**International Journal of Engineering Research and Development**
*e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com*
*Volume 12, Issue 4(April 2016), PP.43-49*

# Innovative Indoor Illumination Design

Rana Mayur, Panchal Vishal, Suthar Jaimin, Patel Shitanshu,
Mr. Pravinchandra Mehta, Ms. Richa Dubey
[1]*Shroff S. R. Rotary Institute of chemical technology, Final year B.E. in Electrical Department, Ankles war, Gujarat.*
[2]*Shroff S. R. Rotary Institute of chemical technology, Final year B.E. in Electrical Department, Ankles war, Gujarat.*
[3]*Shroff S. R. Rotary Institute of chemical technology, Final year B.E. in Electrical Department, Ankles war, Gujarat.*
[4]*Shroff S. R. Rotary Institute of chemical technology, Final year B.E. in Electrical Department, Ankles war, Gujarat.*
[5]*Persotech Solutions, CEO, Vadodara, Gujarat.*
[6]*Shroff S. R. Rotary Institute of chemical technology, Assistant Professor in Electrical Department, Ankles war, Gujarat.*

**Abstract: -**Indoor Illuminationnaturally attracts the attention of the persons working inside the building.The workplace whether it may be educational institute, industry or commercial complex plays vital role in efficiency of the persons working there.Illumination inside the building is the principal infrastructure.The paper covers the various aspects of Illumination Design. Standards applicable for required intensity of light for various purpose and its extracts are the primary topic. The paper deals with how to design the illumination level in a particular complex whether it may be indoor or outdoor may be for Industrial or commercial purpose. Selection of luminaries based on the end users specifications/requirements is the main function of illumination design. The paperalso covers the sample design of a Seminar Hall as a case study with all calculations. To make it innovative various types of luminaries, control gears with automatic features are considered The illumination design is done taking care of all the inputs like lumens output of particular luminary, dimensions of working area, working height, height of luminary, absorption/reflection capacity of the medium where light is to be thrown, maintenance factor, Related all topics are described in the project.

**Keywords: -**Indoor Illumination design,CG lux, Calculation of Illumination design, LED, Seminar Hall

## I. INTRODUCTION

Use of Electricity is essential for day to day life. Growth of any society or nation is measured in terms of electricity consumed. Out of many uses,Lighting is the most common use of electricity. In other terminology the lighting is called as "Illumination". For various categories of works different intensity of light is required .The required intensity for each type of categories of use/work are setup by every national and commonly accepted international standards for guidelines and accordingly the luminaries are supposed to be fitted to cater that much intensity of light .The art and science of deciding various type of luminaries for required job is known as Illumination Design.

### A. WHAT IS ILLUMINATION DESIGN?

Illumination design starts with developing the objectives and then qualifying these by specifying the criteria. When looking objectives, the lighting designer will consider day lighting and how it is used, types of artificial lighting to be considered, required light levels and uniformity, types and methods of lighting control, maintenance, the efficiency (efficacy) goals of the lighting system, etc.
Illumination design starts with developing the objectives and then qualifying these by specifying the criteria. When looking objectives, the lighting designer will consider day lighting and how it is used, types of artificial lighting to be considered, required light levels and uniformity, types and methods of lighting control, maintenance, the efficiency (efficacy) goals of the lighting system, etc.

### B. FACTORS CONSIDERING FOR ILLUMINATION DESIGN

Illumination design is considering the following factor into account.

***1) Area of workplace***

There are two types of area concludes in the project:-

1. Indoor Area: -Indoor area like rooms, buildings, seminar halls, industries, offices, etc.For different places different lux level is required according to end user's specifications/requirements, atmospheric siltation, different-different work, etc.
2. Outdoor Area: - Outdoor area like roads, highways, markets, street area, lobby, etc. Similarly indoor area design in outdoor area, for different places different lux level is required according to end user's specifications/requirements, atmospheric siltation, different-different work, etc.

***2) Lumens output of luminaries***

Luminous flux emitted within unit solid angle (one radian) by a point source having uniform luminous intensity of 1 candela. [1]

a. Lumens = Candle power × Solid angle

i. = C.P. ×θ …(1)

***3) Maintenance factor of luminary***

Maintenance factor is defined as the ratio of illumination under normal working conditions to the illumination when the things are perfectly clean. It is always less than unity.

***4) Utilization factor***

Utilization factor or coefficient of utilization is defined as the ratio of total lumens reaching the working plane to the total lumens given out by the lamp.

***5) Reflection factor (wall and ceiling)***

It is ratioof the reflected radiant or luminous flux to the incident flux. [1]

***6) Beam efficiency***

The beam efficiency is known as light output ratio. It is defined as the ratio of the beam flux to the lamp flux. Light output ratio for the beam is calculated at 10% and 50% of the peak intensity. Beam flux is related to the luminary output flux whereas lamp flux means the luminous flux produced by the lamp in this luminary.

***7) Light Loss Factor***

It is ratio of the average illuminance on the working plane after a specified period of use of a lighting installation to the average illuminance obtained under the same conditions for a new installation. [1]

## C. CALCULATION OF SEMINAR HALL LIGHTING-A CASE STUDY.

Calculation of Indoor Lighting Using Lumen Method:-

Design of indoor illumination of seminar hall
Design inputs:-Area of workplace=18 × 8m
Required level=300 lux
Luminaries to be used= T5 LFL
Lumens output=2700 lumens
Maintenance factor=0.7
Utilization factor=0.8
Beam Efficiency=0.4
Light Loss Factor=0.64

$$\text{No. of fittings} = \frac{Average Illuminance \ * Area for workplace}{Lumens per luminaire \ * Co-efficient of Utilization \ * Light Loss Factor \ * maintenance factor}$$

$$= \frac{300 * 18 * 8}{2700 * 0.8 * 0.64 * 0.7}$$

= 44

## II. INDOOR ILLUMINATION DESIGN WITH SOFTWARE

Variousluminaries manufacturer companies have their own software for lighting design.( like CG lux, Relux, etc). In this paper CG lux software is used. This software can be design for indoor area and outdoor area. Indoor area likes rooms, offices, seminar halls, etc. And Outdoor area like roads, highways, street, sports, etc.

### A. CG lux software

CG Lux is lighting software provided by "*Crompton Greaves"*.For lighting calculation simpler and quicker, CG Lux is lighting design software which is designed by "Optical and Photometric Technology Pvt. Ltd.".This software can be used for indoor places like rooms, offices, sports, shopping centers, malls, etc and for outdoor places like gardens, street area, roads, highways, etc.CG lux have library of luminary where different types of luminaries available for different places and for different purposes manufactured by "Crompton Greeves".
There are two type of calculation in CG lux software for illumination design.

#### *1) Quick Estimation*

Quick estimation method as a means of estimating illuminance based on typical spacing criteria for a concept. It can be used to Estimate average illuminance for small to large rooms and to Estimate illuminance at a point.Caution is necessary using quick estimation method when the spatial characteristics (room size and finish) or lamp selection varies from the manufacturer's basis for the actual method.

#### *2) Point By Point Method*

In point by point method designer can decide to place luminary at a particular place according to lux requirement, end user's specification,typeof luminary, situation, also consider daylight. In point by point method designer can change the placement of luminary and dimensions. This method is used for small and large rooms and estimates the average lux of a particular place.

### B. Results:-

#### *1) Illumination Tabulation*

In illumination tabulation, which is simulated in CG Lux software seminar hall dimension are given. Each corner of seminar hall is described with their respective co-ordinates. The above table also shows the value of lux at each coordinate point. It also shows the value of average lux, minimum lux and maximum luxfor the given area.

#### *2) Greyscale*

Greyscale is a range of shades of gray without apparent colour. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths. Intermediate sets of gray are represented by equal brightness levels of the primary colours (red, green, blue) for transmitted light.

#### *3) ISO Lux*

In ISO Lux, the contours provide the points of equal illuminance, in foot-candles or lux, on the floor or wall plane, from a specific stated mounting position. The diagram can be used to assess the distribution characteristics of luminary in addition to determining lighting level.

#### *4) 3D Lux web*

The 3dimension view oflux distribution. The sheet like image shows Lux spreading in workplace. The maximum point in the 3D figure shows the value of maximum lux and minimumlux.

## III. INNOVATIVE ILLUMINATION DESIGN

### A. Design of seminar hall:

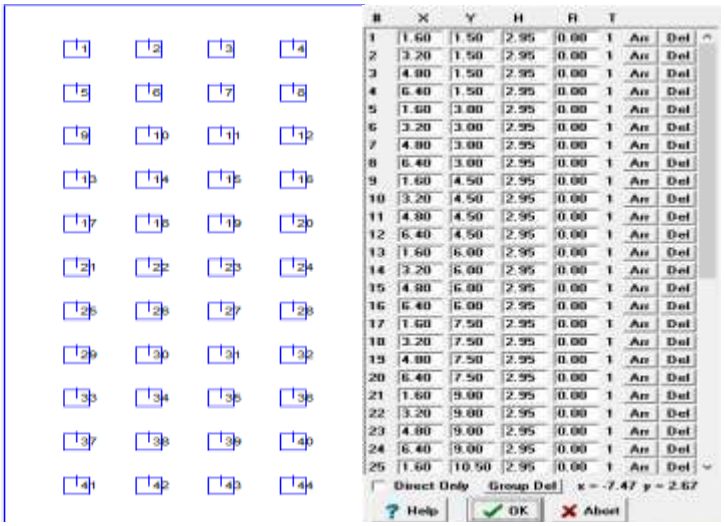



**Fig.1: (a) Luminaries Position, (b) Co-ordinates of Luminaries**

### B. Luminary detail

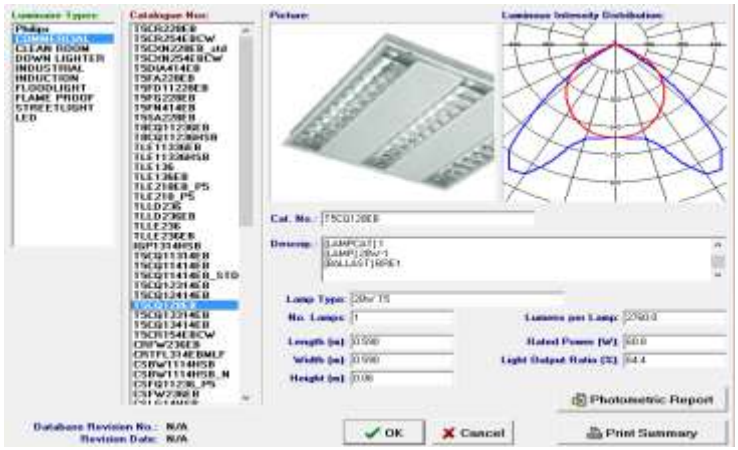



**Fig.2: Luminary detail**

### C. Illuminance Tabulation

| | 0.50 | 0.87 | 1.24 | 1.61 | 1.97 | 2.34 | 2.71 | 3.08 | 3.45 | 3.82 | 4.18 | 4.55 | 4.92 | 5.29 | 5.66 | 6.03 | 6.39 | 6.76 | 7.13 | 7.50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.50 | 160 | 167 | 181 | 200 | 214 | 223 | 237 | 250 | 252 | 245 | 245 | 252 | 250 | 237 | 223 | 214 | 200 | 181 | 167 | 160 |
| 1.29 | 207 | 219 | 245 | 277 | 299 | 312 | 337 | 361 | 362 | 348 | 348 | 362 | 361 | 337 | 312 | 299 | 277 | 245 | 219 | 207 |
| 2.29 | 239 | 253 | 284 | 325 | 352 | 369 | 401 | 429 | 431 | 415 | 415 | 431 | 429 | 401 | 369 | 352 | 325 | 284 | 253 | 239 |
| 3.18 | 253 | 269 | 304 | 347 | 377 | 397 | 431 | 462 | 464 | 447 | 447 | 464 | 462 | 431 | 397 | 377 | 347 | 304 | 269 | 253 |
| 4.08 | 260 | 276 | 311 | 355 | 387 | 408 | 443 | 474 | 477 | 460 | 460 | 477 | 474 | 443 | 408 | 387 | 355 | 311 | 276 | 260 |
| 4.97 | 262 | 278 | 314 | 358 | 391 | 412 | 447 | 477 | 481 | 464 | 464 | 481 | 477 | 447 | 412 | 391 | 358 | 314 | 278 | 262 |
| 5.87 | 262 | 279 | 315 | 359 | 391 | 412 | 448 | 479 | 482 | 464 | 464 | 482 | 479 | 448 | 412 | 391 | 359 | 315 | 279 | 262 |
| 6.76 | 262 | 279 | 314 | 359 | 391 | 412 | 448 | 478 | 482 | 466 | 466 | 482 | 478 | 447 | 412 | 391 | 359 | 314 | 279 | 262 |
| 7.66 | 262 | 279 | 315 | 359 | 392 | 412 | 448 | 479 | 482 | 465 | 465 | 482 | 479 | 448 | 412 | 392 | 359 | 315 | 279 | 262 |
| 8.55 | 262 | 279 | 314 | 358 | 391 | 412 | 448 | 478 | 482 | 465 | 465 | 482 | 478 | 448 | 412 | 391 | 358 | 314 | 279 | 262 |
| 9.45 | 262 | 279 | 314 | 358 | 391 | 412 | 448 | 478 | 482 | 465 | 465 | 482 | 478 | 448 | 412 | 391 | 358 | 314 | 279 | 262 |
| 10.3 | 262 | 279 | 315 | 359 | 392 | 412 | 448 | 479 | 482 | 465 | 465 | 482 | 479 | 448 | 412 | 392 | 359 | 315 | 279 | 262 |
| 11.2 | 262 | 279 | 314 | 359 | 391 | 412 | 448 | 478 | 482 | 466 | 466 | 482 | 478 | 448 | 412 | 391 | 359 | 314 | 279 | 262 |
| 12.1 | 262 | 279 | 315 | 359 | 391 | 412 | 448 | 479 | 482 | 464 | 464 | 482 | 479 | 448 | 412 | 391 | 359 | 315 | 279 | 262 |
| 13.0 | 262 | 279 | 314 | 358 | 391 | 412 | 447 | 477 | 481 | 464 | 464 | 481 | 477 | 447 | 412 | 391 | 358 | 314 | 279 | 262 |
| 13.9 | 260 | 276 | 311 | 355 | 387 | 408 | 443 | 474 | 477 | 460 | 460 | 477 | 474 | 443 | 408 | 387 | 355 | 311 | 276 | 260 |
| 14.8 | 253 | 269 | 304 | 347 | 377 | 397 | 431 | 462 | 464 | 447 | 447 | 464 | 462 | 431 | 397 | 377 | 347 | 304 | 269 | 253 |
| 15.7 | 239 | 253 | 284 | 325 | 352 | 369 | 401 | 429 | 431 | 415 | 415 | 431 | 429 | 401 | 369 | 352 | 325 | 284 | 253 | 239 |
| 16.6 | 207 | 219 | 245 | 277 | 299 | 312 | 337 | 361 | 362 | 348 | 348 | 362 | 361 | 337 | 312 | 299 | 277 | 245 | 219 | 207 |
| 17.5 | 160 | 167 | 181 | 200 | 214 | 223 | 237 | 250 | 252 | 245 | 245 | 252 | 250 | 237 | 223 | 214 | 200 | 181 | 167 | 160 |

**Fig.3: Illuminance Tabulation**

**D. Grayscale**

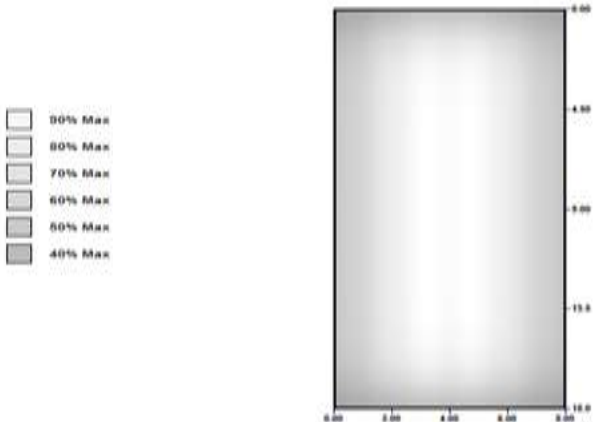



**Fig.4: Greyscale**

**E. ISO lux**

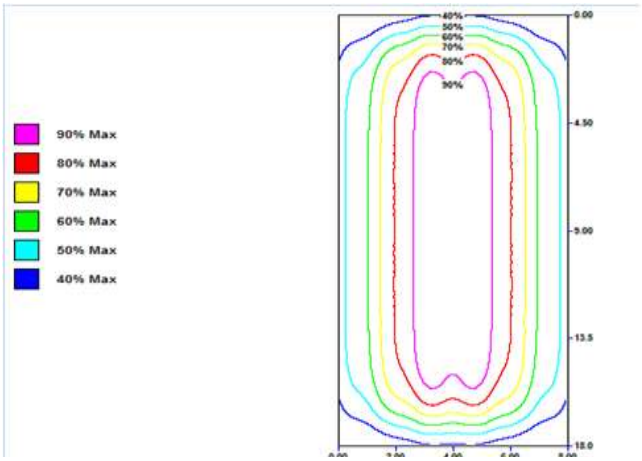



**Fig.5: ISO lux**

**F. 3D lux web**

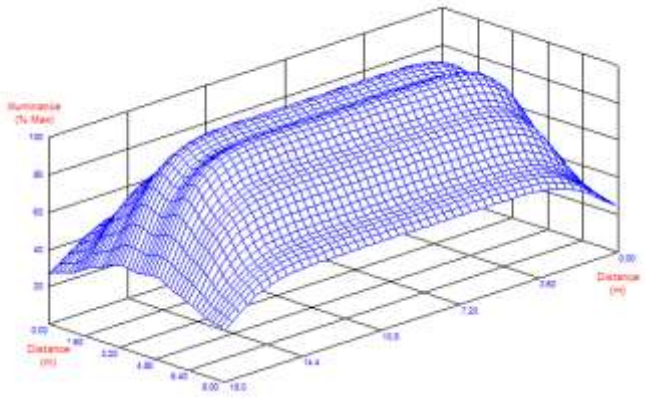
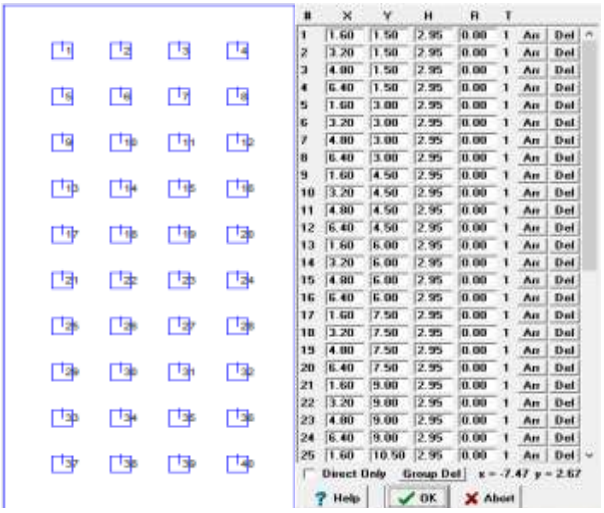


**Fig.6: 3D lux web**

## IV. MODIFIED INNOVATIVE INDOOR ILLUMINATION DESIGN

In this innovative design using cg lux software the above system of seminar hall is simulated. By using this software we got 40 luminaries instead of 44 luminaries which we has observed by using lumen's method of lighting calculation. Also, we are getting average lux in seminar hall 325 lux which is optimum according to I.S. standards.

**A. Design of seminar hall**



| # | X | Y | H | R | T | | |
|---|---|---|---|---|---|---|---|
| 1 | 1.60 | 1.50 | 2.95 | 0.00 | 1 | An | Del |
| 2 | 3.20 | 1.50 | 2.95 | 0.00 | 1 | An | Del |
| 3 | 4.80 | 1.50 | 2.95 | 0.00 | 1 | An | Del |
| 4 | 6.40 | 1.50 | 2.95 | 0.00 | 1 | An | Del |
| 5 | 1.60 | 3.00 | 2.95 | 0.00 | 1 | An | Del |
| 6 | 3.20 | 3.00 | 2.95 | 0.00 | 1 | An | Del |
| 7 | 4.80 | 3.00 | 2.95 | 0.00 | 1 | An | Del |
| 8 | 6.40 | 3.00 | 2.95 | 0.00 | 1 | An | Del |
| 9 | 1.60 | 4.50 | 2.95 | 0.00 | 1 | An | Del |
| 10 | 3.20 | 4.50 | 2.95 | 0.00 | 1 | An | Del |
| 11 | 4.80 | 4.50 | 2.95 | 0.00 | 1 | An | Del |
| 12 | 6.40 | 4.50 | 2.95 | 0.00 | 1 | An | Del |
| 13 | 1.60 | 6.00 | 2.95 | 0.00 | 1 | An | Del |
| 14 | 3.20 | 6.00 | 2.95 | 0.00 | 1 | An | Del |
| 15 | 4.80 | 6.00 | 2.95 | 0.00 | 1 | An | Del |
| 16 | 6.40 | 6.00 | 2.95 | 0.00 | 1 | An | Del |
| 17 | 1.60 | 7.50 | 2.95 | 0.00 | 1 | An | Del |
| 18 | 3.20 | 7.50 | 2.95 | 0.00 | 1 | An | Del |
| 19 | 4.80 | 7.50 | 2.95 | 0.00 | 1 | An | Del |
| 20 | 6.40 | 7.50 | 2.95 | 0.00 | 1 | An | Del |
| 21 | 1.60 | 9.00 | 2.95 | 0.00 | 1 | An | Del |
| 22 | 3.20 | 9.00 | 2.95 | 0.00 | 1 | An | Del |
| 23 | 4.80 | 9.00 | 2.95 | 0.00 | 1 | An | Del |
| 24 | 6.40 | 9.00 | 2.95 | 0.00 | 1 | An | Del |
| 25 | 1.60 | 10.50 | 2.95 | 0.00 | 1 | An | Del |

Direct Only | Group Del | x = -7.47 y = 2.67

Help | OK | Abort

**Fig.7: (a) Luminaries Position, (b) Co-ordinates of Luminaries**

**B. Illuminance Tabulation**

Average: 325 lx | Maximum: 443 lx | Minimum: 139 lx
Max / Min: 3.182 | Ave / Min: 2.334

| | 0.50 | 0.87 | 1.24 | 1.61 | 1.97 | 2.34 | 2.71 | 3.08 | 3.45 | 3.82 | 4.18 | 4.55 | 4.92 | 5.29 | 5.66 | 6.03 | 6.39 | 6.76 | 7.13 | 7.50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.50 | 143 | 149 | 161 | 177 | 189 | 197 | 210 | 221 | 222 | 217 | 217 | 222 | 221 | 210 | 197 | 189 | 177 | 161 | 149 | 143 |
| 1.39 | 188 | 199 | 222 | 250 | 270 | 283 | 306 | 326 | 327 | 315 | 315 | 327 | 326 | 306 | 283 | 270 | 250 | 222 | 199 | 188 |
| 2.29 | 217 | 230 | 259 | 296 | 321 | 336 | 365 | 391 | 393 | 377 | 377 | 393 | 391 | 365 | 336 | 321 | 296 | 259 | 230 | 217 |
| 3.18 | 232 | 247 | 278 | 318 | 346 | 365 | 396 | 423 | 425 | 410 | 410 | 425 | 423 | 396 | 365 | 346 | 318 | 278 | 247 | 232 |
| 4.08 | 237 | 252 | 284 | 325 | 355 | 373 | 405 | 434 | 437 | 421 | 421 | 437 | 434 | 405 | 373 | 355 | 325 | 284 | 252 | 237 |
| 4.97 | 240 | 256 | 288 | 329 | 359 | 379 | 411 | 439 | 442 | 426 | 426 | 442 | 439 | 411 | 379 | 359 | 329 | 288 | 256 | 240 |
| 5.87 | 240 | 255 | 288 | 329 | 359 | 377 | 410 | 439 | 442 | 426 | 426 | 442 | 439 | 410 | 377 | 359 | 329 | 288 | 255 | 240 |
| 6.76 | 240 | 256 | 289 | 329 | 360 | 379 | 412 | 440 | 443 | 427 | 427 | 443 | 440 | 412 | 379 | 360 | 329 | 289 | 256 | 240 |
| 7.66 | 240 | 255 | 288 | 329 | 359 | 378 | 411 | 439 | 442 | 427 | 427 | 442 | 439 | 411 | 378 | 359 | 329 | 288 | 255 | 240 |
| 8.55 | 240 | 256 | 288 | 329 | 359 | 378 | 411 | 439 | 442 | 427 | 427 | 442 | 439 | 411 | 378 | 359 | 329 | 288 | 256 | 240 |
| 9.45 | 240 | 256 | 288 | 329 | 359 | 379 | 411 | 439 | 442 | 427 | 427 | 442 | 439 | 411 | 379 | 359 | 329 | 288 | 256 | 240 |
| 10.3 | 240 | 255 | 288 | 329 | 359 | 378 | 410 | 439 | 442 | 427 | 427 | 442 | 439 | 410 | 378 | 359 | 329 | 288 | 255 | 240 |
| 11.2 | 240 | 256 | 289 | 330 | 360 | 380 | 412 | 440 | 443 | 428 | 428 | 443 | 440 | 412 | 380 | 360 | 330 | 289 | 256 | 240 |
| 12.1 | 240 | 255 | 287 | 329 | 359 | 377 | 410 | 439 | 442 | 426 | 426 | 442 | 439 | 410 | 377 | 359 | 329 | 287 | 255 | 240 |
| 13.0 | 240 | 256 | 288 | 329 | 359 | 379 | 411 | 439 | 442 | 426 | 426 | 442 | 439 | 411 | 379 | 359 | 329 | 288 | 256 | 240 |
| 13.9 | 237 | 252 | 284 | 325 | 354 | 372 | 405 | 433 | 436 | 421 | 421 | 436 | 433 | 405 | 372 | 354 | 325 | 284 | 252 | 237 |
| 14.8 | 231 | 246 | 277 | 316 | 345 | 363 | 394 | 422 | 424 | 408 | 408 | 424 | 422 | 394 | 363 | 345 | 316 | 277 | 246 | 231 |
| 15.7 | 216 | 228 | 257 | 293 | 318 | 333 | 361 | 388 | 390 | 374 | 374 | 390 | 388 | 361 | 333 | 318 | 293 | 257 | 228 | 216 |
| 16.6 | 185 | 195 | 217 | 245 | 265 | 277 | 299 | 318 | 319 | 308 | 308 | 319 | 318 | 299 | 277 | 265 | 245 | 217 | 195 | 185 |
| 17.5 | 139 | 145 | 157 | 171 | 183 | 191 | 203 | 213 | 214 | 209 | 209 | 214 | 213 | 203 | 191 | 183 | 171 | 157 | 145 | 139 |

**Fig.8: Illuminance Tabulation**

**C. Grayscale**

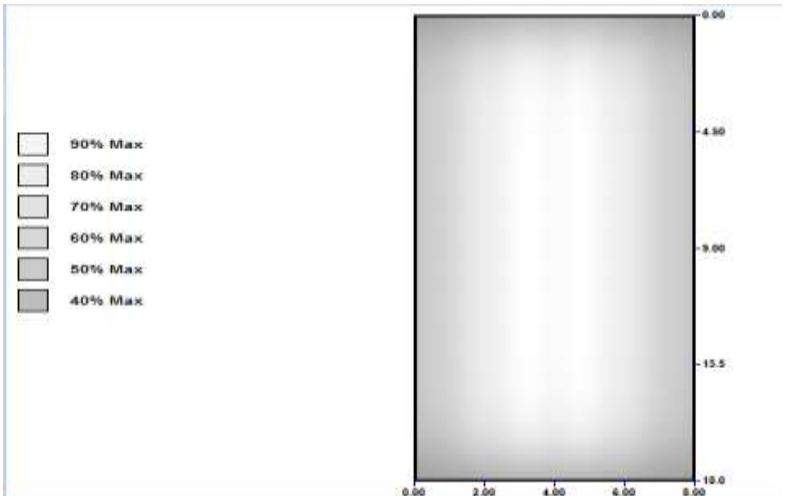



**Fig.9: Greyscale**

**D. ISO lux**

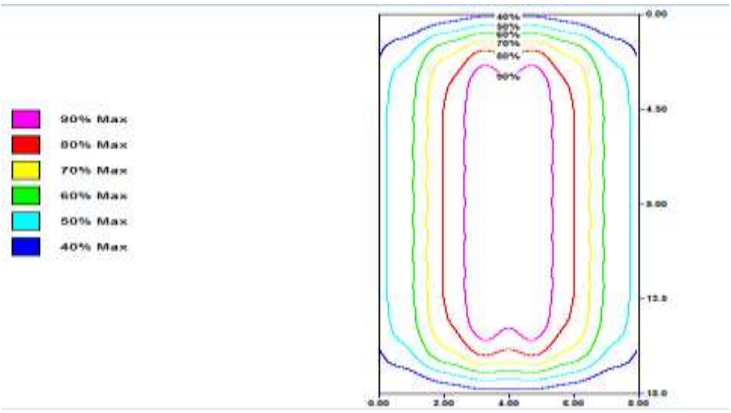



**Fig.10: ISO lux**

**E. 3D lux web**

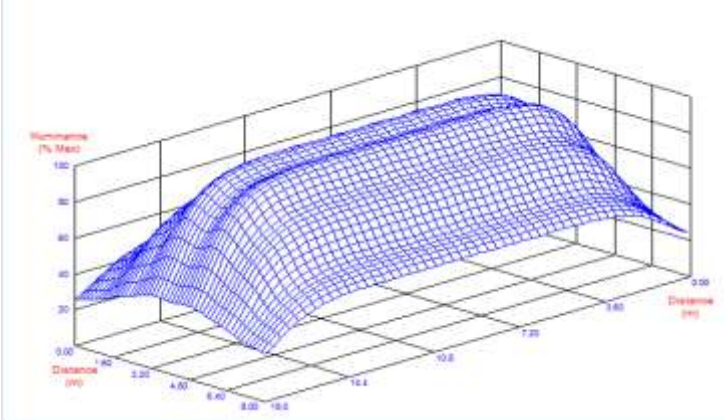


**Fig.11: 3D lux web**

## I. CONCLUSION

By using manual Lumen's method it require 44 luminaries fittings with 356 average lux for area of 144m$^2$ seminar hall. But by using computer software –CG lux, innovative illumination design can be achieved with the use of 40 luminaries of same type for same area with the obtained average lux level of 325. We can choose the different types of decorative, high intensity, low intensity, costly/cheaperetc. as per overall requirements and thereby achieve many alternative with less efforts. Comparing all the alternatives and selecting the better one make the design innovative.By optimizing the number of luminaries required by studying the output of respective luminaries and real requirements of the average value of standard lux,illumination design ultimately increases efficiency of system and reduce the running and capital cost.

## REFERENCES

[1]. IS-3646 (PART-1) 1992" - General Requirements and Recommendation for Working Interior by Bureau ofIndian Standard"

[2]. Brian Cook "High Efficiency Lighting in Industry and Commercial building" Power Engineering Journal IEE October 1998.

[3]. Commercial and Industrial Building Lighting Efficiency" April-2011 "Sustainable EnergyAssociation of Australia" prepared by – Newcastle Innovation.

[4]. Rudiger Ganslandt, Harald Hofmann"Handbook of Lighting Design" ERCO Edition.

[5]. R. Harrold, D. Mennie "IESNA Ready Reference" Illumination Engineering Society of North America."