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FLEX-TRUCTURE: Community Services and Structural Emergency Preparedness through a Proposed Two-storey Multi-functional Building Design for Barangay Calangain, Lubao,Pampanga

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Abstract:

"FLEX-TRUCTURE: Community Services and Structural Emergency Preparedness through a Proposed Two-storey Multi-functional Building Design for Barangay Calangain, Lubao,Pampanga" aimed to provide a safe and versatile space focusing on addressing the challenges faced by Barangay Calangain in Lubao, Pampanga through emphasizing the importance of proactive measures and community resilience in disaster management. The researchers considered the specific needs of the barangay, taking into account its geographical location, population, and vulnerability to natural hazards such as floods obtained through data gathering instruments such as interviews and document review. The study is quantitative and descriptive in nature. National Structural Code ofthe Philippines (NSCP) 2015, Structural Design and Analysis (STAAD) Pro Connect v. 2022 and STAAD RCDC, Uniform Building Code (UBC) 1997, and Microsoft Excel were utilized in designing the structure and for data interpretation. Cost estimates were provided for approximation of the building materials and Evacuation System Plan for the barangay,essential for community evacuation. Proposed two-storey multi-functional building will be a benefit to the community byoffering various facilities for programs and services as well as serving as a temporary shelter or evacuation center in case of emergencies.

Keywords-Multi-functional,CommunityServicesandEmergencyPreparedness

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I. INTRODUCTION

Geographical location of the Philippines makes itproneandvulnerabletovariousnaturaldisasterssuch as typhoon, earthquake and volcanic eruption.NeartothevastPacificOcean,annually,atleast twenty(20)typhoonsortropicalstormsvisitthe PhilippineAreaofResponsibility(PAR).Thecountry also as positioned to the "Pacific Ring ofFire", experienced light to tremendous earthquakeboth due to the movement of tectonic plates andvolcaniceruption.

Philippines ranked third among the most climate-vulnerablenationbasedfrom2017WorldRiskReport experiencing a wide range of climate changeeffects-changesinprecipitationpatternsanddispersion,severe droughts,dangersintheecosystemandbiodiversity,foodshortages,risingofsealevel,publichealththreats,andrisksstovulnerablesectorsincommunities(NICCDIES, 2022).Thecountryalsotoppedonlistof193nations in the World Risk Index 2022 which rankedcountriesaccordingtotheirlevelofriskrepresenting99%of globalpopulation(Luz,2022).

Society'scapacitytoprevent,manage,andrecover from disasters depends on variety of bothsocial and economic factors which is composed ofthe following: closeness to evacuation routes andcenters, residential houses' structure and durability,and the vulnerability of the communities in whichpeople reside (Bollettino et al., 2018). Institutionalprocesses and catastrophic control mechanisms inthePhilippinesusually basedontheresponseorreactionaryapproachcompared toproactiveapproach,whichismoreefficient,requiring adequate strategic planning on utilization of land,building,andotherpreparednessproceduresinorder to prevent or avoid the occurrence of disaster-pronecircumstances (World Bank, 2005).

TyphoonandFlooding

Tropicalcycloneortyphoonisdefinedasaviolentstormwhichformsoverwarmtropicalwaters, having low air pressure, heavy rainfall, andwindsexceeding119km/h(74mph)(Zehnder,2022).

Numerousfatalities,damageinbuildingsandessentialfacilitiesandlong-lastingimpactoneconomy are someoftheeffectsbroughtby thetyphoonsandotherextremeweatherandclimateconditions, annually(WMO, 2022).

EastandSoutheastAsiannationsareveryconcernedontyphoonintensityvariations.Thecontinenthasincreasedinintensityby12–15%while the percentage of category 4 and category 5stormshadquadrupledortripled(Mei&Xie,2016).

Sealevelrise,oneofclimatechangeeffect,intensifiesstrongertyphoons.Withahugeandquicklyexpanding population,Philippines'susceptibilityismadeworseby localizedenvironmentalissues(Holden,2018).Outofthethree recognized zones in the country, Luzon is theisland that has been impacted by the most typhoons.Mostofthetime,typhoonsoccurbetweenthe monthofSeptemberandNovemberduringthetransition from northeast monsoon to the southwestmonsoon(Desquitado, 2020).

Tropical cyclones may cause harm and damagesto buildings and other infrastructures through directimpactandprojectiles–inflictingphysicalharmandcausingdamagesbypropellingdebrisontobuildings. These may also bring storm surges oncoastalareas,torrentialrainandotherrisks(Devaney, 2022).

Withanestimated60%ofthecountry'sgeographical orterritorialareaand74%ofitspopulation vulnerable to multiple risks and naturalcatastrophes,thePhilippinesisconsideredtobeexposedtocatastrophiceventscausedby naturaldisasters (World Bank Group, 2021). Lot of houseshavebeendamagedorconsidereduninhabitable,leavingmany peoplehomeless.Temporary shelterisconsideredtobeanessentialcomponentofhousing reconstruction programs, which are criticaltodisasterrecoveryprocess (Felix, D. et al., 2013).

Based from the study conducted by Gray et al.(2022), death rate was greater in rural compared tourbantowns.Peri-ruralmunicipalitieshadthegreatestproportionatefatalityratebetween2005and2015.Typhoonmortality wasdispersedoverthePhilippineswhereyoungestandoldestagegroupspopulationswerethemostsusceptibleintermsof this natural calamity.

Eightoutoftoptenmostdeadlycyclonestostrike the Philippines left between 1,000 and 2,000dead. Typhoon Haiyan, also known as "Yolanda",approximateofupto10,000peoplekilled,recognizingitthemostdestructiveordeadlieststorminPhilippine'shistory(Brown,2013).

Philippines have been profoundly impacted byglobalclimatechange.Ithasagreateffecton individualswholiveinpoverty,whoaredisadvantaged, andwhodependonnaturalresources for their livelihoods, such as indigenouspeopleand farmers(Novio, 2022).

There were 18.1 percent of Filipinos living inpovertyorthosewhowerecharacterizedasthepopulation having an insufficient yearly or annualincome to meet the basic necessities such as foods,clothingandshelter,accordingtotheinitialfindingsorresultsoftheFamilyIncomeandExpenditure Survey (FIES) in 2021 (PSA, 2022).Supporting this data, the country had 2.3 millionescalation or rise in the population of poor people,from 16.7 percent of 2018 people to over 20 millionor18.1percentin2021,mainlycausedbythepandemic's negative impact to the economy (DelaCruz,2022).

Poor people are more unlikely to be financiallyequippedtogetinvolvedwithriskreduction methods and have greater probability of living inrisk-proneareas.Poorrurallivelihoodsareparticularly exposed to and susceptible to weather-relatedrisks (UNDRR, 2020).

Despite the efforts of civil society, activists, andpeopleadvocatingforanemergencyresponsetosolve the climate issue, band-aid solutions are themost likely course of action especially in disaster-pronelocations (Novio, 2022).

TheeffectsonFilipinos'healthfromthesetremendoustyphoonsareunimaginable.Malnutritionwasaseriousissueamongthecasualtiesasaresultoflackoffoodfromthedamagedcrops.Acuterespiratoryillnesseswerealso more prevalent and measles infections due toovercrowding in evacuation areas. There were alsoincreased spread of water- and food-borne illnessesdue to the lack of access to clean and potable water,hygiene supplies, and sanitation facilities. Dengueand infections were also serious concern when itcomestoflooding(Climate andHealthAlliance,2022).

Due to numerous typhoons that the Philippinesexperienced amid the pandemic, large number ofFilipino individuals has been displaced from theirhomesandasignificantnumberofresidential propertieshavebeenaffected.Overpopulationinevacuation camps and lack of social distance resultstoincreasein COVID-19cases(Rocha,2021).

According to experts, the severity of the tropicalcyclonesthathitthePhilippineseveryyearhasincreased, resulting to more flooding in recent years(Vila, 2021). A flood occurswhen water surpassesitsusualboundariesandspreadsoverpreviouslydryland,rangingfromafewinchestoevenreachingtherooftopsofhouses.Thisnaturalphenomenoncanposeasignificantthreattocommunities, as floods can persist for days, weeks,or even an extended period of time (SciJinks, 2016).Floods recorded between year 1998 and 2017 hadhuge impact on more than 2 billion people globally(Lai,2021).

Flooding makes up around 40% of all naturalcatastrophes, making it the most frequent in bothdeveloping and industrialized nations (Torti, 2012).Ithasthepotentialtoresultinwidespreaddestruction, leading to loss of life, major damage toproperties, and the destruction of essential publichealthinfrastructure.Floodsarebecomingmorefrequentand more intense due tothe increaseinbothsevereprecipitationfrequencyandintensitybrought by changes in global climate (WHO, 2021).Floods caused economic loss as well as long-termeffectswhichincludeslostineducationalopportunities, spread of illnesses, and poor nutritionthatmightaffectthedevelopmentofthenation(WorldBankGroup,2012).Directcontactwithcontaminated waterways poses a higher chance ofbeingexposedtowater-borneillnessessuchdermatitis,throatinfections,woundinfections,typhoidfever,cholera,andleptospirosisthatcaneasilyproliferateduetopollutedoruncleandrinkingwatersystems (Rastogi, 2018).

Floods and typhoons are responsible for 90% ofthe affected persons, 80% of catastrophe fatalities,and 92% of the economic losses. Floods caused bymonsoon rainfall can result to significant damage inlow-lying and sparsely built areas.Inadequateorblocked drainage routes make flooding more likelyduring monsoon seasons, which are becoming moreintense(CFE-DMHA,2021).Citiesandurbanareas aresusceptibletofloodingonlow-lyingareasdueto the overflow from streams. Watershed's naturalresponsetoexcessprecipitationortheamountthatisnotabsorbedbyinfiltrationtotheearth,orwhatiscalledsurfacerunoffresultsinflooding(Tan,2021).

Evaluationoffloodriskstogetherwiththemeasurementofthefloodddamageisvitalintermsofthesustainableandefficientmanagementinflood risks for a long period of time. Flood hazardsassessment can come up with the effectiveness ofmodificationmethodsundertheconditionsofclimate change and the rapid urbanization. Placesmost vulnerable for flooding are those that are low-lying, near bodies of water, or upstream from a dam,whereas the area most at risk for major increases inflood-related mortality are those that are hilly andlocatedinconfinedriver valley(Kefietal.,2020).

Building damage during floods can come fromalterationsingroundwaterflowconditionsaswell as the direct action of the flood wave and surfacewater (Wilk, 2018). As the floodwater side, risingwater on the buildings outside acts inward againstthebuilding'swalls.Building'sstructuralcomponentsmightbepermanentlydeflectedanddamagediftherearee xcessivelateralstresses(Chidambarathanu &Retnan, 2013).

EvacuationCenter

Evacuation is a crucial life-saving precaution inthe country due tothe intensity of typhoonsandgrowing population. It is essential to have enoughand safe evacuation facilities as well as a reliableevacuation strategy (Cajucom et al., 2019). In orderto manage evacuation in the future and reduce thenumber of lives lost, it is essential to know evacueebehaviour. Affected individuals must decide whereto stay in order to avoid an approaching threat whendetermining their evacuation location (Lim et al.,2021).Whereverandwhenevernecessary,evacuation centers must be planned and recognizedahead of time or before of a crisis to guarantee thatplans,sufficientmaterials,andtrainedpersonnelcan be quickly deployed in the event of disaster.Governmenttogetherwithlocalhealth professionals could also need temporary housing inevacuationsheltersintheeventofalarge-scaledisaster(WHO, 2020).

Despitethesignificantresourcesallocatedfordisasterplanning,therewasashortagewhenitcomestoevacuationfacilitiesconcerningcatastrophiccircumstances(Beldad,2022).Basicaccommodations like access to clean water, toilets,andshowers,aswellastelecommunicationsconnectivity and appropriate ventilation in confinedspaces,continuetobeinsufficientinsuchtemporaryshelters.Incongestedevacuationfacilities, diseases still have a tendency to spreadquickly, with young children and the elderly beingamongthe mostvulnerable (The Philippine Star,2022).

Nearlyeverycalamitynecessitatestheuseofevacuationcenters.Educationalinfrastructuresaswellasbarangay centershould not be categorizedas evacuation shelters in disaster-prone country likePhilippines except if adequate sanitary facilities areavailable (Ramoset al., 2015). Additional to theobvious lack of nutrition and WASH facilities intheseevacuationshelters,evacueesoftenhavegeneral concernsaboutprivacy and safety aswellasquestionsregardingequitableaccesstospace. Beyondtheavailabilityofshelter,agreaterexamination ofwhatconstitutesexcellentdesignandimprovedspace managementisnecessary toprotect human dignity in times of crisis (Tumamao-Guittap&Urcia, 2022).

Themajority(63.45%)ofthecountry'sevacuationcenterswereeducationalfacilities,barangay halls,and daycare centers.Only 2.86%among all evacuation centers were used. As of July2020, the Office of Civil Defense (OCD) reportedthat the Department of Public Works and Highways(DPWH)hadscheduled287evacuationcentersaround the nation since 2016. Of these, 130 werefinished,67arebeingbuilt,and90arebeingprocured(Macaraeg, 2020).

Non-residential buildings such as churches andstadiums should only be utilized as evacuations forshort period of time due to the limited capacity toprovidesanitaryandfoodpreparationfacilities.

Resourcesforlaundryandbathingmayalsobeinsufficient(CentersforDiseaseControlandPrevention,2020).

EducationalFacilities

Primary purposeofeducationalfacilitiesistocreate an environment which must be suitable forlearningandteaching.Itmustadapttomodernteachingstrategiesandschoolstructureswhiletaking into account how the educational process hasevolved to become more interactive, interconnected,andingrained insocietyatlarge(Llego, 2022).

Studies have shown that school facilities are thephysical representation of the curriculum in space.The challenge of having adequate and responsiveschoolfacilitieshaslongbeenoneofthemain concernsofeveryeducator.Inordertohavearelevant and effective curriculum, it is essential thateveryschoolhasadequateandfunctionalinfrastructure. To improve the learning environment,all educators and administrators are encouraged toworktogetherandtoensurethatchildrenarelearning in a meaningful way, the school uses itsfacilities.Forstudentstolearnwell,adequatefacilities arekey.Otherresearchhasemphasizedthe fact that when facilities are available, childrenwouldbeexposedtoavarietyofactivitiesthatsomehowstimulatestudentsintheiracademicendeavour (JAMINAL, 2019).

BasedfromthereportreleasedbytheDepartmentofEducation(DepEd),21,724,454students have signed up to attend public and privateschoolsacrossthecountryforthe2020–2021academicyear.Accordingtodepartmentaldata,1, 219,094 students were enrolled in private schoolsasofJuly21comparedto20,475,530studentsenrolledinpublicschools.TheCordilleraAdministrative Region had the fewest enrolees, at333,840,andRegion4-A(CALABARZON),themost, with 2,951,330. In addition to students withdisabilitiesandthoseenrolledinthealternativelearning system, the enrolees ranged in age fromkindergarten to senior high school (Philippine NewsAgency,2020).

The Philippines has established public schools inmany remote places, despite limited transportationandcommunicationtechnologies,tomakeeducationaccessibletochildrenlivingintheseareasandtoaddressthefundamentalrightofchildrentoeducation.However,duetolimitedinfrastructure,schoolsinmountainouslocationsremainlessaccessible tochildren.Because thereare still countless people who want to live in rurallocations, students attending school must walk greatdistancesduetothelackofmotorvehicle-accessible roadways. People become more isolatedandlessinvolvedindataexchangewhentheseinfrastructuresarelacking.Becauseofothergovernment priorities, problems faced by residentsandschoolsintheselocationsaretypicallynotaddressedbythe government. (Peteros etal., 2022)

Inastudyconductedin2018,among79countries,Filipinochildrenaged15scoredthelowest in reading comprehension, ranking 78th inboth math and science. This situation highlights thechallengethatmanyFilipinosfaceintermsofliteracy andbasicmathematicalskills.However,unlikesomeofitsneighboringcountries,thecountrydoesnotallocateasmuchresourcestoprioritizehigh-qualityeducation.Despitetheadvancementsinthedigitalage,manypublicschools in the country still lack computers and othernecessaryequipment.Moreover,theshortageofteachers in public schools remains a pressing issue,astheyareamongthelowest-paidgovernmentemployees(Child HopePhilippines,2021).

Multi-FunctionalBuilding

Multi-functional building is defined as one thathasatleasttwodistinctdestinationspaces,satisfyingthedemandornecessitiesofresidentsinacommunity.Ittypicallyhasawiderangeofpurposesforitsspaces,whichtogetherformacomplexsystem (Gerigk,2017).

In general, a multipurpose structure is one thatservesavarietyofpurposes,includingoffices,stores, shops, restaurants, and other facilities. Themultipurposestructureistheidealsettingforallofahumangroup'srequirements,necessitiesand demandsofresidentsatthemulti-functionalbuilding,whetherthecommunityneedsahugespace for conference or a space for mass gathering.Since the beginning of the Renaissance in the 1990s,there are far too many multi-purpose buildings to befound everywhere around the world (Shakhshiretal.,2015).

Themultipurposestructuresarefrequentlyutilized to deliver educational and social services tothe local populations as well as to host a variety ofeventsincludingathleticorsportstournament,public gatherings or social occasions, symposiums,seminars,massimmunizationsites,andmedicaland dental missions. Department of Public Worksand Highways has been working on a number ofinitiatives to give regional communities access todependablepublicfacilitiesfortheprovisionofgovernmentservices (Tecson, 2022).

In the past, it was generally easier to integratestructureswithmanyapplicationsthantoincorporateseveralusesintoasinglestructure.Withthedevelopmentofnewbuildingmaterialsandmethods,itwasultimatelydeterminedtocontrol the construction of structures with certainpurposesbyassemblingthemintoproperlyspecifiedregions (ThePlan, 2021).

Long-terminfrastructurecostscanbesignificantly reduced by developing a multipurposefacility for utilities in building are all housed in onearea rather than being spread out throughout severalfacilities and frequently different locations (Moorse,2021). Flexible buildings can easily adapt and meetchanging requirements for space, functionality, andcomponentswithoutbeingtechnically impracticalortooexpensivegiventhattheworldisexperiencing ecological and climatic catastrophe aswellasnatural resourceshortage(Souza,2022).

Structural flexibility into construction projectsrequires costs and provides advantages. Comparedtothecostofmanagingunexpectedchanges,flexibility is far less expensive. Flexibility can beconsidered as adding value to projects by enhancingtheirgeneraleffectivenessandpeople'sdemand(Shahu,2017).

Building vulnerabilities, which are common, areblamed for cost rises and construction delays. Poorworkmanship,ratherthanthequalityofthecomponents or goods used, causes these technicaldefects.Natureoferrorsduringconstructionis predominantlytechnical,thoseathandoverareeitheraestheticortechnical (Forcadaetal.,2014).

Buildingflawsarestillaproblemforthebuilding sector. Industry continues to struggle withdesigners andinstallersignorance of the primarycauses that lead to these failures. Building failureinvestigations and repair and maintenance are a bigpart of what building surveyors doevery day.Ittakesintoaccountbothcontemporary,andtraditionalbuildingtechniques,aswellasolderonestheuniquechallengesofremodelingandalteringwork(Douglas, J.&&Ransom, B.,2013).

Residentsfrequentlylackabasicunderstandingofthesurroundingsand/orevacuationroutes,andtheremayalsobeavarietyofindividualssuchaschildrenandPersonwithDisability(PWD's).Evacuationiscomplicatedby allofthis.Therefore,itwillbenecessarytotakeintoaccountorgivenconsiderationthestructuralframe'scapacity toenduretheexperiencedimpactwhenthefacilitymust also be safely evacuated (Nilsson et al., 2012).Needforthe researchofpedestrian dynamicshaslatelygrownduetothegrowingurbanpopulationandurbanization.Thisincreasehasledtogreater andmorefrequentlarge-scaleeventswhicharebecomingmorepopularcallingfornewsecuritystrategiesthataretailoredforthemassivenumberofparticipantsorattendeesduringmassgathering(Wagoum&Seyfried,2013).Structuralflexibilityinto construction projects requires costs andprovidesadvantages.Comparedtothecostof managingunexpectedchanges,flexibilityisfarlessexpensive.Flexibilitycanbeconsideredasaddingvaluetoprojectsbyenhancingtheirgeneral effectivenessandpeople'sdemand(Shahu,2017).

StudyArea

BasedfromtheMeteorologicalDisasterRiskProfile of the Philippines, most disaster occurs inRegionIII/themainislandgroupofLuzon.

Compared to its adjacent 10 provinces, it has abouttwice as many 105 meteorological disasters everyyear(Abello,2017).CentralLuzonprovinces– Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac,andZambales-categorizedashazard-proneprovinces in the Philippines according to the Officeof Civil Defense (OCD) Regional Director JosefinaTimoteo and recognized by Mines and GeosciencesBureau (MGB)as those provinces prone to bothlandslideandfloodingandhaveoperationalProvincialDisasterRiskReductionandManagementCouncils (PDRRMC)(David,2012).

Fig1.2.1MapofPampangaProvince

ThefigureaboveshowstheprovinceofPampanga which belongs to the plains of CentralRegion of Luzon, has one of the largest drainagebasins (also known as the Pampanga River Basin)andduringmonsoonseasonandtyphoon,theprovince is usually struck resulting to major flooddisasters(Nagumo,2016).Critical-levelfloodingoccurred from all powerful tropical cyclones thatpassed directly through the basin. From the studyconducted by Macalalad, et al. (2021), all floodingincidentsinthePampangaRiverBasin,regardlessof intensity, were brought on by tropical-cyclone-inducedprecipitation.

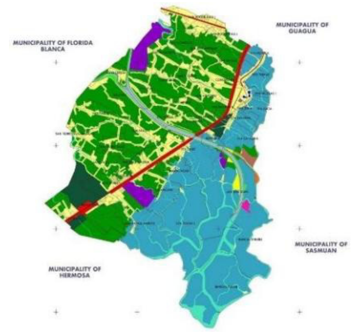


Fig1.2.2MapofLubao,Pampanga

The term "lubo," which translate as low in thenative tongue, was the origin of the name of theLubaomunicipality.Theword"Lubo,"whichistypically muddy and flooded, subsequently changedto "lubao," the town's current name. Lubao, showninthefigureabove(Figure1.2)isoneofthetwenty-two(22)townsormunicipalityofPampanga situated at the south-western part of theprovince which is bounded by the municipalities ofGuagua (Northern portion) Sasmuan (Eastern part),Floridablanca (West direction) and Orani, Bataan(on south).The ground elevation or terrain in Lubaois mostly level which merely has a 0–3 meter heightwhich makes some barangays prone and susceptibletofloodingprovenfromtheMulti-hazardMap(Figure1.2.3)andFloodHazardMapofLubao(Figure 1.2.4). Approximately 64.30% of its entirelandmass is made up of broad plains. The GumainandKaulamanRivers,aswellasotherminorstreams acting as drainage basins, cut through it.The Pampanga province's coastline region includesLubao's southernmost section which is used by themunicipality asitsfishinggrounds.Belowshowsthe multi-hazard map of the Municipality of Lubaoshowing the branches of rivers within the area andalsoportraysthehazardsforbarangaysthatareprone tolandslides,stormsurges,tsunamiandfloods.

Themajorfactorcontributingtoitsfrequentflooding isitstopographicalposition.Waterflowingupstream(fromPorac,Bataan,andFloridablanca) is another element that might cause asignificantamountoffloodingwithinthearea.Tropical cyclones that might provide nonstop rainareanother important aspectto beconsidered.

Table1.2.1
AreasatRiskduringFlood(BarangayCalangain)

BARANGAY	HIGH Population	MEDIUM Population	LOW Population
Calangain	1700	1275	

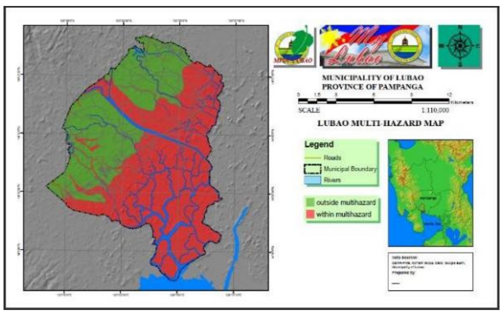


Figure1.2.3Multi-hazardMapofLubao,Pampanga

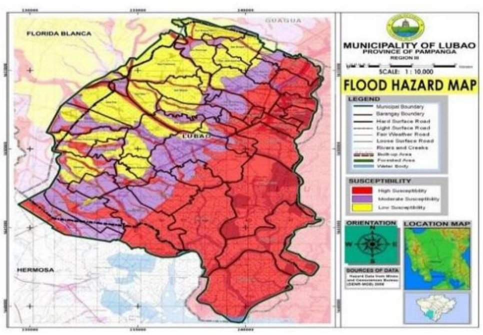


Figure1.2.4:FloodHazardMapofLubao,Pampanga

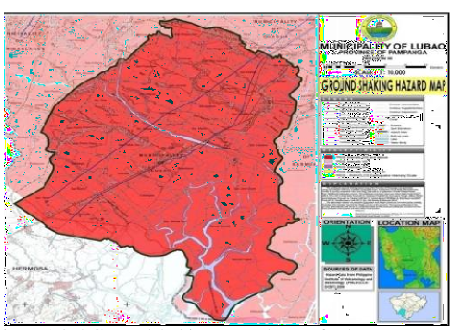


Figure1.2.5:GroundshakingHazardMapofLubao,Pampanga

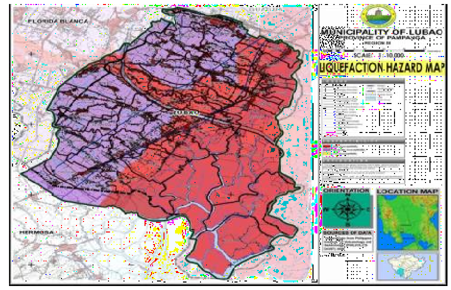


Figure1.2.6:LiquefactionHazardMapofLubao,Pampanga

The figures above show the Ground ShakingMap (Figure 1.5) and Liquefaction Hazard Map ofLubao(Figure1.6)gatheredfromtheMunicipalDisasterRiskReductionManagementOffice(MDDRMO)includetheBarangayCalangaintoaffected areas of the Municipality of Lubao.Theisland barangays (San Jose Gumi, Bancal Sinubli,Bancal Pugad, and Sta. Teresa II (Lambiki)) alongtheshoreofPampangaBayarelocatedinthesouthernsection,whereelevationincreasesandranges from 3 to 0 meters. The municipality has atotal lot area of 15,731.11 hectares and politicallysplitinto44barangayswhichincludesbarangayCalangain(Municipalityof Lubao, 2020).

Figure1.2.7:Calangain,Lubao,Pampanga

Figure1.2.8:LotArea LocationforProposedMulti-functionalBuilding

BarangayCalangainencompassesanapproximate area of 563.25 hectares, with specificallocations for variouspurposes. Out of the totalarea,200 hectaresaredesignated foragriculturaluse,50hectaresareidlelandswithoutcrops,another50hectaresareallocatedforresidentialpurpose, and an additional 50 hectares are set asidefor commercial or business purposes. In terms ofgeographicallocation,BarangayCalangainissituated 3 kilometers away from the town or citycenter,wherethemunicipalhalliserected.ItisborderedbyBarangaySanRoquetotheeast,Barangay Sta. Teresa to the west, Barangay Baruyatothenorth, and BarangaySta. Cruzto thesouth.

Thetotalpopulationofthebarangayis3,038. The overall household in the barangay is 790.Meanwhile,thetotalityoffamilieslivinginthebarangayis 2,270.

StatementoftheProblem

This study focused on the aid that can beprovided through the proposal of a multi-functionalinfrastructuredesignthatcaterstocommunityservices as well as serves as structural emergencypreparednessofBarangayCalangainLubao,Pampanga. Specifically, the study sought to answerthefollowing:

1. What is the significant improvement in thatareaconcerningtheproposedmulti-functional building and the features it offerstothebarangay?
2. Howmaythisprojectbenefitthepeoplearoundthatarea?Howmayithelpthevulnerablesectors/areas ofthecommunity?
3. How can this proposal of multi-functionalinfrastructuredesignmeetthepresentdemandsofthecommunityandprobable/unpredictableconcernsofthecommunityin thefuture?

GeneralObjectives

The objective of the study was to develop acomprehensivestructuralandarchitecturaldesignfor the two-storey multi-functional building locatedinBarangayCalangain,Lubao,Pampanga.Thefocus of the design included the detailed planningand specifications for the roofing, beams, columns,floor slabs, foundations, walls, and staircase of thebuilding; design of the structure was based on theNational Structural Code of the Philippines (NSCP)2015; and provide cost and estimate to the materials,labor, and others expenditure to be included in thepossibleconstructionofthedesignproject.Theproposed multi-functional building design served asa disaster-resilient facility capable of withstandingmajor natural catastrophes while also assuring thesafetyofallresidentsofthebarangayandneighboring communities.

SpecificObjectives

Thestudyspecificallyaimedto:

- assessandevaluatetheneedsoftheresidents upon the proposed design of themulti-functionalbuilding
- designArchitecturalplansbasedoncommunity servicesandstructuralemergency preparedness as well as providestructural plans basing NSCP 2015 providecost analysis of the materials used regardingtheproposedmulti-functionalbuildingdesign based from price and availability inthepresent market.
- provideanorderlyandsecureevacuationsystemplanforthefacilitythatisunobstructedbyanything that could hindera

safeevacuationforpersonnelandresidentsinth eevent ofanemergency.

Significanceof theStudy

Theresultsofthestudyhavesubstantialbenefits fortheresidentsofBarangayCalangainLubao,Pampan ga,aswellastheneighboringbarangaywhicharevulner abletodisasters.Thegoalofthisresearchistohelppeople moreeffectivelyandsafelyremovethemselvesfromsit uations that pose a risk to their lives or property,either now or in the future. This research will alsobenefitthefollowing:

Residents. Outcomeofthestudyprovidedthemwith a plan when a disaster occurs and how peopleshould be evacuated. As a result, barangay becamemore aware and capable of protecting its residentsfromdisasters.Furthermore,theresidentsofC alangainbenefitfromthefacilitiesandcommunity services offered by the building asidefromservingasevacuation center.

Barangay Officials. The study was a great help tothebarangayofficialsespeciallytostructuralapproac h in disaster risk reduction management aswell as implementing programs and project that willpromotesafety,peace,wellnessandorderandsuffic ethe needs of the community.

LocalGovernmentUnits. Thefindingsofthestudy can be helpful to the Local Government Unitsplandifferentworkshopsorseminarsandtakeacti on to increase the awareness and make people intheircommunityknowledgeableduringdisasterprep aredness. Additionally, it can also be used as abasisforotherneighboringmunicipalityorprovincest oassessthecommunityissuesanddemands and design for an efficient and adaptablemulti-functionalbuilding.

FutureResearchers. Thefindingsofthisstudyholdpot entialvalue forfuture researchers inthefieldasadditionalreferencestotheirstudiesandasa sourceofgaps forfutureresearch.

ScopeandLimitations of the Study

This study focused on the proposed multi-functional building design for Barangay CalangainLubao, Pampanga providing the architectural andstructuralplansoftheinfrastructure,thecostanalysi sorestimateofthebuilding,andtheevacuationsystem plan.

Theparkinglot,landscaping,ProjectEvaluatio nandReviewTechnique(PERT),andCritical Path Method (CPM) were not included inthestudy.

ConceptualFramework

Evacuation SystemPlan

First step conducted by the researchers wasthegatheringofthepertinentdatafromthemunicipa lofficialsofLubao,aswellasthebarangay officials of Calangainwhichis usedindesigningthemulti-functionalbuildingbasedontheneedsofthecommunity .Thenforstructuraldesign,theUltimateStrengthDesig n(USD)andLoad Resistant Factor Design (LRFD) were used incalculations.Researchersprovidedcostestimatenee ded in the construction of the proposed building.Lastly,theyalsoprovidedanevacuationsyste mplan for the residents of the barangay essential incaseofemergency.

II. METHODOLOGY

ResearchDesign

This study used descriptive research sincetheresearchersweredescribingtheflexibilityofth e proposed building project, essential in the structuraldesignfortheresidenceofBarangayCalangain.The study also used quantitative research throughinterviewsandquestionnairesastheresearchmethodtocollectand interpretthe gathereddata.

ResearchLocale

ThestudywasconductedinCalangain,Lubao,Pampanga.Thisplacewasselectedtoprovide a multi-functional building that may serveasadisaster-resilientfacility,capableofwithstanding major natural catastrophes while alsoassuring the safety of all residents of the barangayandtheneighboringcommunity.Thischosen barangay and its neighbor, especially barangay Sta.Teresa2nd,wherethelandisnotcapableofsupporting the structure that we planned to designwill benefit since this area is also prone to flooding.Calangainisabarangayinthemunicipalityof Lubao, province of Pampanga. The population inbarangay Calangain is 3,038 representing 1.71% ofthetotal population ofLubao.

ResearchInstrument

Theresearchersemployedinterviewsasameansofgatheringandacquiringdata.Aninterviewischaracterizedasformalconversationbetween the interviewer and interviewee, in whichthe former poses series of questions. As stated byVaughn (2019), a semi-structured interview can bedefined as a method of collecting data that involvesposingasetofquestionstoparticipantsandsubsequently following up with probe questions todelvedeeperintotheirresponsesandthetopicbeinginvestigated.Theresearchersusedsemi-structured face-to-face interviews. Semi-structuredinterviews combine elements of both structured andunstructuredinterviews,ascertainquestionsarepredetermined while others allow for flexibility andexploration.Sincetheyaimedtohaveasiteobservation,theinterviewer/saskedaseriesofquestionstomunicipalandbarangayofficialstogather accurate data on how important it is for theirbarangayto haveamultifunctional building.

During the interview process, the researcheremployedvariousdevicesincludinganaudio recorder,videorecorder,andcameratoensureaccurate documentation of the respondents' answersand to minimize the risk of misinterpretations andbiases.However,it'simportanttonotethattheusage of these devices was done with the consent ofthe municipal and barangay officials. Additionally,theresearchersalsorecordedtheresponsesprovidedbythe respondentsthrough writtennotes.

Observation/ Site investigation was utilizedtodeterminethespaceofthelocationandcharacteristicsofthelotareaofthepossibleconstruction of the proposed design and obtainedrelevantinformationthroughassessingthesurroundingsandenvironmentaswellasidentifying the possible hazards experienced by thecommunity topographically, availability of essentialfacilities,accessibilityandroutetowardsthelocation,etc.

The researcher had a document review aswellforreviewingthedataanddocumentsthatwere used for a study like cases for natural hazardsin the location, hazard mapping, number of familieswhowereaffectedintimesofcalamities,anycasualtiesthatcanaffecttheresidenceofthebarangay,etc.

DataGathering Procedure

Toeffectivelygatherinformation,theresearchers createda requestletter informing theofficials of the municipality to conduct an interview.Theresearchersconductedsemi-structuredinterviewswherequestionswereposedwithinapredetermined thematic framework to gather data,frequently open-ended and flexible. It's simple tocompare responses when questions were asked in aspecificorder, but it canberestricted.

Thequestionswerebasedonthecurrentsituationofthebarangayregardingdisasterreadiness, the availability of sufficient facilities forresidents,alocationthatcanaccommodatepeoplein emergencyandpotentialimprovementstothebarangay.Fordocumentreview,theresearchersortedandanalysedrelevantdata,records,and documents about the barangay's population, numberof households, number of families, and availabilityofbasicfacilitiestogainadeeperunderstandingand the intent to discover or validate informationaboutthe barangay thatwillbe used for designingoftheproposed infrastructure.

The barangay has a low-lying area that issusceptibletosuddenincreasesinfloodwater.These areas are from Purok 4 to Purok 7. The worstscenario that occurred was that the water reached adepth of three feet near the shore of Sapang Dulu.The following are data from previous typhoons thatstruckthe barangay:

Table2.4.1:Typhoon“Falcon”asofJune21,2011toJune25,2011

Purok (Zone)	Height offlooding (infeet)	No. ofaffected individuals	No. ofaffected families	Location ofevacuation
4,5, 6&7	3ft	438	208	Elementary School &BasketballCourt
No.of blownhouses	Damage on powerlines	Infrastructuraldamages		Agricultural Damages
None	None	None		Blownricefieldsand flooded fishponds

Table2.4.2:Typhoon“Salome”asofAugust06, 2012toAugust08,2012

Purok (Zone)	Height offlooding (infeet)	No. ofaffected individuals	No. ofaffected families	Location ofevacuation
4,5, 6 &7	3ft	649	256	Church /Elementary School
No. of blown houses	Damage on powerl	Infrastructuraldamages		Agricultural Damages
				fieldsand floodedf ishponds

Figure 2.4.1 Flood during Typhoon Salome at Barangay Calangain

Table2.4.3:Typhoon“Inday”asofJuly18,2018toJuly21,2018

Purok (Zone)	Height offlooding (infeet)	No. ofaffected individuals	No. ofaffected families	Location ofevacuation
5, 6& 7	2ft	425	205	Elementary School /Church /Barangay Hall
No. of blown houses	Damage on powerlines	Infrastructuraldamages		Agricultural Damages
None	None	None		Blown ricefields andfloode

Figure2.4.2Flood duringTyphoon IndayatBarangayCalangain

Table2.4.4:Typhoon“Karding”asofAugust06,2018toAugust16,2018

Purok (Zone)	Height offlooding(infeet)	No. ofaffected individuals	No. ofaffectedfamilies	Location ofevacuation
4, 6&7	2ft	367	122	Elementary

				School/ Barangay Hall
No. ofblo wn houses	Damage onpower lines	Infrastructuraldamages		Agricultural Damages
None	None	None		Blown ricefields andfloode d fishponds

Figure 2.4.3. Flood during Typhoon Inday at Barangay Calangain

Table2.4.5:Typhoon“Paeng”asofOctober28,2022toNovember3,2022

Purok (Zone)	Heightof flooding (infeet)	No. of affectedindiv iduals	No.of affected families	Location ofevacuati on
5,6& 7	2ft	280	93	Elementary School &BarangayHa ll
No. ofblo wn houses	Damage onpowerlin es	Infrastructuraldamages		Agricultural Damages
None	None	None		Blown ricefields andfloode

Figure2.4.4FlooddduringTyphoonPaengatBarangayCalangain

Asidefromflooding,studentsfromtheCalangainElementarySchoolexperiencesalsoproblemssuchastheovercrowdingtosome sections and lack of classrooms for other classes,due to the number of students at the educationalinstitution.Othereducationalfacilitiesarealsobeing used as temporary shelters for those affectedby the calamity in the area during heavy rains andtyphoons.Therearetwosectionsforeachgradefrom Grade 1 to Grade 6 which are reserved for theschoolwithapproximately600studentswithaseparate of 42 daycare pupils in the daycare centerhavingthreeshiftingofclasses,resultinginovercrowdingpersectionaswell.Thebarangayalso lacks of other facilities such as Senior CitizenOffice which will be beneficial to the population ofSeniorCitizensespeciallyduringsomeoftheiressentialevents;promotionandprotectionofvariousprograms relatedtoSeniorCitizen.Barangay Calangain also lacks of storage room fortheir emergency equipment where they only storethem on an outpost in their barangay. Tables belowshowthetotalnumberofelementarystudents(Table2.4.6–Table2.4.11)inCalangainElementarySchoolfrom2017–2023whileTable 2.4.12showstheinfrastructureexistinginthebarangay.

Calangain Elementary School Total Number ofStudents

Table2.4.6:TotalNumberofStudentsforSchoolYear2017-2018

GradeLevel	Male	Female	Total
Kindergarten	31	27	58
Grade1	18	16	34
Grade2	22	30	52
Grade3	38	28	66
Grade4	22	23	45
Grade5	25	20	45
Grade6	30	32	62

Table2.4.7:TotalNumberofStudentsforSchoolYear2018–2019

GradeLevel	Male	Female	Total
Kindergarten	29	44	73

Grade1	31	27	56
Grade2	13	20	33
Grade3	22	31	53

Grade4	39	27	66
Grade5	23	24	47
Grade6	25	19	44

Table2.4.8:TotalNumberofStudentsforSchoolYear2019-2020

GradeLevel	Male	Female	Total
Kindergarten	15	10	25
Grade1	27	42	69
Grade2	29	27	56
Grade3	18	17	35
Grade4	21	27	48
Grade5	39	27	66
Grade6	24	22	46

Table2.4.9:TotalNumberofStudentsforSchoolYear2020 -2021

GradeLevel	Male	Female	Total
Kindergarten	22	29	51
Grade1	11	18	29
Grade2	28	42	70
Grade3	29	28	57
Grade4	20	17	37
Grade5	21	28	49
Grade6	39	26	65

Table2.4.10:TotalNumberofStudents forSchoolYear2021-2022

GradeLevel	Male	Female	Total
Kindergarten	34	25	59
Grade1	24	29	53
Grade2	16	11	27
Grade3	25	40	65
Grade4	27	29	56
Grade5	19	18	37
Grade6	21	29	50

Table2.4.11:TotalNumberofStudentsforSchoolYear2022 -2023

GradeLevel	Male	Female	Total
Kindergarten	25	24	49
Grade1	28	28	56
Grade2	23	30	53
Grade3	19	8	27
Grade4	26	34	60
Grade5	29	29	58
Grade6	17	12	39

Table 2.4.12: Buildings and other infrastructure existing in BarangayCalangain,Lubao,Pampanga

INSFRASTRUCTURE	NUMBER
BarangayHall	1
Health:Hospital	0
Health:HealthCenter	1
Health:BirthingClinic	0
NutritionPost	0
School:DayCareBuilding	1
School:Elementary	1
School:HighSchool	0
School:College	0
DayCareCenter	1
PlaygroundforChildren	1
OfficeofSenior CitizenAssociation (OSCA)	0
Centerfor PWDs	0
Evacuation Center	0
YouthCenter /SK Center	1
CoveredCourt/Gymnasium	1

2.5DataAnalysis

Researchers used quantitative data analysisin order to come up with a general concept for thedesignoftheproposemulti-functionalbuildingalignedwiththeneedsofthecommunityandservices that the infrastructure may offer not onlywhennaturalcalamitiesoccurbutalsoforotherfunctions relevant to the development and progressof thebarangayand its people.

Figure 2.5.1: Total Number of Students of Grade 1 of Calangain from 2017-2023

Thereare44Grade1studentsfromyear2017-2018 from Calangain Elementary School, 58Grade1studentsfrom2018-2019havinganincrease of 31.81%. There are total of 69 Grade 1studentsfrom2019-2020havinganincreaseof18.97%comparedtothepreviousyear.Thereatotal of 29 Grade 1 students during 2020-2021 orbeginning ofpandemicperioddecreasing 57.97%oftotalpopulationofthatyear.Thereare53Grade1 students from year 2021-2022 having an increaseof 82.75% from the previous year. Lastly, there are56 Grade 1 students from year 2022-2023 or postpandemic having an increase of 6% of populationfromthepreviousyear.

Figure 2.5.2: Total Number of Grade 2 Students of Calangain from 2017-2023

Thereare52Grade2studentsfromyear2017-2018 from Calangain Elementary School, 33Grade 2 students from 2018-2019 having a decreaseof36.54%.Therearetotalof56Grade2students from2019-2020havinganincreaseof69.69%compared to the previous year. There a total of 70Grade 2 students during 2020-2021 or beginning ofpandemic period increasing 25% of total populationof that year. There are 27 Grade 2 students fromyear 2021-2022 having a decrease of 61.43% fromthepreviousyear.Lastly,thereare53Grade2studentsfromyear2022-2023orpostpandemicperiod having an increase of 96.27% of populationfromthepreviousyear.

Figure 2.5.3: Total Number of Grade 3 Students of Calangain from 2017-2023

Thereare66Grade3studentsfromyear2017-2018 from Calangain Elementary School, 53Grade 3 students from 2018-2019 having a decreaseof 19.70%. There are total of 35 Grade 3 studentsfrom2019-2020havingadecreaseof33.96%compared to the previous year. There a total of 57Grade 3 students during 2020-2021 or beginning ofpandemicperiodincreasing62.86%oftotal populationofthatyear.Thereare65Grade3students from year 2021-2022 having an increase of14.04% from the previous year. Lastly, there are 27Grade3studentsfromyear2022-2023orpostpandemic period having a decrease of 58.46% ofpopulationfrom thepreviousyear.

Figure 2.5.4: Total Number of Grade 4 Students of Calangain from 2017-2023

Thereare45Grade4studentsfromyear2017-2018 from Calangain Elementary School, 66Grade4studentsfrom2018-2019havinganincrease of 46.67%. There are total of 48 Grade 4studentsfrom2019-2020havingadecreaseof27.27%comparedtothepreviousyear.Thereatotal of 37 Grade 4 students during 2020-2021 orbeginning ofpandemicperioddecreasing 22.92%oftotalpopulationofthatyear.Thereare56Grade4 students from year 2021-2022 having an increaseof 51.35% from the previous year. Lastly, there are60 Grade 4 students from year 2022-2023 or postpandemic period having an increase of 7.14% ofpopulationfrom thepreviousyear.

Figure 2.5.5: Total Number of Grade 5 Students of Calangain from 2017-2023

Thereare45Grade5studentsfromyear2017-2018 from Calangain Elementary School, 44Grade 5 students from 2018-2019 having a decreaseof2.22%.Therearetotalof66Grade5students from2019-2020havinganincreaseof50%compared to the previous year. There a total of 49Grade 5 students during 2020-2021 or beginning ofpandemicperioddecreasing25.76%oftotalpopulationofthatyear.Thereare37Grade5students from year 2021-2022 having a decrease of24.49% from the previous year. Lastly, there are 58Grade 5 students from year 2022-2023 having anincrease of 56.76% of population from the previousyear.

Figure 2.5.6: Total Number of Grade 6 Students of Calangain from 2017-2023

Thereare62Grade6studentsfromyear2017-2018 from Calangain Elementary School, 44Grade 6 students from 2018-2019 having a decreaseof 29.03%. There are total of 46 Grade 6 studentsfrom2019-2020havinganincreaseof4.54%compared to the previous year. There a total of 65Grade 6 students during 2020-2021 or beginning ofpandemicperiodincreasing41.30%oftotalpopulationofthatyear.Thereare50Grade6students from year 2021-2022 having a decrease of23.08% from the previous year. Lastly, there are 39Grade6studentsfromyear2022-2023havingadecrease of 22% of population from the previousyear.

Figure2.5.7:TotalNumberofKindergartenStudentsofCalangainfrom2017 -2023

There are 58 Grade Kindergarten studentsfrom year 2017-2018 from Calangain ElementarySchool, 73 Grade Kindergarten students from 2018-2019 having an increase of 25.86%. There are totalof 25 Grade Kindergarten students from 2019-2020havingdecreaseof65.75%comparedtotheprevio usyear.Thereatotalof51GradeKindergartenstudentsd uring2020-2021orbeginning of pandemic period increasing 104% oftotal population of that year. There are 59 GradeKindergarten students from year 2021-2022 havinganincreaseof15.69%fromthepreviousyear.Las tly,thereare51GradeKindergartenstudentsfrom year 2022-2023 having decrease of 13.56% ofpopulationfrom thepreviousyear.

DesignParameters

The propose multi-functional building design ofBarangayCalangainLubao,Pampangawasanalyzed basedonthe resultsofinterviewswithmunicipal officials and barangay officials as well asdocumentreviewsprovidingarchitecturalplansfrom floorplans,locationandsiteplansandperspectivesorele vations oftheinfrastructure.

Figure 2.6.1 Front View of the Proposed Multi-functional Building forCalangain

Figure 2.6.2 Side View of the Proposed Multi-functional Building forCalangain

Figure 2.6.3 Exterior Perspective of the Proposed Multi-functional BuildingforCalangain

Figure 2.6.4 Exterior Perspective of the Proposed Multi-functional BuildingforCalangain

Figure 2.6.5: Exterior Perspective of the Proposed Multi-functional BuildingforCalangain

Figure 2.6.6: Exterior Perspective of the Proposed Multi-functional BuildingforCalangain

Thefiguresabove(Figure2.6.1–Figure2.6.6) show the exterior perspective of the proposedtwo-storeymulti-functionalbuilding–naturalventilationthroughslidingandawningglasswindows,outdoorlightingswereprovidedwhichare essential during nighttime, long span rib typeroofing were used for the roof, walls were coveredby smooth plain cement plaster in semi-gloss paintfinishfibercement,wallcladdinganddecorativemasonry wall were utilized for aesthetic coveringwhileoutsidedoorsweredouble leafpanel doors.

DesignStructural

Theproposedmulti-functionalbuildingdesignofBarangayCalangainLubao,Pampangawasanalysedbasedontheresultsofinterviewswith municipal officials and barangay officials aswellasdocumentreviewsprovidingdesignofstructural members of the proposed multi-functionalbuildingdesignaccordingtoUltimateStrengthDesign (USD) and Load Resistant Factor Design(LRFD)specifications,andbasedfromthesections andprovisionsoftheNationalStructuralCodeofthePhilippines (NSCP) 2015.

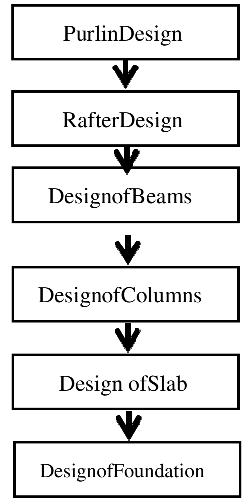


Figure2.7.1FlowcharttoshowtheflowanalysisofStructuralDesign

Processof Designing:
PurlinDesign

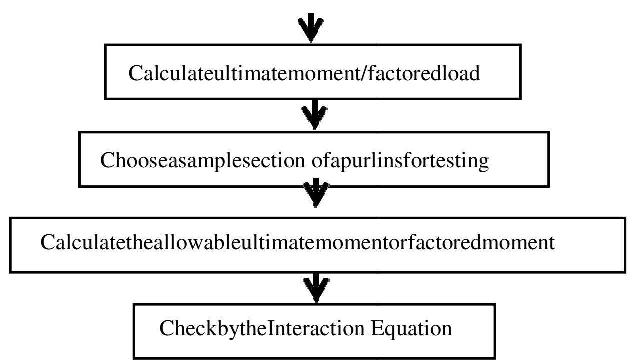


Figure2.7.2PurlinDesignFlowChart

RafterDesign

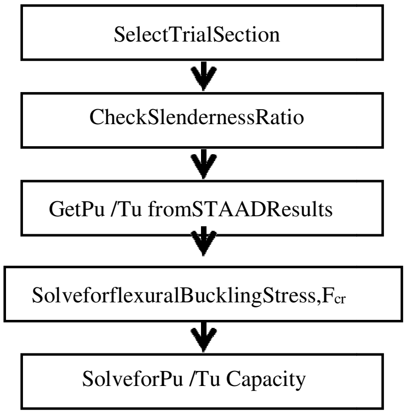


Figure2.7.3RafterDesignFlowChart

DesignofColumns

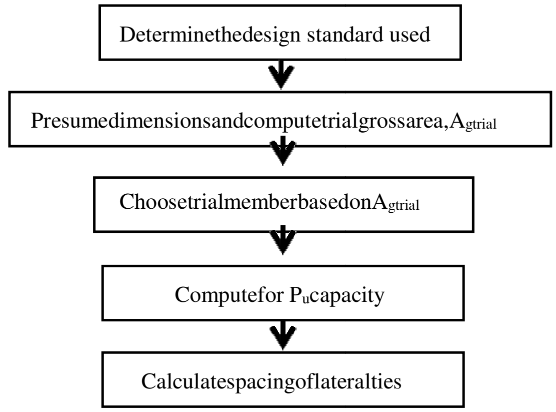


Figure2.7.5ColumnDesignFlowChart

DesignofBeams

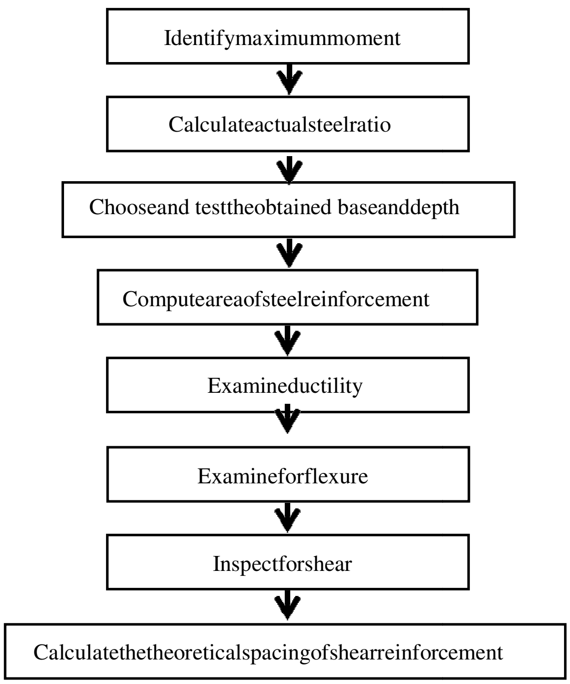


Figure2.7.4BeamDesignFlowChart

Designof Slab

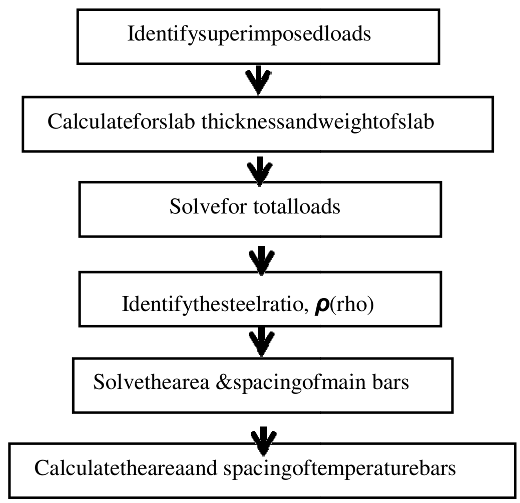


Figure2.7.6SlabDesignFlowChart

DesignofFooting

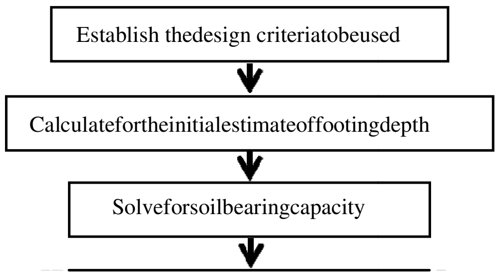


Figure2.7.7FoundationDesignFlowChart

Design Cost

Theresearchersprovidedabreakdownofcostintomajorcategorieslikelabor,materials,supplies; summary to provide good basis for costplanning; and helped price the individual item ofworksaccordingtothepresentvalueavailableinthemarket.

EvacuationSystemPlan

Researchers provided a safe or secure and efficientcommunity-basedevacuationsystemplanfortheresidenceonhowtoaccesstheevacuationareahaving a risk-free route, emergency plans during acatastrophe,effectiveinformationdisseminationand post-rehabilitationprocesswithinthecommunity.Thissectionincludesthefollowing:

- IdentificationofEvacuationCenters
- CommunicationandWarning
- EarlyWarningSystem
- EmergencyKitPreparation
- TrainingandEducation
- EvacuationProcedure

III. RESULTSANDDISCUSSION

Thischapterpresentsresearchers'resultsandanalysisofthedatacollectedfrominterviewand document review presented through tables aswellastheanalysisoftheproposedMulti-functional Building in Barangay Calangain, Lubao,Pampangathroughdesignparameter,structural designwhichincludesthedesignedstructuralmembers necessaryfortheproposaloftheinfrastructure, cost estimate and/or analysis as wellasthe proposedevacuation system plan.

Figure 3.1.1 Total Number of Calangain Elementary School Students from2017-2023

There are a total of 362 enrolled elementarystudentsofCalangainfromschoolyear2017–2018whichincreasedbyapproximately3.31%having a total of 374 elementary students by schoolyear 2018 – 2019. From 2019 – 2020 school year, itdecreased by 7.75% having a sum of 345 studentscompared to 374 students during pre-pandemic year.By the school year of 2020 – 2021, the total numberofstudentsincreasedbyanestimateof3.77%making it 358 elementary students from that year.There are a total of 347 elementary students fromschool year 2021 – 2022 which decreased by 3.07%.Lastly,fromthecurrentyear2022–2023,thenumberdecreasedaswellby0.86%havingatotalof 344 elementarystudents.

Figure 3.1.2 Total Affected Individual in Calangain recorded duringTyphoons(2012-2022)

Figure3.1.3TotalAffectedFamiliesinCalangainrecordedduringTyphoons(2012-2022)

Figure 3.1.2 and Figure 3.1.3 illustrate thetotal number of individuals and/or families affectedduringdifferenttyphoonsthatstruckthemunicipalityofLubaoandaffectedbarangayCalangain'speoplefrom2012to2022.Thenumbersorpopulationaffecteddependsontheintensityoftyphoons,typhoonSalome broughtfloods and heavy windsaffecting thecommunityhaving a total of 256 families or 649 individualsaffected during the storm. During typhoon Falcon,93 families or 280 individuals were affected whichhas the least among the other typhoons from 2012 –2022.

DesignParameter

This chapter shows the design parameter ofthe proposed two-storey multi-functional buildingdesignforBarangayCalangain,Lubao,Pampanga.

Architecturalplans,andplumbingandelectricalplanswereprovided in this section.

Architectural plans were shown above which include the following: site development plan,ground floor elevation, second floor elevation, frontelevation, rear elevation, right-side elevation, left-sideelevation,crossandlongitudinalsection.Electrical plans include the ground floor and secondfloorlightinglay-out,boxconnectiondetail,conduit on box installation detail, riser diagram, oneline diagram and schedule of loads. Plumbing planswerecomposedofwaterlinelayout,sewerlinelayoutand storm drainagelay-out.

Themulti-functionalbuildingdesigninBarangay Calangain had various facilities such as asenior citizens' office, event hall, a storage room,educational facilities, and evacuation facilities. Inorder to provide the elderly of the barangay withtheirownoffice,theresearchersdecidedtoincludea senior citizen office so that they would have aspace to use when they needed to discuss matters. Astorage room was also added to accommodate otherbarangay equipment. The lack of facilities in theelementary school was the reason why the multi-functionalbuildinginBarangayCalangainalsohad educational facilities, which served as extra roomsfor students or could be used during emergencies.The event hall servedas a venuefor seminarsoranyprogramsthatthebarangay.Theevacuationroom was one of the most essential facilities for thebarangaysincetherewasnoexistingevacuationcenter. Aside from the mentioned above, bathroomsand restrooms were also included for the purpose ofevacuationareahygieneandsanitation.Thebuilding design also provided hand-washing areasoutside.

DesignStructural

ThischapterpresentsthedesignbasisfortheCivil/StructuralEngineeringWorksoftheProposed Two-StoreyMulti-functional Building forBarangayCalangain,Lubao,Pampanga.

General

Structural,AnalysisandDesign(STAAD)ProConnectv.2022,offersstructuralanalysisanddesignfornearly anysortofconstructionliketowers,buildings,culverts, plants,bridges,
stadiums, and constructions for the sea and the land.Itisutilizedindoing3D structuralanalysisanddesignfor bothsteel andconcretestructures Itprovidesversatilesolutiontohandleallofstructural engineering requirements starting at thefoundation.STAADisacompletetoolforstructuralfiniteelementanalysisanddesignthatenables users to analyze any structure that is subjectto thermal, movement, wind, earthquake, and staticstresses.

APPLIED CODES, STANDARDS &REFERENCES

Specifications,codes,provisionsandstandards from the latest versions or editions as abasisfortheengineeringdesignworkswereasfollows:

- NationalStructuralCodeofthePhilippines,Vol.1,7thedition(ReinforcedConcreteDesign)
- NSCP2015,1997UniformBuildingCode(SeismicAnalysis)

DESIGN CRITERIALOADS:

DEADLOADS

A. ROOF

G.I.Roofing=0.06kPaIn sulation=0.05kPa
Purlins = 0.04 kPa C-50x100x1.5mm@60cm.o.c.

B. WALLS

ExteriorWalls
6"CHB=3.13kPa
(Bothfacesplastered)InteriorWalls
4"CHB=2.98kPa
(Both faces plastered)GlassWalls/Doorsw/AluminumFrame =0.5 kPa

C. FLOORFINISHES

Ceramictiles=1.1kPa(Solidflattileon25mmmortarbase)

D. CEILING

CeilingFraming=0.1kPa(SuspendedSteelChannelsystem)
GypsumBoard=0.07kPa(9mmGypsumBoard)
MEP (Mechanical, Electrical,Plumbing)Allowance=0.2kPa

E. MATERIALS

Concrete=24kN/cu.m.Steel= 77 kN/cu.m.
Soil=18 kN/cu.m.
DoorsandWindows=0.4kPa

LIVELOADS

Evacuation Area = 4.8 kPaCorridors = 4.8 kPaStaircases (Residential) = 4.8kPa
RoofLive Load=1kPa

MaterialStrength

Concrete: f'c = 21 MPa or 3000 psiReinforcingSteel:
for 16mmΦ and above fy = 414 MPa or GRADE 60for 16mmΦ below fy =276 MPa or GRADE 40StructuralSteel:
Fy = 248 MPaFu=414 MPa

SoilProperties

Soil Allowable Bearing Stress = 150kPa (assumedsinceno soil test is available)
UnitWeight of Soil=18 kN/m3

NOTE:

1. ConsultStructuralEngineerifthereisaliquefiable layer during footing excavation.Itisrecommendedthattheselayers beplacedalongwithgroundimprovementprocedures for the structure's overall long-termstability.
2. Foundation shall rest on natural soil. No partofthefoundation shall rest on fill.
3. Before pouring concreteandonce footingexcavationiscomplete,Contractormustinform the Engineer to validate the designsoilbearingcapacity.

SEISMICANALYSIS

SeismicLoadistheforceapplicationofseismic oscillation toa structure or alsodescribedas horizontal and vertical forces equivalent in theirdesign effect to the loads cause by the movement ofthe ground during an earthquake. Seismic load isbasedonNationalStructuralCodeofthePhilippines(NSCP)2015whichispatternedonUniformBuildingCode1997 (UBC97).

AccordingtoNSCP2015Figure208-1"Seismic Zone Map of the Philippines" Calangain,Lubao,PampangaisunderZone4located60.6kmfromWest ValleyFault

Figure3.2.1:ReferencedSeismicMapofthePhilippines

Figure3.2.2:Distancefromsitelocationtothenearestactivefault

Figure3.2.3:Distancefromsitelocationtothenearestactivefault

SeismicParameters:
SeismicSourceType:A(Table208-4SeismicSourceType)
SoilProfileType:SD(208.4.3SiteGeologyandSoilStructure, Exception)
Seismic Zone: 0.40 (Table 208-3 Seismic ZoneFactor)
OccupancyCategory:IEssentialFacility(Table103-1OccupancyCategory)

NumericalCoefficient:
Baseshear coefficient shall be derived using thefollowing formula stipulated in NSCP EarthquakeLoadProvisionsfor BuildingStructures
Totalseismicdeadload(W),(SoilParametersnotavailable)
Nv = 1.0 (Table 208-5 Near-Source Factor)Na=1.0(Table208-4Near-SourceFactor)
Ca:acceleration-controlledcoefficient(Table208-8Seismic Coefficient)
Ca=0.44(Na) =0.44(1)=0.44
Cv:velocity-controlledcoefficient(Table208-7SeismicCoefficient)
Cv=0.96 (Na)=0.96(1.00) =0.96
I(ImportanceFactor)=1.5(Table208-1SeismicImportance Factor)
Moment Resisting Frame Systems (R) = 8.5Ct=0.0731(ReinforcedConcreteStructure)

EarthquakeBaseShearResult,StoreyDriftResult,Soft Storey CheckAsce7
Allowable Story Drift: Table 12.12-1
NSCPStructuresotherthanmasonry,shearwall,4storiesorlesswithinteriorwall,partitions,ceilingexteriorwalls.OccupancycategoryI=0.025H:ORL/238=0.0042FACTOR = 0.0042

BaseShearResult
BaseShearatX-Direction=1227.36kN

```
***********************************************************
*                                                         *
*  X  DIRECTION : Ta =  0.294 Tb =  0.409 Tuser =  0.000  *
*  T =  0.294, LOAD FACTOR = -1.000                       *
* UBC TYPE = 97                                           *
* UBC FACTOR V = 0.1941 x       6322.79 =    1227.36 KN   *
*                                                         *
***********************************************************
```

BaseShearatZ–Direction=1227.36kN

```
***********************************************************
*                                                         *
*  Z  DIRECTION : Ta =  0.294 Tb =  0.380 Tuser =  0.000  *
*  T =  0.380, LOAD FACTOR =  1.000                       *
* UBC TYPE = 97                                           *
* UBC FACTOR V = 0.1941 x       6322.79 =    1227.36 KN   *
*                                                         *
***********************************************************
```

StoreyDriftCheck

STORY HEIGHT LOAD AVG.DISP(CM) DRIFT(CM) RATIO STATUS

\- -

(METER) X Z X

ZBASE=0.00

ALLOW.DRIFT=L/238

10.00	9	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	10	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	11	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	12	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	13	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	14	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	15	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	16	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	17	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	20	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	24	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	32	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	36	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	44	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	45	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	49	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	57	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	61	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	69	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	73	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	81	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	82	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	83	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	84	0.0000	0.0000	0.0000	0.0000 L/999999	PASS
	88	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	92	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	96	0.0000	0.0000	0.0000	0.0000 L/999999	PASS
	104	0.0000	0.0000	0.0000	0.0000L/999999	PASS
	112	0.0000	0.0000	0.0000	0.0000L/999999	PASS
23.40	9	0.0064	0.0012	0.0064	0.0012L/ 52832	PASS
	10	0.0056	0.0026	0.0056	0.0026L/ 60481	PASS
	11	0.0004	-0.0003	0.0004	0.0003L/999999	PASS
	12	0.2582	-0.0004	0.2582	0.0004 L/ 1317	PASS
	13	-0.2582	0.0004	0.2582	0.0004 L/ 1317	PASS
	14	-0.0000	0.4088	0.0000	0.4088 L/ 832	PASS
	15	0.0000	-0.4087	0.0000	0.4087 L/ 832	PASS
	16	0.1374	0.0008	0.1374	0.0008 L/ 2474	PASS
	17	-0.1208	0.0011	0.1208	0.0011 L/ 2815	PASS
	20	0.2717	0.0035	0.2717	0.0035 L/ 1251	PASS
	24	0.7240	0.0033	0.7240	0.0033 L/ 469	PASS
	32	0.2640	0.0007	0.2640	0.0007 L/ 1288	PASS
	36	0.7165	0.0004	0.7165	0.0004 L/ 474	PASS
	44	0.0124	0.0035	0.0124	0.0035L/27370PASS	
	45	0.1271	0.0027	0.1271	0.0027L/ 2675	PASS
	49	0.3919	0.0025	0.3919	0.0025 L/ 867	PASS

SoftStoreyCheck

VERTICAL STRUCTURAL IRREGULARITIES : SOFT STORY CHECK - ASCE/SEI 7-05

STORY	FL. LEVEL IN METE	STATUS X	STATUS Z
1	3.40	OK	OK

Note:NOSOFTSTOREYISDETECTED

WINDLOAD ANALYSIS

WindLoadsParameters

OccupancyCategory:IEssentialFacility(Table103-1OccupancyCategory)

I(ImportanceFactor)=1.5(Table208-1SeismicImportance Factor)

SurfaceRoughnessCategory:B(207A.7.2SurfaceRoughnessCategory)

ExposureCategory: C(207A.7.3 Exposure Category)

WindPressureCalculations

OccupancyCategory:**I**EssentialFacility(Table103-1OccupancyCategory)

I(ImportanceFactor)=**1.5**(Table208-1SeismicImportance Factor)

Surface Roughness Category:**B**(207A.7.2 SurfaceRoughnessCategory)

ExposureCategory:**C**(207A.7.3 Exposure Category)

Determinetypeofstructure

Period, T = Ct(hn)3/4 = 0.0731(9.20)3/4= 0.386 secFrequency,1/T 2.591 Hz > 1.0 HzTherefore,structureis**RIGID**

ForrigidbuildingsofallheightsP=q GCp -qi(Gcpi)

Where:

G=Gust effectfactor (Sect 207.5.8)=0.85

Cp=ExternalPressureCoefficient(Fig207-6orFig207-8)

GCPi = Internal Pressure Coefficient (Fig 207-5)qz =0.613 KzKztKdV2(N/m²)

Kzt=(1+K1K2K3)2 Assume Kzt = 1.0Kd(WinddirectionalityFactor)/Table207-2Kd =0.85

Kz=2.01(Z/Zg)^(2/alpha)

Zg = 274.32m (Exposure Category C)Alpha=9.5

Calculation

LEVEL	Ht	Kz	qz
Roof	11.58	0.984	2.88kPa

LOADCOMBINATIONS

1. (DRIFT)COMB-1.2DEAD+1.6ROOF LIVE +0.5WIND
2. 1.2DEAD+1 LIVE+0.5ROOFLIVE+1WIND
3. 1.2DEAD+1LIVE+1SEISMIC-H
4. 0.9DEAD+1WIND
5. 0.9DEAD+1SEISMIC-H
6. (SERVICE)COMB- 1DEAD+1LIVE+1ROOFLIVE
7. 1DEAD+0.75LIVE +0.75ROOFLIVE+ 0.45WIND
8. 1DEAD+0.75LIVE +0.75ROOFLIVE+ 0.536SEISMIC-H
9. 0.6DEAD+0.6 WIND
10. 0.6DEAD+0.714SEISMIC-H
11. 1DEAD+1LIVE+0.6WIND
12. 1DEAD+1LIVE+0.714SEISMIC-H
13. (ULTIMATE)COMB-1.4DEAD
14. 1.2DEAD+1.6LIVE +0.5 ROOFLIVE
15. 1.2DEAD+1LIVE +1.6ROOFLIVE
16. 1.2DEAD+1.6 ROOFLIVE +0.5 WIND
17. 1.2DEAD+1 LIVE+0.5ROOFLIVE+1WIND
18. 0.9DEAD+1 WIND
19. 1.68DEAD+1LIVE +1 SEISMIC-H
20. 1.38DEAD+1SEISMIC-H
21. 0.42DEAD+1SEISMIC-H

Figure3.2.4:3D-MODELoftheStructure

Figure3.2.5:StructuralFrameoftheStructure

The figures above (Figure 3.3.2 and Figure3.3.2) show the 3-dimensional isometric view of thestructure as well as structural frame of the proposedmultifunctionalbuildingthroughtheaidofStructuralAnalysisandDesignsoftware orSTAAD.

STAADPROANDANALYSISRESULTS

Figure3.2.6:BendingMomentDiagram(Substructure)

Figure3.2.7:BendingMomentDiagram(Superstructure)

Figures above portray the bending momentdiagramofthesuperstructureandthesubstructureoftheproposedmulti-functionalbuildingwhichidentify the critical section that might cause failureor deformation due to bending stress. The diagramsalso show the key areas where the highest or lowestbending moment values occur and where suitablereinforcingor cross-section is required.

Figure3.2.8:ShearDiagram(Substructure)

Figure3.2.9:ShearDiagram(Superstructure)

Figures above portray the shear diagram ofthesuperstructureandthesubstructureoftheproposed multi-functional building which identifythecriticalsectionthatmightcausefailureordeformation due to shear stress. The diagrams alsoshowthekeyareaswherethehighestorlowestshear values occur and where suitable reinforcing orcross-sectionis required.

PURLINSANALYSISANDDESIGNCALCULATIONS

GradeofSteel:A

Fig.3.2.10:PurlinSection

<u>Purlin Dimensions:</u>Depth (d) = 100 mmFlange (b) = 50 mmLip (l) = 12 mmThickness(t)=1.5mm

<u>Building Parameters:</u>Purlin Spacing = 0.6 mSpan=1.2 m RoofAngle =1deg

S_x	10743.209mm^3	0.656in.^{3}
S_y	3347.832mm.^{3}	0.204in.^{3}

Loads	SI	English
WindPressure:	2.515kPa	52.527psf
WindLoad:	1.509kN/m	103.373lb/ft
Roofing:	0.0575kPa	1.2psf
Insulation:	0.0479kPa	1psf
PurlinWeight:	0.0255kN/m	1.747lb/ft
LiveLoad:	1kPa	20.885psf

Fig.3.2.1:ActingForcesonPurlins

GoverningLoadCombination:

D +W=	2.662 kPa	57.631 psf
D+ Lr=	1.131 kPa	24.833 psf

D+W (governs)

$f_b \leq F_b$

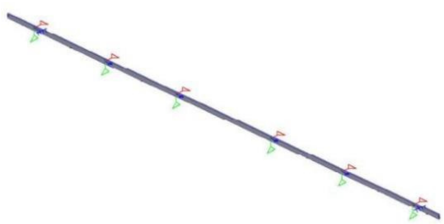
$$fb=\frac{Mn}{Sx}+\frac{Mtwt}{Sy}+\frac{MtLoad}{1/2Sy}\leq Fb=0.6Fy$$

f_b =26.912MPa(3.900ksi)≤F_b= 148.966MPa (21.6ksi)

Purlin Section is

AdequateRAFTERDESIGNCALCUL

ATIONS



```
   26 ST   TUBE                    (BRITISH SECTIONS)
                   PASS   Eq. H1-1b              0.673       11
                0.07 C         0.00              5.31      0.00
|-----------------------------------------------------------------|
| SLENDERNESS                                                     |
| Actual Slenderness Ratio    :    182.157  L/C  :    11          |
| Allowable Slenderness Ratio :    200.000  LOC  :     0.00       |
|-----------------------------------------------------------------|
| STRENGTH CHECKS                                                 |
| Critical L/C  :      11    Ratio      :     0.673(PASS)         |
|          Loc  :    0.00    Condition :   Eq. H1-1b             |
|-----------------------------------------------------------------|
| DESIGN FORCES                                                   |
| Fx:   7.384E-02(C ) Fy:   9.237E+00     Fz:   0.000E+00        |
| Mx:   0.000E+00     My:   0.000E+00     Mz:   5.308E+00        |
|-----------------------------------------------------------------|
| SECTION PROPERTIES  (UNIT: CM  )                                |
| Azz:   1.760E+00     Ayy:   5.760E+00     Cw:  0.000E+00        |
| Szz:   2.844E+01     Syy:   1.513E+01                           |
| Izz:   2.133E+02     Iyy:   3.782E+01     Ix:  1.030E+02        |
|-----------------------------------------------------------------|
| MATERIAL PROPERTIES                                             |
| Fyld:       248000.002   Fu:       399895.953                   |
|-----------------------------------------------------------------|
| Actual Member Length:         4.001                             |
| Design Parameters                                               |
| Kz:    1.00 Ky:    1.00 NSF:    1.00 SLF:    1.00 CSP:   12.00  |
|-----------------------------------------------------------------|
| SECTION CLASS  UNSTIFFENED /    λ        λp       λr       CASE |
|                STIFFENED                                        |
| Compression :  Non-Slender     0.00     N/A      0.00      N/A  |
|                Slender        77.65     N/A     39.76  T.B4.1(a)-6 |
| Flexure     :  Compact        23.88    31.81    39.76  T.B4.1(b)-17 |
|                Non-Compact    77.65    68.72   161.87  T.B4.1(b)-19 |
```

```
|-----------------------------------------------------------------|
| CHECK FOR AXIAL TENSION                                         |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
| Yield       1.35E-01  1.75E+02   0.001     Eq. D2-1     9    4.00 |
| Rupture     1.35E-01  2.35E+02   0.001     Eq. D2-2     9    4.00 |
|-----------------------------------------------------------------|
| CHECK FOR AXIAL COMPRESSION                                     |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
| Maj Buck    1.35E-01  1.02E+02   0.001     Eq. E7-1    10    0.00 |
| Min Buck    1.35E-01  3.68E+01   0.004     Eq. E7-1    10    0.00 |
| Intermediate                                                    |
| Results     Eff Area    KL/r      Fcr        Fe        Pn       |
| Maj Buck    5.72E-04   76.71   1.44E+05  3.35E+05  1.13E+02     |
| Min Buck    5.72E-04  182.16   5.22E+04  5.95E+04  4.09E+01     |
|-----------------------------------------------------------------|
| CHECK FOR SHEAR                                                 |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
| Local-Z     0.00E+00  2.36E+01   0.000     Eq. G2-1     6    0.00 |
| Local-Y     9.24E+00  6.94E+01   0.133     Eq. G2-1    11    0.00 |
| Intermediate                                                    |
| Results        Aw        Cv       Kv      h/tw      Vn          |
| Local-Z     1.76E-04    1.00     5.00    23.88   2.62E+01       |
| Local-Y     5.76E-04    0.90     5.00    77.65   7.71E+01       |
|-----------------------------------------------------------------|
| CHECK FOR TORSION                                               |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
|             0.00E+00  3.32E+00   0.000     Eq. H3-1     6    0.00 |
| Intermediate Fcr         Tn                                     |
|             1.30E+05  3.69E+00                                  |
|-----------------------------------------------------------------|
| CHECK FOR BENDING-YIELDING                                      |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
| Major      -5.31E+00  8.06E+00   0.658     Eq. F7-1    11    4.00 |
| Minor       0.00E+00  3.69E+00   0.000     Eq. F7-1     6    0.00 |
| Intermediate   Mn         My                                    |
| Major       8.96E+00  0.00E+00                                  |
| Minor       4.10E+00  0.00E+00                                  |
```

```
|-----------------------------------------------------------------|
| CHECK FOR BENDING-FLANGE LOCAL BUCKLING                         |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
| Minor       0.00E+00  2.28E+00   0.000     Eq. F7-3     6    0.00 |
| Intermediate   Mn        Fcr                                    |
| Minor       2.53E+00  0.00E+00                                  |
|-----------------------------------------------------------------|
| CHECK FOR BENDING-WEB LOCAL BUCKLING                            |
|                                                                 |
|              FORCE     CAPACITY   RATIO     CRITERIA    L/C   LOC |
| Major      -5.31E+00  7.90E+00   0.672     Eq. F7-5    11    4.00 |
| Intermediate   Mn                                               |
| Major       8.77E+00                                            |
|-----------------------------------------------------------------|
| CHECK FOR FLEXURE TENS/COMP INTERACTION                         |
|                        RATIO     CRITERIA    L/C     LOC        |
| Flexure Comp           0.673     Eq. H1-1b    11     0.00       |
| Flexure Tens           0.672     Eq. H1-1b    11     4.00       |
| Intermediate          Mcx /      Mrx /       Pc /               |
|                       Mcy        Mry         Pr                 |
| Flexure Comp          7.90E+00  -5.31E+00   3.68E+01            |
|                       2.28E+00   0.00E+00   7.38E-02            |
| Flexure Tens          7.90E+00  -5.31E+00   1.75E+02            |
|                       2.28E+00   0.00E+00   7.38E-02            |
|-----------------------------------------------------------------|
```

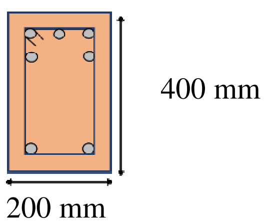
DESIGNOFBEAMS

Beam2FB-1Material Properties: Concretef' c=21MPa

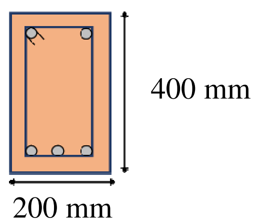
Reinforcing fy = 414 MPaStirrupfy=228 MPa

BeamData:
Span type = both ends
continuousSpanLength=2.68 m
Width (b) = 0.2
mHeight (h) = 0.4
mFlexure bar Ø = 16
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use **200 mm. x 400mm.** section with **5 - 16mmΦ**top bars at support and **3 - 16mmΦ** bottom bars @midspan.Stirrupsarespaced10mm:1@50mm10@100mm 5@150mm REST @250mm O.C. TOC.L.



AtSupport



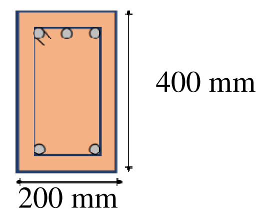
AtMidspan

BEAM2FB-2

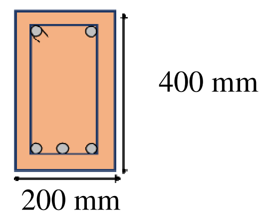
MaterialProperties:
Concrete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = both ends
continuousSpanLength=1.55 m
Width (b) = 0.2
mHeight (h) = 0.4
mFlexure bar Ø = 16
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use**200mm.x400mm.**sectionwith **3-16mmΦ** topbarsatsupportand**3-16mmΦ** bottom bars@ midspan. Stirrups 10mm: 1@50mm 10@100mm5@**150mmREST @250mmO.C. TO C.L.**



AtSupport



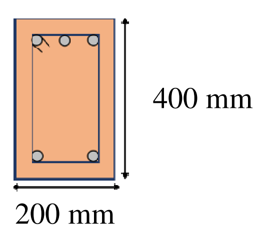
AtMidspan

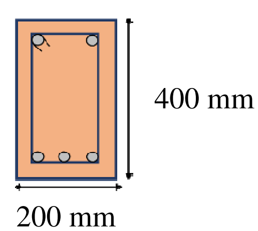
BEAM2FB-3

MaterialProperties:
Concrete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = both ends
continuousSpanLength=2.68 m
Width (b) = 0.2
mHeight (h) = 0.4
mFlexure bar Ø = 16
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use **200 mm. x 400mm.** section with **3 - 16mmΦ**top bars at support and **3 - 16mmΦ** bottom bars @midspan.Stirrups10mm:1@50mm10@100mm5@150mmREST @250mmO.C. TO C.L.





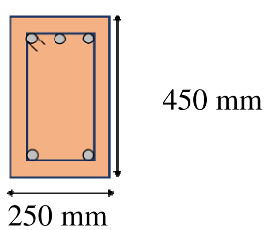
AtSupport **AtMidspan**

BEAM2FGB-1

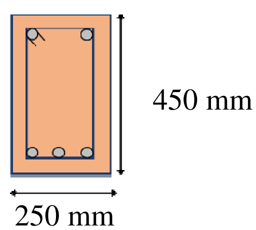
MaterialProperties:
Concrete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = one ends
continuousSpanLength=5.65 m
Width (b) = 0.25
mHeight (h) = 0.45
mFlexure bar Ø = 28
mmShear bar Ø = 12
mmTorsionbarØ=16m
m

Use **250 mm. x 450mm.** section with **3 - 16mmΦ**top bars at support and **3 - 16mmΦ** bottom bars
@midspan.Stirrups10mm:1@50mm10@100mm7
@150mmREST @250mmO.C. TO C.L.



AtSupport



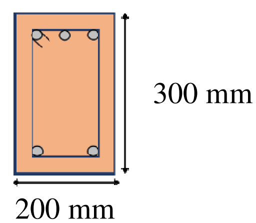
AtMidspan

BEAMRB-1

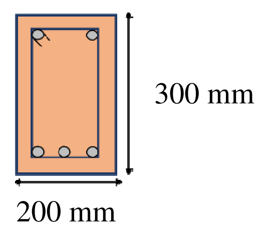
MaterialProperties: Conc
rete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = both ends
continuousSpanLength=3.7 m
Width (b) = 0.2
mHeight (h) = 0.3
mFlexure bar Ø = 16
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use **200 mm. x 300mm.** section with **3 - 16mmΦ**top bars at support and **3 - 16mmΦ** bottom bars
@midspan.Stirrups10mm:1@50mm10@100mm7@
150mmREST @250mmO.C. TO C.L.



AtSupport



AtMidspan

BEAMRB-2

MaterialProperties: Conc
rete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = both ends
continuousSpanLength=2.65 m
Width (b) = 0.2
mHeight (h) = 0.3
mFlexure bar Ø = 16
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use **200 mm. x 300mm.** section with **2 - 16mmΦ**top bars at support and **2 - 16mmΦ** bottom bars @midspan.Stirrups10mm:1@50mm10@100mm7 @150mmREST @250mmO.C. TO C.L.

300 mm 300 mm

200 mm 200 mm

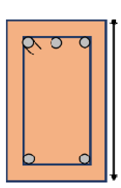
AtSupport **AtMidspan**

BEAMRGB-1

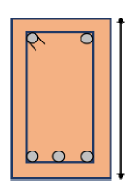
MaterialProperties:
Concrete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = One ends
continuousSpanLength=5.65 m
Width (b) = 0.25
mHeight (h) = 0.35
mFlexure bar Ø = 20
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use **250 mm. x 350mm.** section with **3 - 16mmΦ**top bars at support and **3 - 16mmΦ** bottom bars @midspan.Stirrups10mm:1@50mm10@100mm10 @125mmREST @250mm O.C.TO C.L.



350 mm



350 mm

250 mm 250 mm

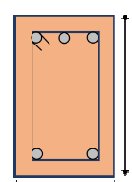
AtSupport **At**

MidspanBEAMGB

MaterialProperties:
Concrete f'c = 21
MPaReinforcing fy = 414
MPaStirrupfy=228 MPa

BeamData:
Span type = both ends
continuousSpanLength=3.65 m
Width (b) = 0.2
mHeight (h) = 0.4
mFlexure bar Ø = 16
mmShear bar Ø = 10
mmTorsionbarØ=16m
m

Use **200 mm. x 400mm.** section with **3 - 16mmΦ**top bars at support and **2 - 16mmΦ** bottom bars @midspan.Stirrups10mm:1@50mm10@100mm5@ 150mmREST @250mmO.C. TO C.L.



400 mm 300 mm

200 mm 200 mm

AtSupport **AtMidspan**

DESIGNOFCOLUMNS

Figure3.2.12:STAADResultfortheMaximumAxialForce(kN)forcolumn

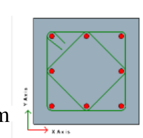
Figure3.2.13:STAADResultBeamGraphfortheMaximumAxialForce(kN)forcolumn

Figure3.2.14:STAAD ResultBeamGraphfor theMaximumMoment (kN-m)

Column1withPu=581.798kN(MaxAxial Force)
Column1withMaxMoment=51.4kN-m

NOTE: The maximum axial load that the columnshould carry is equal to 581.798 kN, some of thecolumnhasmomentslikethecolumnduringearthquakeloadapplication(Mu=51.4kN-m)please follow seismic provision of ties for columnforthesecases.

a. DesignParameters:
MaximumAxialLoad(Pu)=581.798kNAg =350 mm. x350mm.
f'c = 21 MPafy=414 MPa
RSB=16mm
LateralTies=10mmΦTry8-16mm;
As=1608.5sqm.



350mm

350mm

b.CheckforAxial LoadCapacity:

Pucap=1468.40N>PuthereforeSAFE!

c.No.ofRSBandSpacing
n=8-16mmbars
Use67mmspacing(Lo/3)atsupportandrestat175 mm O.C.

Therefore,use350mmx350mmcolumnsection with 8-16 mm. Φ RSB with 10mmΦ LateralTies spaced @50mm at Lo/3 at support and rest 180mm O.C.

DESIGNOFSLAB

Slab (S1)
Level = 3.4 m.
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 3.000 m
ImposedLoad = 2.500 kN/sqm
LiveLoad,Qk = 4.800 kN/sqm
SlabThickness = 120.000mmEffective
Depth along LX, Deffx=95.00mmEffective
Depth along LY, Deffy=85.000mmSelf-Weight = 3.000
kN/sqmTotalLoad, TL(ultimate) = 14.280
kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM (Unfactored)(kNm)	4.23	3.96	5.19	4.86
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 185	#10@ 175
Checkforstressinsteel				
Fst(N/sqmm)	114.4	120.15	140.49	139.9
fs,perm(N/sqmm)	184	184	184	184

Checkforstressin concrete				
Fst(N/sqmm)	4.08	4.57	5.01	5.5
fs,perm(N/sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				
Wcr(mm)	0.1481	0.1794	0.1819	0.199
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S2)
Level = 3.4m
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm.
LongSpan,Ly = 4.000 m.
ShortSpan, Lx = 3.000m
ImposedLoad = 2.500kN/sqm
LiveLoad,Qk = 4.800kN/sqmSlabThickness =120.000 mm
Effective Depth along LX, Deffx= 95.000 mm.Effective Depth along LY, Deffy= 85.000 mm.Self-Weight =3.000 kN/sqm
TotalLoad,TL(ultimate) =14.280kN/sqmSpan =2-Way
LoadCombination = 1.2 DL=1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM (Unfactored)(kNm)	4.23	3.96	5.19	4.86
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 185	#10@ 175
Checkforstressinsteel				
Fst(N/sqmm)	114.4	120.15	140.49	139.9
fs,perm(N / sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	4.08	4.57	5.01	5.5
fs,perm(N / sqmm)	9.31	9.31	9.31	9.31

CrackwidthCheck				
Wcr(mm)	0.1481	0.1794	0.1819	0.199
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S4)
Level = 3.4
mGradeof Concrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 3.000 m
ImposedLoad = 2.500kN/sqm
LiveLoad,Qk = 4.800kN/sqm
SlabThickness = 120.000 mm
EffectiveDepthalongLX,Deffx= 95.000 mmEffective DepthalongLY,Deffy =85.000 mmSelf-Weight = 3.000 kN/sqmTotalLoad,TL(ultimate) = 14.280 kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM (Unfactored)(kNm)	4.28	2.37	5.26	4.39
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 185	#10@ 185
Checkforstressinsteel				
Fst(N/sqmm)	115.76	71.85	142.17	133.43
fs,perm(N/sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	4.13	2.73	5.07	5.08
fs,perm(N/sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				
Wcr(mm)	0.1499	0.1073	0.184	0.1992
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S8)

Level = 3.4 m
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 3.000 m
ImposedLoad = 2.500kN/sqm
LiveLoad,Qk = 4.800kN/sqm
SlabThickness = 120.000 mm
Effective Depth along LX, Deffx = 95.000
mmEffective Depth along LY, Deffy = 85.000
mmSelf-Weight = 3.000
kN/sqmTotalLoad,TL(ultimate)= 14.280
kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM (Unfactored)(kNm)	2.6	3.96	4.82	4.86
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 185	#10 @1 75
Checkforstressinsteel				
Fst(N/sqmm)	70.25	120.15	130.46	139.9
fs,perm(N / sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	2.51	4.57	4.66	5.5
fs,perm(N / sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				
Wcr(mm)	0.0909	0.1794	0.1689	0.199
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S9)

Level = 3.4 m
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 3.000 m
ImposedLoad = 2.500kN/sqm
LiveLoad,Qk = 4.800kN/sqm
SlabThickness = 120.000
mmEffectiveDepthalongLX,Deffx=95.000
mmEffective
DepthalongLY,Deffy = 85.000 mmSelf-
Weight = 3.000
kN/sqmTotalLoad,TL(ultimate) = 14.280
kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @ Lx(Co nt)	Top @ Ly(Co nt)
BM (Unfactored)(kNm)	2.6	2.43	4.82	4.51
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 185	#10@ 180
Checkforstressinsteel				
Fst(N/sqmm)	70.25	73.78	130.46	133.46
fs,perm(N/sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	2.51	2.81	4.66	5.16
fs,perm(N/sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				
Wcr(mm)	0.0909	0.1102	0.1689	0.1946
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S15)

Level = 3.4 m
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 4.000 m
ImposedLoad = 2.500kN/sqm
LiveLoad,Qk = 4.800kN/sqm
SlabThickness = 120.000 mm
Effective Depth along LX, Deffx = 95.000
mmEffective Depth along LY, Deffy = 85.000
mmSelf-Weight = 3.000
kN/sqmTotal Load, TL (ultimate) = 14.280
kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM	5.56	3.42	6.83	6.34

(Unfactored)(kNm)				
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 165	#10@ 150
Checkforstressinsteel				
Fst(N/sqmm)	150.51	103.75	165.6	157.62
fs,perm(N/sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	5.37	3.95	6.31	6.77
fs,perm(N/sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				
Wcr(mm)	0.1948	0.1549	0.1937	0.1965
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S16)

Level = 3.4
Gradeof Concrete mC2
= 1
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 4.000 m
ImposedLoad = 2.500
LiveLoad,Qk = kN/sqm4.800
SlabThickness = kN/sqm
120.000 mm
Effective Depth along LX, Deffx = 95.000
mmEffective DepthalongLY,Deffy= 85.000
mmSelf-Weight = 3.000
kN/sqmTotalLoad,TL(ultimate)=14.280kN/sqm
Span = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM (Unfactored)(kNm)	3.42	3.42	6.34	6.34
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 185	#10@ 170	#10@ 150
Checkforstressinsteel				
Fst(N/sqmm)	92.42	103.75	158.24	157.62

fs,perm(N/sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	3.3	3.95	5.93	6.77
fs,perm(N/sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				
Wcr(mm)	0.1196	0.1549	0.19	0.1965
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S17)

Level = 3.4
mGradeof Concrete =
C21GradeofSte
el = Fy(276)
ClearCover = 20.000
mmLongSpan,Ly =
4.000mShortSpan,
Lx = 4.000
mImposedLoad = 2.500
kN/sqmLiveLoad,Qk = 4.800
kN/sqmSlabThickness= 120.000 mm
Effective Depth along LX, Deffx =
95.000mmEffective Depth along LY, Deffy =
85.000 mmSelf-Weight = 3.000
kN/sqmTotal Load, TL (ultimate) = 14.280
kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx (Cont)	Top @Ly (Cont)
BM (Unfactored)(kNm)	3.42	5.56	6.34	6.83
Cmin(mm)	20	20	20	20
Reinforcement	#10@ 185	#10@ 160	#10@ 170	#10@ 145
Checkforstressinsteel				
Fst(N/sqmm)	92.42	147.02	158.24	164.33
fs,perm(N/sqmm)	184	184	184	184
Checkforstressin concrete				
Fst(N/sqmm)	3.3	6.08	5.93	7.2
fs,perm(N/sqmm)	9.31	9.31	9.31	9.31
CrackwidthCheck				

Wcr(mm)	0.1196	0.1936	0.19	0.1992
WcrPerm(mm)	0.2	0.2	0.2	0.2

Slab (S28)

Level = 3.4 m
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 3.000 m
ImposedLoad = 2.500kN/sqm
LiveLoad,Qk = 4.800kN/sqm
SlabThickness = 120.000 mm
Effective Depth along LX, Deffx = 95.000
mmEffective Depth along LY, Deffy = 85.000
mmSelf-Weight = 3.000
kN/sqmTotal Load, TL (ultimate) = 14.280
kN/sqmSpan = 2-Way
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @Lx(Cont)	Top @Ly(Cont)
BM (Unfactored)(kNm)	2.6	5.83	4.82	0
Cmin(mm)	20	20	20	-
Reinforcement	#10@ 185	#10@ 155	#10@ 185	-
Checkforstressinsteel				
Fst(N/sqmm)	70.25	149.46	130.46	0
fs,perm(N / sqmm)	184	184	184	0
Checkforstressin concrete				
Fst(N/sqmm)	2.51	6.3	4.66	0
fs,perm(N / sqmm)	9.31	9.31	9.31	0
CrackwidthCheck				
Wcr(mm)	0.0909	0.1916	0.1689	0
WcrPerm(mm)	0.2	0.2	0.2	0

Slab(S31)

Level = 3.4 m
GradeofConcrete = C21
GradeofSteel = Fy(276)
ClearCover = 20.000 mm
LongSpan,Ly = 4.000 m
ShortSpan, Lx = 1.900 m
ImposedLoad = 1.000kN/sqm
LiveLoad,Qk = 4.800kN/sqm
SlabThickness = 100.000 mm
Effective Depth along LX, Deffx = 75.000
mmSelf-Weight = 2.500
kN/sqmTotalLoad,TL(ultimate) = 11.880
kN/sqmSpan = 1-Way
End Condition = EndSpan
LoadCombination = 1.2 DL= 1.6LL

	Bottom @Lx	Bottom @ Ly	Top @ Lx(Cont)	Top @ Ly(Cont)
BM (Unfactored)(kNm)	2.14	-	3	-
Cmin(mm)	20	-	20	-
Reinforcement	#10@ 150	-	#10@ 150	-
Checkforstressinsteel				
Fst(N/sqmm)	60.60	-	80.84	-
fs,perm(N/ sqmm)	184	-	184	-
Checkforstressin concrete				
Fst(N/sqmm)	2.8	-	3.92	-
fs,perm(N/sqmm)	9.31	-	9.31	-
CrackwidthCheck				
Wcr(mm)	0.0708	-	0.0991	-
WcrPerm(mm)	0.2	-	0.2	-

Design ofFootings

Designfor Spread Footing(IsolatedFooting–F1)

Figure3.2.15:Footing1Design

Figure3.2.16:Footing2Design

MaterialProperties:
Concrete f'c = 21
MPaReinforcing(fy)=414MPa

SoilProperties:
σall = 150
kPaY =18
kN/m

ColumnProperties:
Width = 0.35
m.Height=0.35
m.Location=Center-
mid

ReinforcingDetails:
Location:#
BotBarDia.:16.00A
longx=9
Alongy=9
Cover(mm.)=75.00

FootingProperties:
Length = 1.80
m.Width = 1.80
m.Thickness=0.35
m.Depth= 1.50 m.

Use **1.8 m x 1.8 m x 350 mm.** section with **9 - 16mmΦRSB** spacedat**190mm**bothways.

Design forSpreadFooting(IsolatedFooting–F2)

MaterialProperties:
Concrete f'c = 21
MPaReinforcing(fy)=414MPa

SoilProperties:
σall = 150
kPaY =18
kN/m

ColumnProperties:
Width = 0.35
m.Height=0.35
m.Location=Center-
mid

ReinforcingDetails:
Location:#
Bot Bar Dia.:
16.00Alongx=6
Alongy=6
Cover(mm.)=75.00

FootingProperties:
Length = 1.20
m.Width = 1.20
m.Thickness = 0.30
m.Depth= 1.50 m.

Use**1.2 m. x 1.2 m. x 350 mm.** section with **6 - 16mmΦRSB** spacedat**190mm**bothways.

COSTANALYSIS&ESTIMATE

Thischaptershowscostanalysisandestimatefortheproposedtwo-storeymulti-functional building from total material cost up tototallabor cost.

A.GeneralWorks	
Earthworks	470,920.00
Mobilization	77,000.00
LayoutStaking	21,120.00
Clearingand Grubbing	14,080.00
B.Architectural	
Roofing	526,050.00
Wood works&MetalCeiling	376,094.00

Doors	219,540.00
Windows	351,120.00
FinishingCarpentry	200,700.00
ArchitecturalFinish	1,121,044.00
Painting	154,130.00
RCMouldings/FabricatedMaterials	158,400.00
C.Structrual	
ConcreteWork	2,571,693.00
Reinforcement	1,013,028.00
SteelWorks	230,057.00
Scaffolding&formworks	95,700.00
D.Plumbing	
Sanitary	188,780.00
Water Line	63,301.00
E.Electrical	295,810.00
F.Manpower	3,005,594.52
G.Equipment	913,220.70
H.Misc.AndContingencies	811,336.70
TOTALCONSTRUCTIONCOST	**12,878,718.92**

EVACUATIONSYSTEMPLAN

Researchers provided a safe or secure andefficientevacuation system plan for the residenceon how to access the evacuation area having a risk-free route, emergency plans during a catastrophe,effectiveinformationdisseminationandpost-rehabilitationprocess withinthecommunity.

COMMUNITY-BASED EVACUATION SYSTEMPLANFORBARANGAYCALANGAIN,LUBAO, PAMPANGA:

Identificationof EvacuationCenters

This map will serve as a guide, to visualizethe locations of possible evacuation route in case ofemergenciesornaturalcatastrophesandprovidesafeandeasilyunderstooddirectionstoguidepeopletothemostappropriateassemblyareaforthecommunityorresidentsparticularlytothosewhobelongtodisaster-proneareaslikefloodingfromPurok4 -Purok7 of barangayCalangain.

Thethree-stopevacuationrouteshowsdirection on how to get to the three safe places ortemporary shelter in terms of disaster such as thechurch, the Calangain Elementary School, and thelocationoftheproposedmulti-functionalbuilding.

Figure3.6.1Calangain,LubaoEvacuationMap

CommunicationandWarning

Barangay must provide proper and promptwarningofanimpendingdisasterespeciallytovulnerablepopulationsothatpeoplecaneitherevacuate on the situation or take safety measuresconsideringthatduringdisasters,operational communicationservicesmaynotbeaccessible.Communication technology is required and viablewhen it comes to disastrous event, power lines andreceivingstationsmaybedamagedduringemergencysituation.

- Maintain surveillance on the water level in theriverorlandthatmay causeflooding inthebarangay and inform Barangay Disaster RiskReductionManagementCouncil(BDRRMC)or the Barangay Captain of Calangain, Lubao,Pampangaassoonaspossibleaboutitscondition so that the Barangay Disaster RiskReductionManagementCouncil(BDRRMC)cantakeimmediateaction;
- Providecorrect,timelyandaccurateinformationorwarningtothecommunityforanearly,promptandsafedecisiononwhatis

theappropriateactionoftheBDRRMCorevacuation of people living in dangerous area ifnecessary,evenwithoutthedisasteroranyothercontributinghazard or risk.

- Itisensuredthatthebarangaysystems,procedures, andcommunicationtoolsareappropriate, accurate, and organized especiallyinregardtoDisasterRiskReductionManagement(DRRM);

CoordinatesandcollaborateswithotherBDRRMCsub-committeesorlocalgovernmentagenciesregardingBarangayDisasterRiskReductionManagementCouncil(BDRRM)andespeciallyduringemergencies ordisasters.

In case of emergency, the following hotlinenumbers maybecontacted:

BarangayHall	0967-286-3326 0916-332-7548
PunongBarangay	0946-555-7487
BarangayOperation &Rescue Center	0919-618-1204
BarangayKagawad (Peaceand Order)	0929-711-6255
PNP(City/Municipality)	0917-827-1987
FireStation(City/Municipality)	0921-738-6374
Provincial Disaster Risk ReductionManagementOffice(PDRRMO)	0917-852-4201 (045)-455-0278 (045)-436-0341

Figure3.6.2:EmergencyHotlinesforBarangayCalangain

Early WarningSystem(EWS)

AnEarly WarningSystem(EWS)definedasamechanismorcollectionofproceduresintended to identify and alert people to impendingdangers or threats so that appropriate action can betaken to lessen their effects. Early Warning Systemsare frequently engagedin a variety of situations,suchaspandemics,industrialaccidents,naturaldisasters,and securitythreats

Its main goal is to give people, communities,and government timely information about cominghazardssotheycangetreadyandtakethenecessary precautionstolessenany potentialrisksor damages. Early warnings can be anything fromnoticesofdiseaseepidemics,technicalrisks,orsecuritythreatstoalertsaboutextremeweatherconditionslik etyphoon,floods,orvolcaniceruption.

Figure3.6.3:RainfallWarning(PAGASA)

Figure3.6.4:VolcanicEruptionWarning(PHILVOCS)

Preparationof EmergencyKits

The contents of a disaster kit or emergencysupplies can vary depending on the type of disasterandspecificcircumstances.However,itisreco mmendedtohavecertainessentialitemsonhandin caseof an emergencysuchas thefollowing:

- Water:Atleastonegallonofwaterperperson per day that can last for at least threedays.
- Food:Havingnon-perishablefooditemssuch as canned goods, noodles, and biscuitseasilyaccessible canbeadvantageous.
- Firstaidkit:Basicfirstaidkitshouldcompriseof bandages,gauze,antisepticwipes,and othermedicalsupplies.
- Flashlightandwhistle:Duringapoweroutage, flashlight becomes essential as it isuse in providing illumination in the absenceofelectricity.
- Battery-powered radio:Thiscan helpyoustayinformedaboutthelatestnewsand updatesduringadisaster.
- Extrabatteries:Ifyouhaveelectronicdevices such as flashlights or radios, makesureto have extrabatteries on hand.
- Personalhygieneitems:Thiscanincludeitemss uchas handsanitizer andtoiletries.
- Cash:IncaseATMsandcreditcardmachines are not working during a disaster,it'sa good ideato havesomecash onhand.
- Important documents: To ensure safety andpreservationofimportantdocumentslikeid entification,insurancepolicies,andmedical records, it is advisable to store themin a container that is both waterproof andfireproof.
- Emergency contact list: Make sure to have alist of emergency contacts, including phonenumbersandaddresses,incasecommuni cationlines are down.

It's important to regularly check and update yourdisaster kit, and to have a plan in place for what todo in case of an emergency. Below is the preparedposter for emergency kit to increase awareness fortheresidentsofbarangayCalangaincaseofemerge ncies

Figure3.6.5:EmergencyKitPoster

TrainingandEducation

InthePhilippines,theNationalDisasterResilienceMonthisobservedeveryJuly,whichserves as an opportunity for various stakeholders toraiseawarenessondisasterriskreductionandmanagement. During this month, various activities,training, and drills related to disaster preparednessmaybeconducted.

Additionally,thePhilippinesisvulnerabletotyphoonsandtropicalstorms,whichtypicallyoccurfromJunetoNovember.Thus,disasterpreparedness seminars and drills may be conductedin the months leading up to the typhoon season toensurethatindividuals,communities,andorganizations are equipped to respond in case of adisaster. Earthquakedrillsmustalsobeconductedinthecountry, particularlyinareasthatarepronetoearthquakes.PhilippinesbelongstotheareaofPacific Ring of Fire, which means that it is at highriskofearthquakes andvolcanic eruptions.

It's important to note that disaster preparednessshould be a year-round effort, and individuals andcommunities should stay informed and educated onpotentialrisksandhowtorespondincaseofadisaster.

- Earthquakedrill:Inearthquake-proneareas,people are trained to "drop, cover, and hold on"duringanearthquakedrill to preparethem for
- theshakingandpotential aftershocks.
- Flood evacuation plan: Communities in flood-prone areas are educated on the risks and giveninstructions on how to evacuate safely in case ofaflood.
- Firesafetytraining:Itinvolvesinstructingindividualsonfirepreventiontechniques,properusageoffireextinguishers,andsafeevacuationproceduresinthe eventofa fire.
- *Cardiopulmonary resuscitation (*CPR) and firstaid training: People are taught how to perform(CPR) and basic first aid techniques in case of amedicalemergency.
- Pandemic response training: Healthcare workersand public health officials may receive trainingonhowtorespondtoapandemic,includinghowtohelppatients,andhowtoimplementpublic health measures such as quarantine andcontacttracing.
- Mentalhealthfirstaidtraining:Peoplearetrainedon howtorecognizesignsofmentalillness or distress in others and how to provideinitialsupportuntilprofessionalhelpcanbe obtained.

Ingeneral,disasterpreparednesstrainingand education can help people understand the risks,develop emergency plans, and be better equipped torespondin caseofanemergency.

Figure3.6.6:FirePreventionMonthPoster

Figure3.6.7:EarthquakeDrillPoster

EvacuationProcedures

Emergencyproceduresarepredeterminedsets of steps or protocols that should be followed inthe event of an emergency. They offer a systematicand planned way to deal with crises and lessen theireffects.Organizationsandinstitutionsgenerallycreate emergency plans to maintain people's healthandsafety,protectproperty,andkeepregularactivitiesas unaffectedas possible.

Dependingonthesortofemergency,thesetting in which it occurs, and the organization orindustryconcerned,severalemergencyprotocolsmaybeused.Emergencyprotocolsfrequentlyincludesecuritythreatresponseplans,hazardousmaterialspillresponseprotocols,severeweatherresponse protocols, medical emergency protocols,andfireevacuation plans.

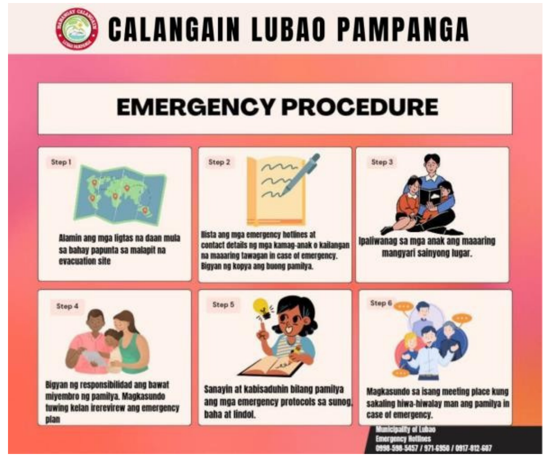


Figure3.6.8:EmergencyProcedurePoster

III. CONCLUSION

Two-storey multi-functional building designof the barangay Calangain, Lubao, Pampanga willgreatlyhelpespeciallyasaflexiblestructureinterms of its purposes or usages; it may serve as atemporaryshelterorevacuationareaincaseofemergencyorwhennaturaldisasteraffectthebarangay,aneventhallfordifferentcommunityprograms,seminars andbarangay meeting,Officeof the Senior Citizen Affairs for protecting as wellaspromotingthenecessitiesofseniorcitizens,storagefortheequipmentofthebarangay,andeducationalfacilitiesfortheconsumptionofelementarystudentsandkindergarten.Theflexibilityofthebuildingdoesnotonlybecomeadvantageousforthecommunityservicesandemergency preparedness it offers but also beneficialfor it is cost-effective and help in conserving landarea.

The architectural plan of the building wascrafted in AutoCAD concerning the data gatheredbothfromthemunicipalityofLubaoandthebarangay Calangain. The exterior design was basedon the aesthetic of the barangays from the locality.CodesandprovisionsoftheNationalStructural Code of the Philippines (NSCP) 2015 were utilizedin designing the structure through the aid as well oftheStructuralAnalysisandDesignsoftware(STAAD) to check if the design is safe for variousloads.Theproposedtwo-storymulti-functional building design for barangay Calangain has a totalamountofPhp12,878,718.92intermsoftheconstruction materials which includes the electricaland plumbing of the structure as well as the laborcost. The evacuation system plan was thoroughlyplannedtoraisetheawarenessoftheresidentsthrough posters and suggested evacuation routes forthebarangay.

ProposedMulti-functionalbuildingcouldbeone of the important facilities within the barangayserving different community services and structuralemergencypreparednessforvarioushazards andcalamities.Therecommendationsfortheimprovementsare as follows:

1. Mechanicalworksandplansaswellasstormand sanitaryandfireprotectionsystemshouldbeconducted inthefacility.
2. Soil bearing capacity and soil type throughgeotechnical soil investigation in the localeof the study to verify the quality of the soilnecessaryformaintainingthestructure'sstability.
3. Modelinglandscapeforfunctionalandbeautifulspaces foroutdoor living.
4. Properly designed and constructed parkingarea for the consumptionof vehicles(suchas ambulance, barangay vehicle, tricycle etc.foramassgathering)
5. ProjectEvaluationandReviewTechnique(PERT) and Critical Path Method (CPM) forproject management and task organization,aidingin project planningandcontrol.

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