or less, use filament lamps. Otherwise use high - intensity -discharge sources or fluorscent fixtures in the largest practical size.

2 - Use the largest wattage fixtures and the fewest locations that will deliver amount of light wanted. With area - type luminaires spacing generally should exceed two to four times distance from the surface being lighted to the lighting equipments.

3 - Consider the cost of relamping and cleaning fixtures.

4 - Keep in mind the styling of the lighting equipment.

5 - Buy top - quality fixtures, lamps, and poles, in order to achieve lowest total owning cost.

If uniformity is desired with large area outdoor lighting, these steps will help obtain it, provided that the floodlights are spaced at recommended distances from the building :

1 - Beams should overlap so that any given area receives as much light from the floodlight on either side as from the one directly in front of it.

2 - The widest beam spread available should be used consistent with reasonable utilization

3 - The largest lamp available should be used, consistent with acceptable uniformity. Obviously, proper aiming of floodlights is important. Approximate aiming can be determined by scaled sketches showing beam overlap. Exact aiming, however, must be adjusted in the field regardless of how carefully it was planned and laid out.

When the floodlighting equipment is aimed upword from a low level, the shadows that exist in daylight will be reversed or perhaps even eliminated While flat, head on illumination destroys depth and perspective large brightness contrasts may not produce desirable effects either. The resons is that bright areas appear closer and dark ares appear farther away to distance observers. For very tall structures apparent uniformity is achived if the top portions are illuminated so that they are from two to four times as bright as the lower portions. Greater illumination at the top also accentuates apparent height. Illuminating the lower portion of the building at a somewhat lesser level also minimies possible annoyance to pedestrians

Most lighting designers feel that shadows should appear as natural as practical. That is to say, if duplication of the type of shadows produce by the sun is not feasible, the shadows should at least present an interesting pattern and not destroy the basic form and depth of the architecture
The basic floodlighting effects can be categorized as :
1 - Flat floodligfhting
2 - Grazing floodlighting
3 - Interior floodlighting
4 - Accent or outline floodlighting

The type of equipment used, for the most part, will depend upon the size of the building. Monumental buildings will most generally be floodlighted by large units, except for interior lighting effects when fluorscent or quartz (tungsten - halogen) lamps may be used at the windows to illuminate draperies or window surrounds. Buildings of lesser size often employ projector (PAR) and reflector (R) lamps, particularly for grazing floodlighting and accent floodlighting ; outline lihghting may be accomplished using generalservice incandesent lamps or sign lamps

Grazing Floodlighting :

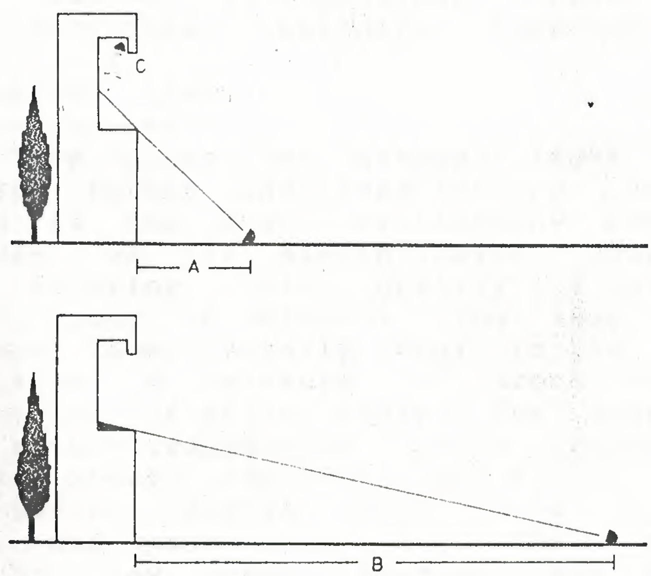
Grazing floodlighting often produces strong high lights and shadows, particularly when the floodlights are mounted very close to the facade. In addition to being desirable aesthetically, the grazing technique will be suitable functionally where lack of space, appearance considerations, or other restrictions prevent mounting floodlights in front of the building. Incandecent, fluorescent, and high - intensity discharge lamps have all been used for grazing floodlighting. Equipment may consist of spread - lens and fresnel - lens incandescent units, fluorescent floodlights with large specular reflectors, or tungsten - halogen and high intensity discharge lamps in reflector type fixtures with clear glass covers. In some cases, even small, single lamp fluorescent units with white reflectors can be used effectively for low buildings.

Facades with recessed parts ;

These may be balconies which are set back or galleries with railings at the front. Obviously a large part of the built - in space will be in shadow if the floodlights are placed only a short distance from the facade.
In such a case supplementary lighting will be required in the balcony and for this light of onther color

may be used. If this done, a particularly striking effect can be achieved, at the same time creating a greater impression of depth.

Floodlighting from a larger distance, however, reduces shadow, making it less visible to the viewer, thus obviating the need for extra lighting. The figure shown below.



LAMPS TYPES :

Three types of lamps are in common use for exterior lighting ;

a) Tungsten filament
b) Sodium
c) Mercury

Tungsten - filament lamps are available up to 1500 W loading. They render all colors satisfactorily, red in particular. Nowadays, tungsten - halogen lamps have become very popular for floodlighting applications. In general they provide some 15 per cent more light and twice the life of ordinary filament lamps used for floodlighting applications are of linear double - ended construction and therefore give a fan - shape beam, which is narro w in vertical plane. Reflector lamps using the sealed - beam prin-cple are useful in confined space or for high lighting particular building features.

SODIUM - VAPOUR LAMP :

This lamp gives an orange light and is used mainly for street and roadlighting, and on airfields. The lamp is the most effficiency produce of light but becouse of its single color characteristic it gives an inferior color quality (everyting looks) yellow or grey to black). The lamp consist of a long glass tube, usually bent in to U - shape. The tube contains a mixture of argon and neon gases, with particles of solid sodium. The lamps is operated from an auto - transformer which raises the mains voltage to about 350 V to 400 V.

Low pressure sodium lamps have a high luminous efficiency and poor life, but their predominantly ye-llow light, low powder loading and poor color -re-nding limit their application in floodligting. Th-eir prime use in to produce yellow light. The high - pressure sodium lamp provides a source of high light output with exceptionaly good golden color appearance and color rending almost like the warmth of the setting sun

Sodium lamps are classified by means of a three or four - letter designation. The first letter is al-ways " S ".

Type SO/H : This lamp has an arc tube enclosed in an outer jacket and is removable. The "H" indicates that the lamp is designed for horizontal operation.

Type SLI/H : In this type, the arc tube is linear instead of U -shaped arc tube of the other sodium types.

Type SOX : This type is broadly similar in construction to the SOI/H lamp exect that it has a heat reflecting coating on the inner surface of the enclosing jacket. Also designed for horizontal operation.

The average life of all sodium lamps is 6000 hours. The high pressure sodium lamp is a recet development. This discharge is contained in a pencil shape translucent ceramic tube which is housed in an enacuated outer jacket. With an efficiency of 100 lm/W and a light output of nearly 40,000 lumens, the 400 W type of lamp is the most efficincy light source yet developed. A high voltege source is necessary for starting and is provided by a thyristor ignitor. The lamp can be used in any burning position. There is a good color rendering.

It is used where color rending is not important Therefore it is not usefull for indoors. It is usful for outdoor lighting such as carpark, highway light etc. It is more economically , short recognization time and moving objects. The characteristics of high pressure sodium lamps which I used it in my project shown below table ;

Rating (watts)	type of envp.	Lighting design lumens	Op. Volts (V)	Op. Currt. (A)	cap	Mx. dimn. (mm)	
						ovral lenght	bulb dimt
150	tubu lar	19500	240	3.0	E40	227	91
250	tubu lar	27000	240	3.0	E40	257	53
400	tubu lar	47000	240	4.4	E40	292	122
1000	tubu	130000	240	4.4	E40	292	53

High pressure sodium lamps characteristics are show above table.

Definition : High - pressure sodium vapor lamps, for outdoor and indoor use, with sitered aluminium oxide discharge tube enclosed in a clear, tubular hard glass outer bulb.

Description :

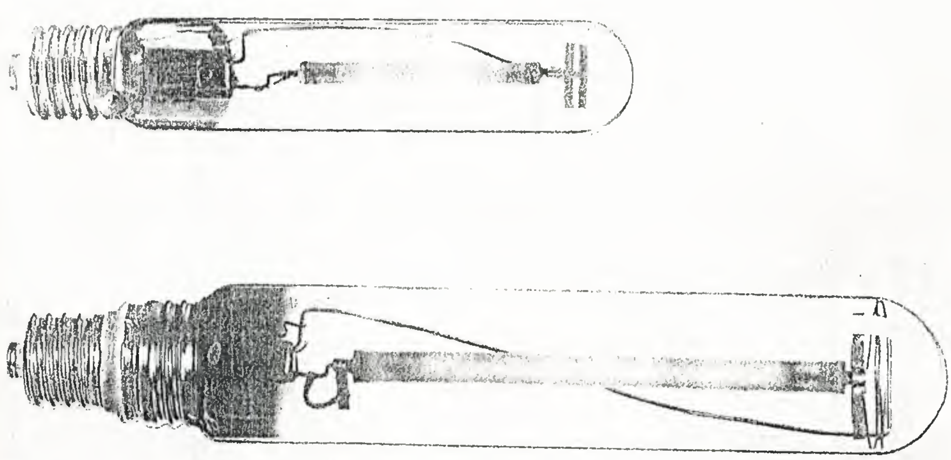
- Becouse of the high sodium pressure the lamp has a high luminous efficiency and a good color appearance.
- The clear, tubular outer bulb makes this light source highly suitable for use with specially designed optical systems.

- Additional assets :
  * Long economical life
  * Excelent lumen maintenance
  * Reliable, stable operation.

Applications :

- Public lighting
- Parking lost
- Airports
- Floodlighting
- Industrial lighting
- Plant irradiation
- Sports lighting

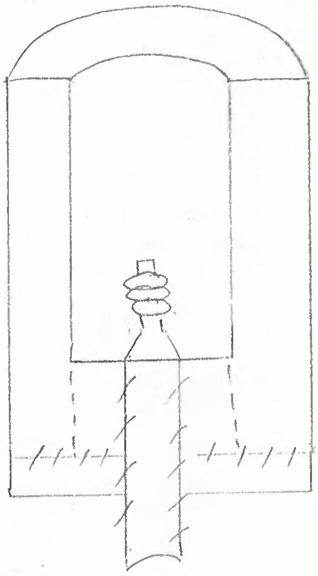
High-pressure sodium lamps



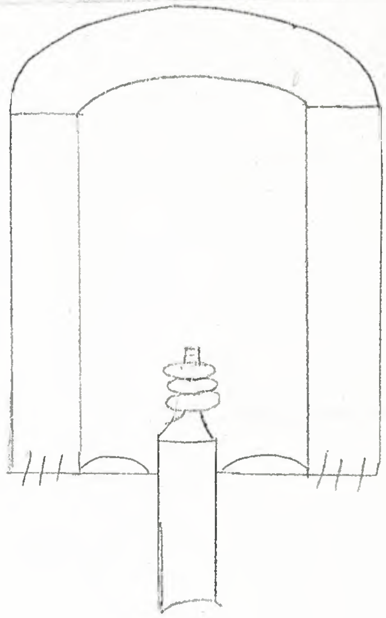
SON-T 150W
SON-T 250W
SON-T 400W
SON-T 1000W

SON-T lamps

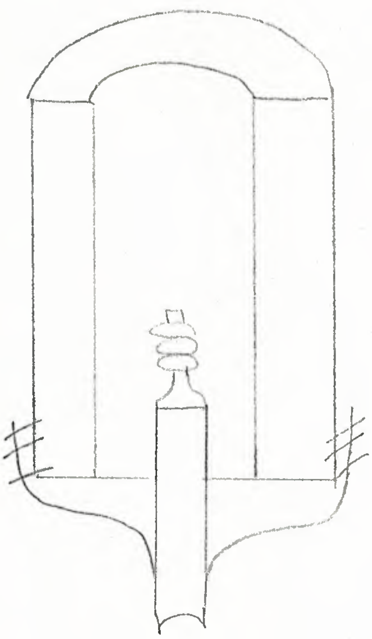
Possible constraction for high pressure sodium lamp in seramic arc tube shown below figures.



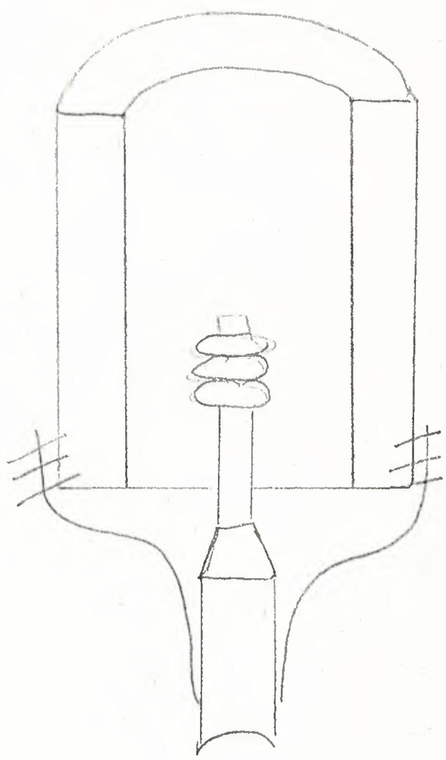
(a)



(b)



(c)



(d)

CHAPTER 4

HIGH - PRESSURE MERCURY - VAPOUR LAMP :

This type of lamp is used for street and road lighting, floodlighting and lighting industrial premises. The light emitted is bluish - green in color. There are several types of HPMV lamp. They are classed according to the loading per cantimetre if arc lenght. The lamp consists of an inner bulb or lamp proper made of special silicate glass bulb.

High - pressure mercury vapour lamps have a much longer life and a higher efficiency. The average life of this lamp is 5000 hours. It is relatively larger source size, the control of light distribution is not quite so precise as with tungsten lamps.

MERCURY LAMPS:

Mercury lamps as a general description covers a wide range of light sources. They are all based on the operation of an electric discharge tube generally made of fused silica and containing mercury vapour at a pressure of some atmospheres. In most cases no liquid mercury is present in the lamp when it is full opeation.

The color and luminous efficacy of mercury lamps primarily depend on the vapour density within the lamp. They can be modified by the use of phosphors by the addition of other elements to the discharge and by adding light from an incandescent filament. Lamps within the range are used in general lighting light projection and special applications.

CALCULATION TECHNIQUES:

Once the lighting requipments have been decided, floodlighting design falls into three stages. Firstly a partical assessment is made of where to locate the floodlights, the light distribution required, and the light source characteristics which suit the particular application.

Secondly, a " Lumen calculation " is carried out to establish the number and the loading of the luminaires to achieve the design objectives.

Thirtly, " point -by - point calculations " are performed to determine the precise aiming of the floodlights to give a stated illuminance diversity : this in turn may necessiate slight modifications to the preliminary calculation.

For a large facade the lumen method should be used. This based upon a certain average luminous efficiency. For high and small objects, castle steeples chimneys, minaret, etc, the luminous intensity method should be used. This is based on the luminous itensity radiation in a certain direction.

LUMEN METHOD :

As the name suggests, this method consists in calculating the number of lumens to be directed on to a facade in order to obtain a certain illumination level.

The number of lumens cab be calculated by means of the formula :

$$Q = (F * E)/n$$

Where Q is the total number of lamp - lumens, i.e. the total luminous flux produced by all lamps.

Where F is the surface of the facade to be illuminated in meter square.

Where E is the desired illumination in lux on that facade.

Where n is a factor which takes into account the efficiency of the fitting and the light losses (luminous efficiency).

```
                                        |
            I                E          |
@ >-  -  -  -  -  >  -  -  ->           |          E = I / D*D
                                        |
/-  -  -  -  D  -  -  -  -/             |
________________________________________|          fig. 5
```

The percence of a utilization factor in this formula indicates that not all the lamp lumens contribute to the illumination level on the facade. The lumen produce by the lamps are concentrated by reflectors in which process some loss is in volved. If the initial output is 100 % lamp lumens, 60 to 75 % are projected through the lighting eqipment and 40 to 25 % are lost in the fitting itself through inter-reflection in the reflector and absorption by other parts of the fitting.

After the floodlighting has been in operation for some time, a further percentage of the actual number of lamp lumens is lost becouse of the decrease in luminous flux due to the ageing of the lamp and dirt which collects on the lamp and fitting.

Finally a percentage of the losses is account for by wasted light, that is light not incident to the building facade. In practice an average utilization factor varying between 0.25 and 0.35 may be reckoned with. Using this figure in the formula given page 23. The total luminous flux needed, Qt ca be calculated. Once the total number of lumens is known, the number of fitting (N) needed can be calculated by dividing this amount by the number of lumens installed per fitting :

N = Qt / Qf

Note : If fitting are eqipped with two lamps, Q fitting is twice Q lamp.

LUMINOUS INTENSITY METHOD :

In this method the starting point is the luminous intensity, in candela, radiated by a light source in a particular direction. This luminous intensity may be derived from the limunous intensity diagram or from a table. This data can usually be found in the appropriate catalogue and brochures.
The calculation is made with the formula (fig.4 and 5).

```
                          E  /|  /
                            / |  |
                  I    /      |
                      /       |  |
                     /        |  h
                    /         |
                  /           |  |
---------@----------------   /
        / -  - D  -  - /
```

The formula is ;

$E = (1 / h) \sin^2\theta * a \cos^2\theta a$ $\tan a = h / D$

Where E is the vertical illumination on the facade,
I is the luminous intensity at the angle a,
h is the height of the object above the level on which the fittings are arranged,
a is the angle at which the light beam strikes the normal on the plane to be illuminated.

LIGHTING UNITS AND DEFINITIONS :

Luminance : (L)

The luminous intensity in a given direction divided by the area of the surface pependicular to taht direction.

Candela : (cd)

Units of luminuos intensity. Also called the new international candela. Equal to the luminous intensity of a surface of black -body radiator operated at the temperature of solidifying platinum.

Candela - Power :

Units of luminous intensity. Orginally the luminous intensity of a specified candle burning at a specified rate.

Illuminance : (E)

Luminous flux on a surface element divided by the area of the element ; in lumens per square meter or lux.

Lumen : (lm)

The flux emitted in unit solid angle by a uniform point source of one candela. It is unit of luminous flux.

Lux : (lx)

Unit of illuminations, the illumination produced on the surface of a sphere, having a radius of one meter, by a uniform point source of one candela situated at its centre. It correspond to a flux density of one lumen per square meter.

Flux, radiant : (Qe)

Power emitted, transsferred or received as radiation : in watts.

Luminous flux : (Q , F, unit : lumen)

The rated of passage of radiant energy evaluated by refference to the luminous sensation produced thereby.

Luminance intensity :(symbol ;I , unit: candela)

The quantity which describes the light - giving power of a source in any particular direction . If F is the luminous flux emitted within a cone of very small angle w, having its apex at the source and its axis.

Objective brightness :

This is a luminous intensity of a light source. It is the light output divided by the projected area of the kight source in the particular direction, measured in candela per unit area.

The ratio of reflection factor :

$$\frac{\text{Lumens reflected from a source}}{\text{Lumens received by the surface}}$$

Coefficient of utilization :

New called the utilization factor, is a factor used in planning schemes, which allows for loss of light by absoption in reflectors, ceilings, walls, etc. It is the ratio ;

$$\frac{\text{Lumens received at the working plane}}{\text{Lumens generated by the light source}}$$

Reflection factor :

The reflection factor describes the relationship between the incident luminous flux and the reflected luminous flux. This factor depends upon the reflection properties of the surface of the material to be illuminated.

Maximum intensity :

The maximum intensity of the beam is the maximum intensity in candela per 1000 lumen of the lamp flux (fig. 1 a)

Beam spread :

This is the deviation in degrees between the lines indicating the direction where the luminous intensity is 1 /2 Imax (Europe).

Beam lumens :

The terms beam lumens refers to the quantity of light (figs. 1-c and 1-d) contained within the beam for I = 0.5 I max (Europe).

Beam efficiency :

It is the ratio between the luminous flux in the beam and total luminous flux of the lamps.

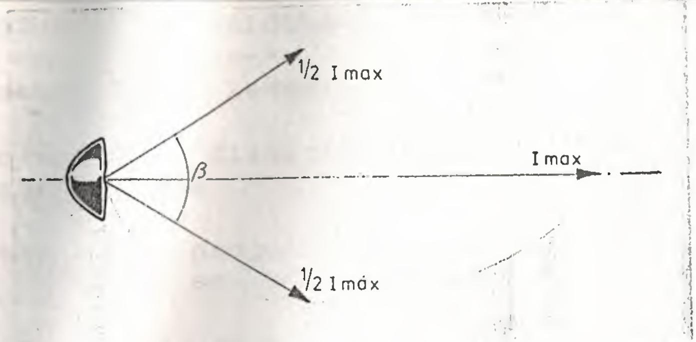


Fig. 66

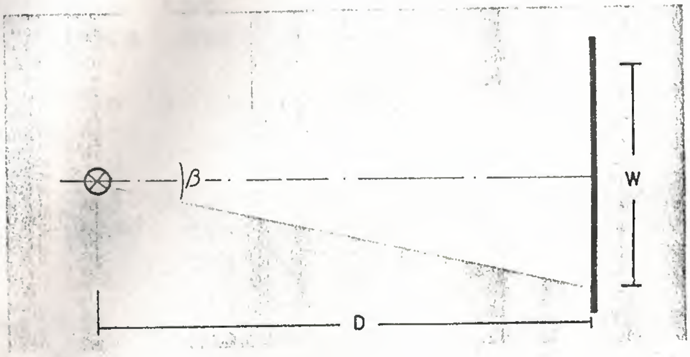


Fig. 67

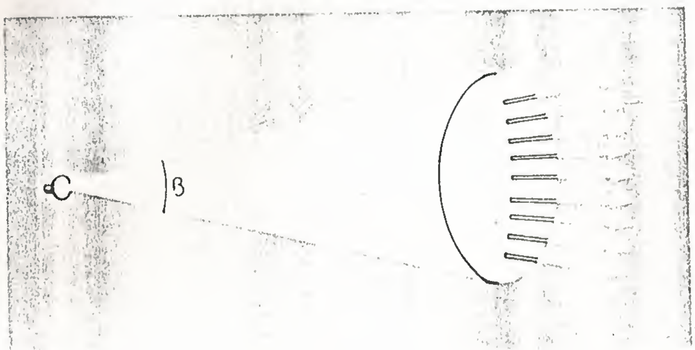


Fig. 68

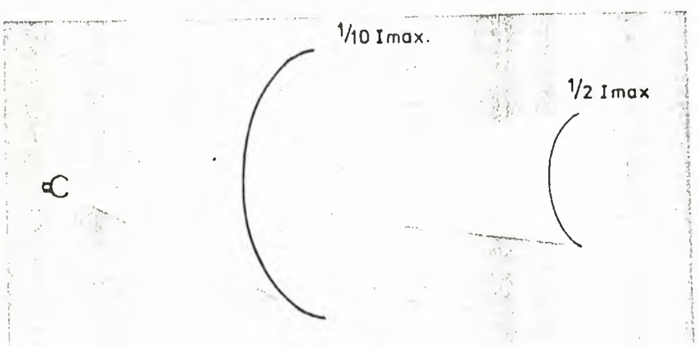
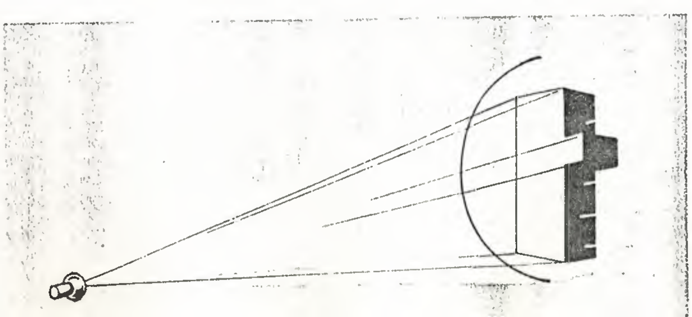


Fig. 69



PROCEDURE OF CALCULATIN :

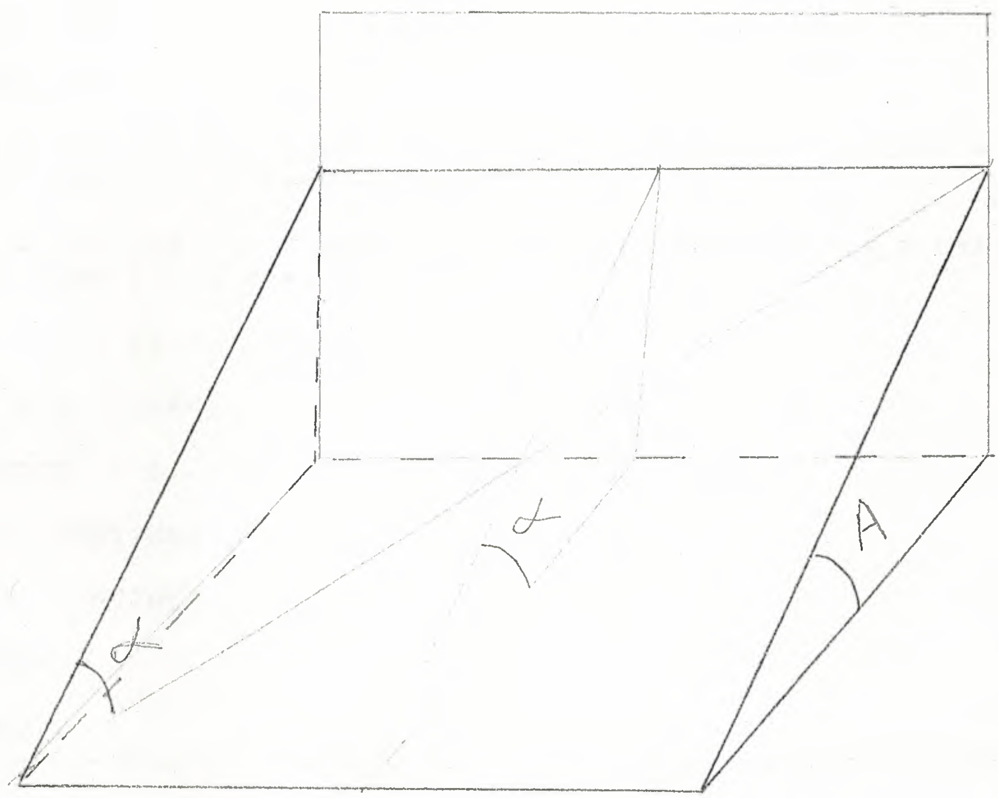
- Measure the lenght and the wide of castle,
- Chose the distance between the projector and the light source,
- Chose the projectors and its isocandela curves which is narrow or wide beam.
- Chose, what type of projector will you use.
- Calculate the light intensity in each point on the isocandela curves
- Find the illuminance at each point on the isocandela curves.
- Draw its figure on the white paper and thin paper for find the distance between the two projectors.
- Used " A and alfa (α) "projectors, calculate "A" and alfa (α) respectively.

The formulas which used our project shown below.

$$A = \tan^{-1} \frac{Y' \sqrt{1 + X_0'^2}}{1 + X' X_0'} - \tan^{-1} \frac{Y_0'}{\sqrt{1 + X_0'^2}}$$

$$\alpha = \cos^{-1} \left[\frac{1 + X' X_0' + Y'^2 \frac{1 + X_0'^2}{1 + X' X_0'}}{\sqrt{(1 + X'^2 + Y'^2)\left(1 + X_0'^2 + Y'^2 * \left(\frac{1 + X_0'^2}{1 + X' X_0'}\right)^2\right)}} \right]$$

$$\cos^3 \Theta = \frac{1}{(1 + X'^2 + Y'^2)^{1.5}}$$



A, α projector.

COMPUTER PROGRAMING FOR CALULATION "A" AND "alfa" :

```
READ  ( 5,*)  C , D

Z = 0

B = 0

DO  10  Z = 0 , 2 , 0.1

DO  20  B = 0 , 2 , 0.1

S = INV COS [ 1/SQRT ( 1 + C**2 + D**2) * ( 1+ D**2 + C*Z) /
    SQRT ( 1 + D**2 + Z**2)]

A = INV COS [ 1 / SQRT ( 1 + C**2 + D**2 ) * (1 + C**2 +D*B)/
   SQRT ( 1 + C**2 + B**2)]

G = 1 / [( 1+ Z**2 + B**2)**1.5)]

H = G / (h**2)

WRITE  ( 5, * ) , C , D , Z , B, E, F, G, H,

20  CONTINUE

10  CONTINUE

STOP

END
```

LET :

Z = X`	E = H * I ,	Xo`= Xo / h
B = Y`		
C = Xo`	X` = X / h	Yo`= Yo / h
S = alfa		
G = $\cos^3\theta$	Y` = Y / h	E = I* $\cos^3\theta$ / h**2

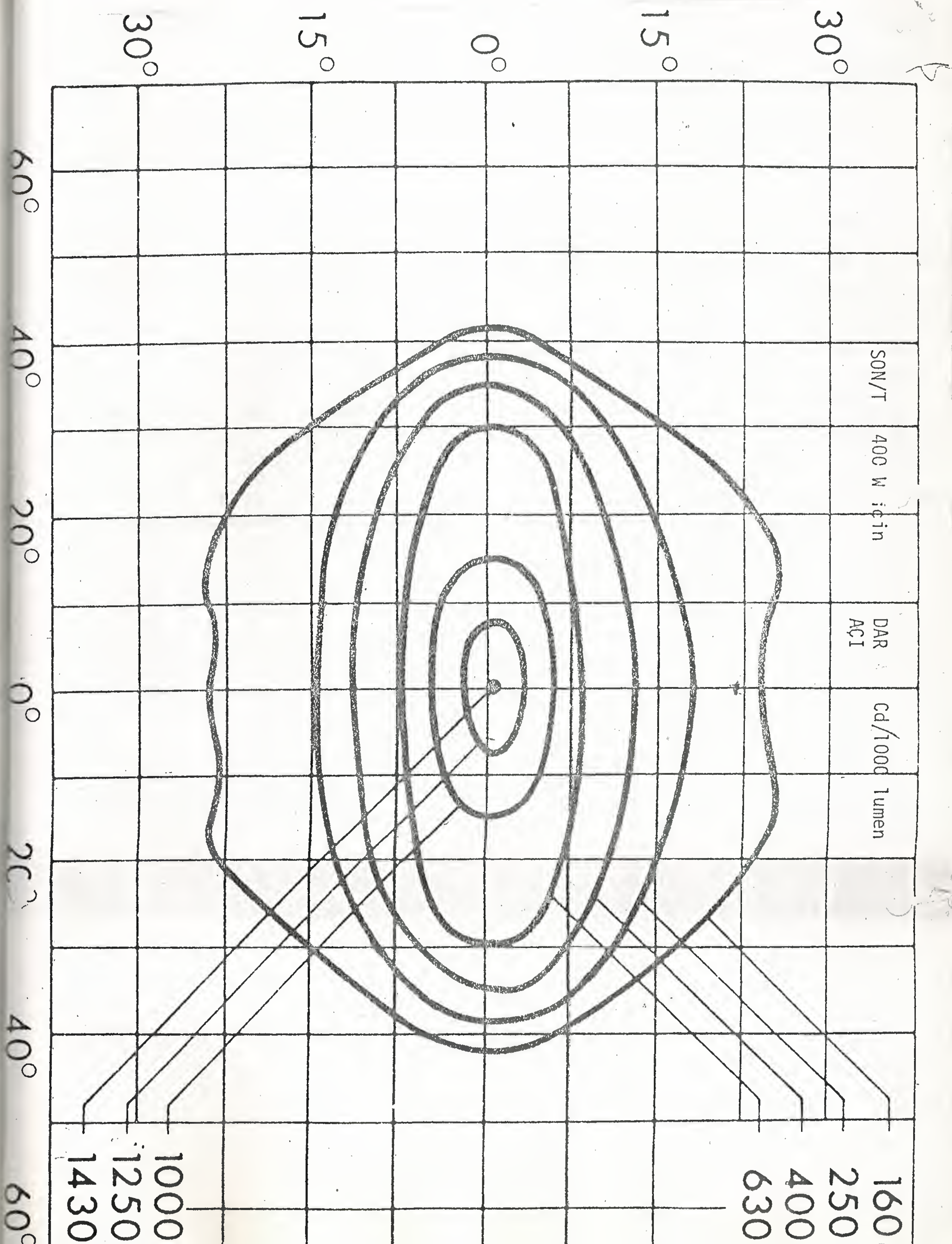
The table shown below is the result of high pressure sodium vapour lamps (SON -T 400 W).

X`	Y`	α	A	I	$\cos^3\theta$	E
0	0	0	0	38610	1.0000000	167.94
0	0.1	0	5.71	34965	0.9851854	149.83
0	0.2	0	11.30	29700	0.9428662	121.8
0	0.3	0	16.69	25795	0.8787398	98.58
0	0.4	0	21.80	22404	0.8000411	78.00
0	0.5	0	26.56	19107.9	0.7155418	59.47
0	0.6	0	30.90	15974.8	0.6305096	43.81
0	0.7	0	34.99	10800	0.5498201	25.82
0	0.8	0	41.98	6750	0.4761395	14.00
0.1	0	5.71	0.00	27000	0.9851854	115.71
0.1	0.1	5.71	5.71	26190	0.9707331	110.57
0.1	0.2	5.71	11.30	23028.3	0.9294288	93.09
0.1	0.3	5.71	16.69	19560.4	0.8667842	73.74
0.1	0.4	5.71	21.80	17280	0.7901714	59.38
0.1	0.5	5.71	26.56	15457.5	0.7070404	47.53
0.1	0.6	5.71	30.90	12042	0.6236188	32.57
0.1	0.7	5.71	34.99	8775	0.5443311	20.77
0.1	0.8	5.71	41.98	6238.4	0.4719176	12.78
0.2	0.0	11.30	0.00	12278.8	0.9428662	50.35
0.2	0.1	11.30	5.71	12042.7	0.9294288	48.68
0.2	0.2	11.30	11.30	11259	0.8909722	43.62
0.2	0.3	11.30	16.69	10395	0.8324965	37.65
0.2	0.4	11.30	21.80	9307.9	0.7607259	30.8
0.2	0.5	11.30	26.56	7256.5	0.6825201	21.54
0.2	0.6	11.30	30.90	6264	0.6036817	16.45
0.2	0.7	11.30	34.99	4320	0.5284001	9.93
0.2	0.8	11.30	41.98	0.00	0.4592362	0.00
0.3	0.0	16.69	0.00	8100	0.8787398	31.0
0.3	0.1	16.69	5.71	7832.7	0.8667842	29.52
0.3	0.2	16.69	11.30	7236	0.8324965	26.18
0.3	0.3	16.69	16.69	6596.5	0.7801480	22.37
0.3	0.4	16.69	21.80	5291	0.7155418	19.28
0.3	0.5	16.69	26.56	4320	0.6446780	14.83
0.3	0.6	16.69	30.90	0.0	0.5727275	0.0
0.3	0.7	16.69	34.99	0.0	0.5035173	0.0
0.3	0.8	16.69	41.98	0.0	0.4394716	0.0
0.4	0.0	21.80	0.00	5541.2	0.8001410	18.9
0.4	0.1	21.80	5.71	5211	0.7901714	17.8
0.4	0.2	21.80	11,30	5041.4	0.7607259	16.67
0.4	0.3	21.80	16.69	5019.7	0.7155418	15.59
0.4	0.4	21.80	21.80	4493.9	0.6593852	12.87
0.4	0.5	21.80	26.56	3354.7	0.5972710	9.80
0.4	0.6	21.80	30.90	0.0	0.5336232	0.00
0.4	0.7	21.80	34.99	0.0	0.4718176	0.00
0.4	0.8	21.80	41.98	0.0	0.4140867	0.00

```
   31---29.52---36-----33.5---34.1----34.1---33.5---36-----29.5---31-
    |     |      |      |      |       |      |      |      |      |
    |     |      |      |      |       |      |      |      |      |
 50.35--48.68---53.55---54.1---52.2----52.2---54.1--53.5---48.62--50.3
    |     |      |      |      |       |      |      |      |      |
    |     |      |      |      |       |      |      |      |      |
 115.7--123.4---114-----106----103-----103----106---114---123.4--115.7
    |  /  |      |      |      |       |      |      |      |      |
    |  2m |      |      |      |       |      |      |      |      |
    |  /  |  /2m /      |      |       |      |      |      |      |
@ 167----164----142-----146.8---133.5---133.5--146.8--142----164---167
    |  0  |      |      |      |       |      |      |      |   0  |
    |     |      |      |      |       |      |      |      |      |
 115.7--123.4---114-----106----103-----103----106---114---123.4--115.7
    |     |      |      |      |       |      |      |      |      |
    |     |      |      |      |       |      |      |      |      |
 50.35--48.68---53.55---54.1---52.2----52.2---54.1--53.5---48.62--50.3
    |     |      |      |      |       |      |      |      |      |
    |     |      |      |      |       |      |      |      |      |
   31---29.52----36-----33.5----34.1----34.1---33.5---36-----29.52--31
    |     |      |      |      |       |      |      |      |      |
    |     |      |      |      |       |      |      |      |      |
   19----17.8----16.67---16-----12.87--12.87---16-----16.67--17.8---19
```

Final illuminance average values between two floodlights. The distance between two floodlights are 18 m. And the height of the floodlights are 8 meters from the ground.

Ioscandela curves figure



The results of SON-T 400 W which I set up on the ground.

X`	Y`	α	A	$\cos^3\theta$	I	E
0	0.0	20.37	20.37	1.000	56676.8	141.7
0	0.25	20.37	7.30	0.9411	55160.14	129.78
0	0.5	20.37	4.53	0.8	41565.62	83.13
0	0.75	20.37	14.48	0.63	36805.88	58.9
0	1.00	20.37	22.5	0.50	32922.47	41.15
0	1.25	20.37	22.28	0.39	27207.77	26.52
0.25	0.00	7.30	20.37	0.9411	42031.42	99.00
0.25	0.25	7.30	7.30	0.8888	40478.75	98.89
0.25	0.5	7.30	4.53	0.7619	39957.5	64.68
0.25	0.75	7.30	14.48	0.6153	29610	45.55
0.25	1.00	7.30	22.5	0.56	26907.5	35.81
0.25	1.25	7.30	22.28	0.4122	23844.66	24.58
0.5	0.00	4.53	20.37	0.8000	17573.91	35.14
0.5	0.25	4.53	7.30	0.7619	17390	33.12
0.5	0.5	4.53	4.53	0.6666	14883	24.8
0.5	0.75	4.53	14.48	0.5517	13868	19.24
0.5	1.00	4.53	22.5	0.44	11750	15.5
0.5	1.25	4.53	22.28	0.35	10058	8.88
0.75	0.00	14.48	20.37	0.64	10692.5	17.28
0.75	0.25	14.48	7.30	0.6153	10692	16.5
0.75	0.75	14.48	4.53	0.5517	10257	14.14
0.75	1.00	14.48	14.48	0.47	9261.7	10.87
0.75	1.25	14.48	22.5	0.3902	8930	8.71
0.75	1.75	14.48	22.8	0.32	0.00	0.00
1.00	0.00	22.5	20.37	0.5	8490.15	10.61
1.00	0.25	22.5	7.30	0.4848	8841.87	10.71
1.00	0.5	22.5	4.53	0.4444	8789	9.76
1.00	0.75	22.5	14.48	0.3902	7520	7.33
1.00	1.00	22.5	22.5	0.3333	0.00	0.00
1.00	1.25	22.5	22.8	0.2807	0.00	0.00

```
     A
     |
     |
     35.4-----42.21----39.85-----38.48-----39.85-----42.21-----35.4
     |         |         |         |         |         |         |
    5  m       |         |         |         |         |         |
     |         |         |         |         |         |         |
   / 99------123.47----100.5-----99.5-----100.5-----123.47-----99
   | |         |         |         |         |         |         |
   |5  m       |         |         |         |         |         |
   | |         |         |         |         |         |         |
   \ |    5m   |         |         |         |         |         |
----141.7-----156.3-----124.3-----117.8-----124.3-----156.3-----141.7
 0  |          |         |         |         |         |    0    |
    |          |         |         |         |         |         |
    |          |         |         |         |         |         |
    99-------123.47----100.5------99.5-----100.5-----123.47----99
    |          |         |         |         |         |         |
    |          |         |         |         |         |         |
    |          |         |         |         |         |         |
   35.4------42.21-----39.85------38.48----39.85------42.21---35.4
```

The distance between two projectors are 15 m. And the aims Xo = 8m , Yo = 8m .

THE COST OF PROJECT :

Material	No	lenght (m)	Price of single material (TL)	Total Cost (TL)
SON -T 400 W	19		366,500	6,963,500
2*2.5mm + ECL PVC		460	2000 1000	230,000
2*16 mm PVC		50	3500	175,000
1*6 mm ECL PVC		50	2500	125,000
KWH (meter)	1		200,000	200,000
Automatic	1		100,000	100,000
Circuit Breaker	1		50,000	50,000
M.D.Board	1		100,000	100,000
FUSE (45 A)	4		10,000	40,000
Photecell	4		50,000	200,000
Iron - Rods	15	10 m each	130,000	1,950,000
				= 10,133,500

CONCLUSION :

Recent have seen the rapid development of the use of artifical lighting out of doors, not only for the commonplace street - lighting, but for sports areas, building sites, carparks, gardens, castels, open area industrial premises, recration ground swimming pools and so on. The exteriors of buildings of historic and architectural interest are also flood-lit to enhance the buildings appearance during the hours of darkness and special type of lamps have been developed to produce colours of light designed to show up the aesthetic beauty ancient stinwork.

In general, most requirements for building flood-lighting can be considered in terms of close -offset or long range floodlighting. Close - offset floodli-ghts are normally rectangular in shape and freque-tly use linear (tubular) lamps in a trough re-flector which gives a fun shape beam of light in planes containing the light source. The light distr-ibution in the vertivcal plane (which is normally be the vertical plane at right angles to the building face) is much narrower. But there is usually a choice of vertical beam - width ; wide, medium , or narrow - angle. Close - offset floodlighting involves regularly spaced lights along the face of the buiding.Long - range floodlights are normaly circular in shape and incorporde an accurate parabolic reflectors, alternat-ive reflectors, either highly specular or slightly diffusing, may be used in conjuction with different lamp types and front glasses to give a selection of beams with symmetrical light - distuributors. The beam - spread is contained in a angle within which the useful light is concentrated.

The lamp type which I used in my project that is high - pressure - sodium - vapour lamp. Which is called SON -T 400 W. It is provides a source of high light output with exceptionally good golden colour appearance and colour rending almost like the warmth of the setting sun. It is best lamp for outdoor becouse of the high sodium pressure the lamp has a high luminous effficiency and color appearance, it has long economical life, excelent maintenance.

For high pressure sodium vapour lamps, I used SON - T 400 W Which is narrow beam and it is cd / 1000 lumen.

ELECTRICAL DISTRIBUTION PLAN